FIFTEENTH REPORT

OF

THE MICHIGAN ACADEMY OF SCIENCE

CONTAINING AN ACCOUNT OF THE ANNUAL MEETING

HELD AT

ANN ARBOR, APRIL 2, 3 AND 4, 1913.

PREPARED UNDER THE DIRECTION OF THE COUNCIL

BY

RICHARD DE ZEEUW

SECRETARY

BY AUTHORITY

LANSING, MICHIGAN
WYNKOOP HALLENBECK CRAWFORD CO., STATE PRINTERS
1913

LETTER OF TRANSMITTAL.

To Hon. Woodbridge N. Ferris, Governor of the State of Michigan:

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

Respectfully,
Richard de Zeeuw,
Secretary.

East Lansing, Michigan, May, 1913.

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OFFICERS FOR 1913-1914.

President, ALEXANDER G. RUTHVEN, Ann Arbor.
Secretary-Treasurer, RICHARD DE ZEEUW, East Lansing.
Librarian, ALEXANDER G. RUTHVEN, Ann Arbor.

VICE-PRESIDENTS.

Agriculture, F. A. SPRAGG, East Lansing.
Geography and Geology, WALTER P. HUNT, Ann Arbor.
Zoology, BERTRAM G. SMITH, Ypsilanti.
Sanitary and Medical Science, ROBERT L. DIXON, Lansing.
Botany, ERNST ATHEARN BESSEY, East Lansing.
Economics, FRANK T. CARLTON, Albion.

PAST PRESIDENTS.

DR. W. J. BEAL, Amherst, Mass.
Professor W. H. SHERZER, Ypsilanti.
BRYANT WALKER, ESQ., Detroit.
Professor V. M. SPAULDING, Tucson, Ariz.
DR. HENRY B. BAKER, Holland, Mich.
Professor JACOB REIGHARD, Ann Arbor.
Professor CHAS. E. BARR, Albion.
Professor V. C. VAUGHAN, Ann Arbor.
Professor F. C. NEWCOMBE, Ann Arbor.
DR. A. C. LANE, Tufts College, Mass.
Professor W. B. BARROWS, East Lansing.
DR. J. B. POLLOCK, Ann Arbor.
Professor M. S. W. JEFFERSON, Ypsilanti.
DR. CHAS. E. MARSHALL, East Lansing.
Professor FRANK LEVERETT, Ann Arbor.
DR. F. G. NOVY, Ann Arbor.
Professor WM. E. PRAEGER, Kalamazoo.
DR. E. C. CASE, Ann Arbor.

COUNCIL.

The Council consists of the above-named officers and all Resident Past-Presidents.

MEMBERSHIP OF THE MICHIGAN ACADEMY OF SCIENCE, MAY, 1912.

(Charter members are marked with an asterisk.)

This list does not contain the names of those who have not paid any dues for two years or more. Failure to pay dues is taken as an indication that it is desired to have the membership lapse. See Chap. I, Sec. 3 of the By-laws of the Michigan Academy of Science.

RESIDENT MEMBERS.

A

Adams, H. C., Ann Arbor.
Alexander, S., 706 Seventeenth St., Detroit.
Allen, R. C., Lansing.
Allen, Ruth F., East Lansing.
Anderson, A. Crosby, East Lansing.
Andrews, A. W., 186 Lathrop Ave., Detroit.

B

Baker, H. Burrington, Museum, Ann Arbor.
Baker, Howard B., 281 Warren Ave., W. Detroit.
*Barr, Chas. E., Albion.
*Barrows, Walter B., East Lansing.
Bean, Fred A., 659 Townsend Ave., Detroit.
Behrens, C. A., 620 Church St., Ann Arbor.
Bennett, C. W., 58 Hanchett St., Coldwater.
Bennett, Ella, 541 Elizabeth St., Ann Arbor.
Bessey, Ernst A., East Lansing.
Bigelow, S. Lawrence, Ann Arbor.
Bissell, John Henry, 525 Bank Chambers, Detroit.
Blain, Dr. Alexander W., 1105 Jefferson Ave. E., Detroit.
Bouyoucos, Geo. J., East Lansing.
Brenton, S., 121 Alexandrine Ave., Detroit.
Bricker, J. I., Saginaw, W. Side.
Brotherton, Wilfred A., Rochester.
Brown, Chas. W., East Lansing.
Burnham, Ernst, 509 S. Rose St., Kalamazoo.
Burt, Frederick, East Lansing.
Butler, Jefferson, 1117 Ford Bldg., Detroit.

C

Cahn, Mary, 443 Stanton Ave., Detroit.
Campbell, Edward de Mille, 1555 Washtenaw Ave., Ann Arbor.
Carlton, Frank T., Albion.

Carney, Frank, Ann Arbor.
Case, E. C., Ann Arbor.
Christian, E. A., Pontiac.
Clark, R. W., 944 Greenwood Ave., Ann Arbor.
Clark, L. T., c|o Parke Davis & Co., Detroit.
Cole, Harry N., 702 Forest Ave., Ann Arbor.
Collin, Rev. Henry P., 98 E Chicago St., Coldwater.
Conover, L. Lenore, 114 Marston Court, Detroit.
Cook, Chas. W., Ann Arbor.
Cooley, Chas. H., Ann Arbor.
Coons, G. H., East Lansing.
Cope, O. M., 1327 Wilmot St., Ann Arbor.
Cummins, Harold, 701 Trimble Ave., Kalamazoo.

D

Davies, Murig L., Bay City.
Davis, C. A., Washington, D. C.
Denton, Wm., 31 E. Elizabeth St., Detroit.
de Zeeuw, Richard, East Lansing.
Dietz, Ada K., 651 Champlain St., Detroit.
Dillon, Florence G., 432 Cadillac Ave., Detroit.
*Dodge, C. K., Port Huron.
Dunbar, Frances J., 610 So. Ingalls St., Ann Arbor.

E

Edwards, S. Fred, Guelph, Ontario.

F

*Farwell, Oliver A., 449 McClellan Ave., Detroit.
Ferry, Newell S., 430 Montclair Ave., Detroit.
Freeman, O. W., Ann Arbor.
Frey, Chas. N., South Haven, Mich.
Friday, David, Ann Arbor.
Frostic, F. W., St. Charles.

G

Gates, Frank C., 524 Elm St., Ann Arbor.
Gilchrist, Maude, East Lansing.
Giltner, Ward, East Lansing.
Glaser, O. C., Ann Arbor.
Gleason, H. A., Ann Arbor.
Goddard, Mary A., Ypsilanti.

H

Hallman, E. T., East Lansing.
Hamilton, O. R., Lansing.
Hamilton, S. M., 1513 So. University Ave., Ann Arbor.
Hamilton, Walton H., Ann Arbor.
Harvey, Caroline C., 51 Winder St., Detroit.

Harvey, L. H., Kalamazoo.
Harvey, N. A., Ypsilanti.
Haug, Bernice L., 301 W Forest Ave., Detroit.
Hedrick, Wilbur O., East Lansing.
Hegner, R. W., Ann Arbor.
Hibbard, R. P., East Lansing.
Hill, C. L., 327 E. Huron St., Ann Arbor.
Hobbs, Wm. H., Ann Arbor.
Hollister, Wesley O., 650 Clinton Ave., Detroit.
Hood, G. W., East Lansing.
Hore, R. E., Houghton.
Houghton, E. Mark, 130 Longfellow Ave., Detroit.
Hubbard, Lucius L., Houghton.
Huber, G. Karl, 1330 Hill St., Ann Arbor.
Hunt, Walter F., Ann Arbor.
Hus, Henri, Ann Arbor.

I

Itano, Arao, East Lansing.

J

Jeffery, J. A., East Lansing.
Jefferson, M. S. W., Ypsilanti.
Jodidi, Samuel L., Ames, Iowa.
Jones, Edward D., Ann Arbor.

K

Kauffman, C. H., Ann Arbor.
Kern, Kate, Bay City.
King, Mrs. Francis, Orchard House, Alma.
King, Frances, Alma.
Kleinstück, Carl G., Saxonia Farm, Kalamazoo.
Koch, Catherine, Kalamazoo.
Kraus, E. H., Ann Arbor.

L

Lancashire, Mrs. J. H., Manchester, Mass.
Lane, Alfred C., Tufts College, Mass.
LaRue, Geo. R., Ann Arbor.
Ledyard, Edgar M., Los Banos, P. I.
Leverett, Frank, Ann Arbor.
*Lombard, Warren P., 805 Oxford Road, Ann Arbor.
Lyons, A. B., 102 Alger Ave., Detroit.

M

McCain, Frederick E., 828 Ford Bldg., Detroit.
McCracken, Wm., Kalamazoo.
MacCurdy, Hansford, Alma.
McDaniel, Eugenia, East Lansing.

MacKay, Sarah D., Ann Arbor.
MacMillan, J. A., 666 Woodward Ave., Detroit.
McNall, Jessie, Hastings.
Magers, S. D., Ypsilanti.
Mains, E. B., 1430 Hill St., Ann Arbor.
*Manton, W. P., 32 Adams Ave. W., Detroit.
Marshall, Chas. E., East Lansing.
Marti, Wm., East Lansing.
Martin, Helen M., 66 North Ave., Battle Creek.
Merrill, C. H., 349 Chene St., Detroit.
Miller, E. C. L., 66 Rosedale Court, Detroit.
Miller, Herbert A., Olivet.
Mitchell, James E., Alma.
Musselman, Harry, East Lansing.
Myers, Jesse J., East Lansing.

N

Nattress, Thos., Amherstburg, Ont.
Nelson, Chas. D., South Haven.
*Newcombe, F. C., Ann Arbor.
Newcomb, Wm. W., 34 Mt. Vernon Ave., Detroit.
Northrop, Zae, East Lansing.
*Novy, Frederick G., Ann Arbor.

O

Obee, Chas. W., Adrian.
Okkelberg, Peter O., 1216 So. University Ave., Ann Arbor.

P

Parkins, A. E., Ypsilanti.
Parry, Carl E., Ann Arbor.
Patten, A. J., East Lansing.
Pearse, A. S., Madison, Wis.
Perkins, W. L., 228 So. Thayer St., Ann Arbor.
Pettee, Edith E., 83 Harper Ave., Detroit.
Pettit, R. H., East Lansing.
Phelps, Jessie, Ypsilanti.
Philbrick, Edwin D., 171 Kirby Ave. N., Detroit.
Pieters, Adrian J., 506 E. Jefferson St., Ann Arbor.
Pollock, J. B., Ann Arbor.
Povah, Alfred H., 341 E. Jefferson St., Ann Arbor.
Praeger, Wm. E., 421 Douglas Ave., Kalamazoo.

Q

Quick, Bert E., Ann Arbor.

R

Reeves, Cora D., Manistee.
*Reighard, Jacob, Ann Arbor.

Robinson, C. S., East Lansing.
Roth, Filibert, Ann Arbor.
Ruthven, A. G., Ann Arbor.
Ryder, Edward H., East Lansing.

S

Scott, D. R., 1814 Wilmot St., Ann Arbor.
Scott, I. D., Ann Arbor.
Seaman, A. E., Houghton.
Shafer, Geo. D., East Lansing.
Shaw, Robert S., East Lansing.
*Sherzer, W. H., Ypsilanti.
Shoesmith, V. M., East Lansing.
Shull, A. F., 935 Greenwood Ave., Ann Arbor.
Smalley, H. S., Ann Arbor.
Smith, Bertram G., Ypsilanti.
Smith, Richard A., Lansing.
Sperr, F. W., Houghton.
Spragg, F. A., East Lansing.
Sprague, R. F., Greenville.
Spurway, Chas. H., East Lansing.
Staley, Ethel M., 525 Walnut St., Ann Arbor.
*Stearns, Frances, 43 Terrace Ave., Grand Rapids.
Stewart, Walter W., 1345 Wilmot St., Ann Arbor.
*Strong, E. A., Ypsilanti.
Sutton, John M., 100 Englewood Ave., Detroit.
Swales, B. H., Grosse Isle.

T

Taverner, P. A., 55 Elmhurst Ave., Detroit.
Taylor, Frank B., 548 Home Ave., Fort Wayne, Ind.
Taylor, Fred M., Ann Arbor.
Taylor, Rose M., East Lansing.
Temple, C. E., Ann Arbor.
Thompson, Bertha E., East Lansing.
Thompson, Crystal, Ann Arbor.
Thompson, Elizabeth L., 520 E. Jefferson St., Ann Arbor.
Thompson, Helen B., Ann Arbor.
Turner, R. A., 8 West St., Hillsdale.

V

Vestal, A. G., Boulder, Colo.
Vohland, M. L., 637 So. Thayer St., Ann Arbor.

W

Waeger, Max Christian, 365 Pine St., Detroit.
*Walker, Bryant, 205 Moffat Bldg., Detroit.
Walsworth, Adelbert M., Corunna.
Wentworth, W. A., East Lansing.
Wenzel, Orrin J., 636 So. Thayer St., Ann Arbor.

Wetmore, Mary, Allegan.
*Wheeler, E. S., 76 Delaware Ave., Detroit.
White, O. K., East Lansing.
Whitney, W. L., 108 Owen St., Saginaw.
Williams, C. B., 214 Stewart Ave., Kalamazoo.
Williams, G. S., Ann Arbor.
*Willson, Mortimer, Port Huron.
Wood, N. A., Ann Arbor.
Wood, L. H., Kalamazoo.

CORRESPONDING MEMBERS.

Barlow, Bronson, 207 Ninth St., S. W. Washington, D. C.
Cooper, Wm. S., North Yakima, Wash.
*Davis, Chas. A., 1733 Columbia Road, Washington, D. C.
Edwards, S. F., Guelph, Ont., Canada.
Grose, Harlow D., 302 Osgood St., Joliet, Ill.
Holt, W. P., 1004 Jefferson Ave., Toledo, Ohio.
Jodidi, Samuel L., Ames, Iowa.
Kempster, Harry, Columbia, Missouri.
*Lane, Alfred C., Tufts College, Mass.
Lancashire, Mrs. J. H., Manchester, Mass.
Loew, F. A., Obee P. O., Huntington, Ind.
Nattress, Thomas, Amherstburg, Ontario.
Pearse, A. S., Madison, Wis.
Taylor, Frank B., Fort Wayne, Ind.
Thomas, Leo, Troy, Ohio.
Winter, Orrin B., Geneva, N. Y.
Wuist, Elizabeth, Fifth and Garfield Sts., Dayton, Ohio.

MINUTES OF THE MEETINGS.

COUNCIL MEETING.

Dec. 20, 1912.

The meeting was called to order by President Case.

The members present were: Newcombe, Barrows, Case, Walker, Bessey, Allen and the Secretary.

A motion was made by Professor Newcombe that the secretary, Professor Barrows and Professor Bessey be appointed as a committee to select a new binding for the Annual Report of the Academy. Seconded. Carried.

The committee that was appointed to look into the possibility of forming a new physics-chemistry section had nothing to report officially. However, President Case had investigated the matter personally. Professor Newcombe made a motion that President Case's unofficial report be substituted for that of the committee. Seconded. Carried.

Professor Case reported that the physics people were in favor of forming a new section but that the chemists held back, since the only people who would belong to the new section were already members of the local section of the American Chemical Association.

A motion was made that the Council recommend that anyone publishing in the Academy Report be not given any rebate for reprints. Seconded. Carried.

A motion was made by Dr. Bessey that the secretary be given an allowance of $75.00 in consideration of such expenses as he may incur in paying stenographer, clerical help, proof-reader and such other help as may be needed. Seconded. Carried.

Professor Bessey made a motion that the Committee on Policy be requested to get its report relative to the summer session of the Academy in shape for the first Council Meeting at the Annual Meeting of the Academy. Seconded. Carried.

A motion was made by Mr. Walker to leave the time of the Spring Meeting to the Local Committee. Seconded. Carried.

Professor Newcombe made a motion that the president and the local committee be empowered to determine on a possible public speaker and the time when a public address, if any, is to be given. Seconded. Carried.

A motion was made to adjourn.

RICHARD DE ZEEUW,
Secretary.

COUNCIL MEETING.

April 2, 1913, 1:00 p. m.

The meeting was called to order by President Case.

Members present were: Sherzer, Newcombe, Ruthven, Case, Walker, Reighard, Barr and the Secretary.

The minutes of the meeting of Council on the 20th of Dec. 1912, were read and approved.

Professor Newcombe reported for the committee that had been appointed to confer in regard to the advisability of having a summer meeting of the Academy. The committee did not feel justified in recommending it. However, any body of members desiring to meet during the summer are recommended for recognition by the Academy as a whole.

A motion was made that Case, Sherzer and Leverett be the official delegates of the Academy to the XIIth International Congress of Geology. Seconded. Carried.

Professor Newcombe made a motion that Dr. Jos. Zawodny be notified that there is no vacancy as corresponding member of the Michigan Academy of Science. Seconded. Carried.

Moved that the following be recommended as members of the Academy: Mary Cahn, Edwin D. Philbrick, Adelbert M. Walsworth, Max Christian Waeger, William A. Perkins and William Denton.

A motion was made to adjourn.

RICHARD DE ZEEUW,
Secretary.

BUSINESS MEETING.

April 2, 1913, 2:00 p. m.

The meeting was called to order by President Case.

Professor Leverett moved that the people recommended by the council as members be accepted as named. Seconded. Carried.

Professor Newcombe made a motion that the suggestion of Dr. Ruthven in regard to the change in the method of publication of the Annual Report of the Academy be put over to the next meeting of council. Seconded. Carried.

RICHARD DE ZEEUW,
Secretary.

COUNCIL MEETING.

April 3, 1913, 8:00 a. m.

The meeting was called to order by President Case.

The members present were: Case, Ruthven, Newcombe, Sherzer, Walker, Barr, Leverett, Okkelberg and the Secretary.

There was an informal discussion on the matter of publication.

A motion was made by Professor Sherzer that Dr. Ruthven and Dr. Newcombe be appointed as an investigating committee. Seconded. Carried.

A motion was made to adjourn.

RICHARD DE ZEEUW,
Secretary.

COUNCIL MEETING.

April 4, 1913, 8:00 a. m.

The meeting was called to order by President Case.

The members present were: Leverett, Newcombe, Allen, Barr, Okkelberg, Case, Taylor and the Secretary.

A motion was made by Professor Newcombe that the Academy pay Professor Chamberlain $15.00 to pay his expenses incident to his coming to Ann Arbor to give an address at the meeting of the Academy of Science. Seconded. Carried.

The Academy Council nominated the following as officers for the ensuing year:

President .... ALEXANDER G RUTHVEN.
Vice Presidents:—
Section of Sanitary and Medical Science .... R. L. DIXON.
Section of Botany .... E. A. BESSEY.
Section of Zoology .... B. G. SMITH.
Section of Geology and Geography .... WALTER P. HUNT.
Section of Economics .... F. T. CARLTON.
Secretary-Treasurer .... RICHARD DE ZEEUW.

A motion was made by Professor Barr to recommend the following members of the Academy of Science: D. A. Tucker, O. M. Cope, W. A. Roth, B. G. Smith, B. A. Barber, B. E. Quick, M. L. Vohland, E. B. Mains, A. Vestal, F. Carney, F. Gaige, E. T. Hallman, L. R. Himmelberger and O. W. Freeman.

There was an informal discussion as to the time of meeting of the Academy. Professor Barr moved that the time of meeting of the Academy be changed to the Friday and Saturday after Thanksgiving. Seconded. Carried.

Professor Newcombe made a motion that the Council ask permission of the Academy that the matter in regard to changing the character of the Academy publication and financing the same be referred to it with power to act. Seconded. Carried.

Professor Newcombe moved that the Secretary be requested to notify every Vice President by Nov. 1 to correspond with such people as are desirable to participate in their sectional meetings. Seconded. Carried.

Professor Newcombe moved that the President and the Secretary be given power to make such arrangements as are necessary for meeting contrary to the constitution. Seconded. Carried.

A motion was made to adjourn.

RICHARD DE ZEEUW,
Secretary.

GENERAL BUSINESS MEETING.

April 4, 1913, 9:00 a. m.

The meeting was called to order by President Case.

Professor Barr moved that the Academy accept the report of the

Council in regard to the reimbursement of Professor Chas. G. Chamberlain. Seconded. Carried.

Professor Barr moved that the officers as nominated by the Council be elected to office. Seconded. Carried.

Mr. Butler moved that all names of the people recommended for membership to the Academy by the Council be accepted as read. Seconded. Carried.

The name of W. Denton was added by the Academy.

A motion was made by Dr. Ruthven that the recommendation of the Council in regard to the change of time of meeting of the Academy be adopted. Seconded. Carried.

Mr. Butler moved that the Council be granted the power asked for in regard to the matter of publication. Seconded.

Professor Kraus moved as an amendment that no increase in dues be made. And, in case such an increase should be necessary, that it be referred to the Academy.

Professor Barr moved to substitute that the matter be carried through in case no increase in dues is necessary. Seconded. Carried.

The Librarian read his report for the year.

Professor Reighard made a motion that the report of the Librarian be accepted. Seconded. Carried.

The treasurer read his report.

Professor Kraus moved that Mr. Scott and Mr. Butler be appointed as Auditing Committee. Seconded. Carried.

Because the Auditing Committee was unable to report at the time, Professor Reighard moved that the Auditing Committee be continued in office and report at the next Annual Meeting. Seconded. Carried.

RICHARD DE ZEEUW,
Secretary.

REPORT OF THE TREASURER

OF THE

MICHIGAN ACADEMY OF SCIENCES.

Expenditures since Dec. 22, 1911:

1912:

Jan. 9.—Postage	$ 2.90
Feb. 12.—Mailing Preliminary Reports	3.20
Feb. 16.—Lawrence & Van Buren Ptg. Co.	4.00
Feb. 17.—Drayage (B. F. Churchill)	.50
Mar. 2.—Drayage (B. F. Churchill)	.20
Mar. 19.—R. M. Roland	2.25
Mar. 23.—Lawrence & Van Buren Ptg Co.	21.00
Mar. 23.—Assistance in mailing programs	1.00
Mar. 23.—Postage	1.65
Apr. 1.—Drayage (B. F. Churchill)	.30
Apr. 4.—Postage	6.46

Apr. 4.—A. A. Michelson (Honorarium)	$25.00
Apr. 20.—Postage	4.26
Apr. 27.—Postage	2.00
May 3.—Drayage (B. F. Churchill)	.20
May 4.—3000 Letterheads	12.55
May 17.—Drayage (B. F. Churchill)	.10
Apr. 21.—Dr. Ruthven (for window cards, signs and janitor)	6.85
May 31.—Postage	.50
Sept. 18.—Express	.25
Oct. 23.—Postage	.18
Oct. 26.—Postage	.25
Nov. 22.—Postage	2.29
1913:	
Jan. 20.—Postage	6.26
Mar. 5.—Postage	.05
Mar. 10.—Postage	.03
Feb. 28.—Reprints	31.50
Mar. 12.—R. M. Roland	3.00
Mar. 18.—Postage	4.52
Mar. 19.—R. M. Roland	.75
Total Expenditures	$137.36
Receipts since Dec. 22, 1911:	
Dues from members	$178.00
For back Reports	3.50
For Reprints	27.56
Total	$209.06
Received from Former Treasurer	68.29
Total Receipts	$277.35
Expenditures	137.36
Balance, April 1, 1913	$139.99

GENERAL PROGRAM.

Wednesday, April 2.

1:00 p. m., Council Meeting, Geological Laboratory, First Floor of Museum.

The Committee on General Policy is urged to be present at this meeting.

2:00 p. m., First Meeting of the Academy, Museum Lecture Room.

2:30 p. m., General Session of the Academy. The general public is cordially invited to attend this meeting. Presidential Address, by Professor E. C. Case, West Lecture Room, Physics Building. Title: The Geological History of Michigan. Reports on the work of the Michigan Geological and Biological Survey, by R. C. Allen, Director, and A. G. Ruthven, Chief Naturalist.

PAPERS ON EUGENICS.

Eugenics—By Professor Victor C. Vaughan, Department of Medicine, University of Michigan, 30 minutes.

The Biological Aspect of Eugenics—By Professor A. Franklin Shull, Department of Zoology, University of Michigan, 30 minutes.

8:00 p. m., Public Address, in West Lecture Room, Physics Building, "Travels in Mexico," by Professor Charles J. Chamberlain, Department of Botany, University of Chicago. The general public is cordially invited.

9:00 p. m., The Research Club of the University of Michigan will give a smoker to the members of the academy in the rooms of the University Club, Memorial Building, immediately after the public address.

Thursday, April 3.

8:00 a. m., Council Meeting, Geological Laboratory, First Floor of Museum.

9:00 a. m., Meetings of Sections. (For places of meeting see programs of Sections.)

12:30 p. m., The Women's Research Club, of the University of Michigan, will entertain the visiting women at an informal luncheon. Members and the wives of members are cordially invited to attend this luncheon.

1:30 p. m., Meetings of Sections for the reading of papers and election of Vice-presidents.

Friday, April 4.

8:00 a. m., Council Meeting, Geological Laboratory, First Floor of Museum.

9:00 a. m., General Business Meeting and Election of Officers, Museum Lecture Room.
10:00 a. m., Sections which have not completed the reading of papers may meet again at this time.
12:00 m., Luncheon for Biologists, Botanical Laboratories.

SECTION OF GEOLOGY AND GEOGRAPHY.

R. C. ALLEN, CHAIRMAN.

RUSSELL SEMINARY ROOM, MUSEUM BUILDING.

Thursday, April 3rd, 9:00 a. m.

1. Dr. Howard B. Baker. Origin of Continental Forms, IV. 20 minutes.
2. Mr. R. A. Smith. Studies in Structure and Stratigraphy in the Saginaw Valley in Relation to Occurrences of Oil and Gas. 15 minutes.
3. Prof. E. C. Case. Climatic Variation in Permian Time as Recorded in Red Beds of Texas. 20 minutes.
4. Prof. W. H. Sherzer. The Discovery of Illinoian Till in the Detroit River Region. 15 minutes.
5. Mr. Frank B. Taylor. The History of Lake Erie in Post-Glacial Time. 20 minutes.
6. Prof. E. H. Kraus. Further Studies on the Variation of the Angle of the Optic Axes, with Temperature. 30 minutes.

2:00 p. m.

7. Prof. W. F. Hunt. Vanadiferous Pyroxenes from Libby, Montana. 15 minutes.
8. Prof. Frank Carney. Some Pro Glacial Lake Shore Lines of the Bellevue Quadrangle, Ohio. 15 minutes.
9. Mr. R. C. Allen. Some Problems in Stratigraphy and Correlation of the Pre-Cambrian Rocks of Michigan. 25 minutes.
10. Mr. Frank Leverett. (a) Results of Levelling along the Algonquin Beach in the Northern Peninsula in 1912. 10 minutes.
    (b) Order of Development of Glacial Lakes in the Great Lakes Region. 20 minutes.
    (c) Centers of Dispersion and Probable Extent of the Kansan and Pre-Kansan Drifts. 15 minutes.

    O. W. Freeman. A Geographic Study of the Growth and Distribution of Population in Michigan. 10 minutes.
11. Prof. E. H. Kraus and Mr. J. P. Goldsberry. The Chemical Composition of Bornite. 15 minutes.
12. Mr. R. E. Hore. The Porcupine Gold Deposits of Ontario. 15 minutes.
13. Ripple Marked Huronian Quartzite at Nipissing Mine, Cobalt, Ontario, R. E. Hore.

SECTION OF SANITARY AND MEDICAL SCIENCE.

WEST LECTURE ROOM, MEDICAL BUILDING.

April 3rd, 1913—1:30 p. m.

Ferments. Dr. J. G. Cumming.
A Bacterial Disease of the Larva of the June Bug (Lachnosterna. sp.) ....Miss Zae Northrup.
Duration of Tr. Gambiense Infection in Rats and Guinea-pigs...J. F. Morgan.
The Environment of Soil Bacteria....Dr. F. H. Hesselink van Suchtelen.
The Influence of Bacterium Lactis Acidi on the Changes Caused in Milk by Some of the Common Milk Microorganisms...C. W. Brown.
The Use of Chlorinated Lime for the Disinfection of Drinking Water.............................Dr. M. L. Holm and E. R. Chambers.
Ozone as a Means of Water Purification................R. W. Pryer.
Toxic Bases in the Urine of Para thyroidectomized Dogs...W. F. Koch.
Serum Tests in the Diagnosis of Infectious Abortion of Cattle...Dr. E. T. Hallman.
The Increase of Hog Cholera Virus by Intraperitoneal Injections of Salt Solution.................................W. S. Robbins.
Studies in Avian Tuberculosis....................L. R. Himmelberger.
The Sensitizing Group in the Protein Molecule.......Dr. V. C. Vaughan.
Immunization Against Tr. Brucei with Cultures.......Dr. F. G. Novy.
Determination of Minimum Lethal Dose of Tr. Brucei....C. A. Behrens.
Cultivation of Spirilla................................P. H. de Kruif.
Secret Remedies, Nostrums and Fakes............Dr. W. S. Hubbard.

SECTION OF ECONOMICS.

Thursday, 10:00 a. m. and 2:30 p. m. Friday, 9:00 a. m.

SECOND FLOOR, ECONOMICS BUILDING.

1. The London Dock Strike of 1912. Carl E. Parry, of the University of Michigan.
   Discussion opened by W. H. Hamilton, of the University of Michigan.
2. Farm Organization as a Factor in Rural Economics. Wilbur O. Hedrick, of Michigan Agricultural College.
   Discussion opened by Edward D. Jones, of the University of Michigan.
3. The Sphere of Pecuniary Valuation. C. H. Cooley, of the University of Michigan.
   Discussion opened by Frank T. Carlton, of Albion College.
4. Psychological Antithesis of Socialism. H. A. Miller, of Olivet College.
   Discussion.
5. The Teaching of Economics in the High School.
   Discussion opened by J. E. Mitchell, of Alma College, and F. M. Taylor, of the University of Michigan.

6. The Taxation of Local Public Utilities in Michigan. E. H. Ryder, of Michigan Agricultural College.
   Public Utility Accounting in Michigan. David Friday, of the University of Michigan.
   Discussion opened by H. C. Adams, of the University of Michigan.

SECTION OF ZOOLOGY.

Thursday, 9:00 a. m. and 1:30 p. m.

ROOM 207, SOUTH WING, UNIVERSITY HALL.

1. Factors Governing Local Distribution of the Thysanoptera. A. F. Shull.
2. Results of the Mershon Expedition to the Charity Islands, Lake Huron Coleoptera. A. W. Andrews.
3. Types of Learning in Animals. J. F. Shepard.
4. The Lepidoptera of the Douglas Lake Region, Cheboygan County, Michigan. Paul S. Welch.
5. Check-list of Michigan Lepidoptera. II. Sphingidae (Hawk-Moths). W. W. Newcomb.
6. On the Breeding Habits of the Log, Perch. Jacob Reighard.
7. A list of the Fish of Douglas Lake, Cheboygan County, Mich., with notes on their Ecological Relations. Jacob Reighard.
8. May the Remains of Adult Lepidoptera be Identified in the Stomach Contents of Birds? F. C. Gates.
9. The Mitochondria. R. W. Hegner.
10. The Unione Fauna of the Great Lakes. Bryant Walker.
11. Notes on the Genus Edaphosaurus Cope. (20 minutes). E. C. Case.
12. Methods of Preparing Teleost Embryos for Class Use. (Demonstrations). B. G. Smith.
13. An Adult Diemyctylus with Bifurcated Tail. B. G. Smith.
14. Notes on the Mollusks of Kalamazoo County, Mich. Harold Cummins.
15. Sarcoptid Mites in the Cat. Harold Cummins.
16. The Origin of Continental Forms, III. Howard Baker.
17. An Ecological Study of the Birds of Manchester, Mich. F. Gaige.
18. Notes on Crustacea Recently Acquired by the Museum of Natural History of the University of Michigan. A. S. Pearse.
19. Distribution of Multiple Embryos on the Blastoderm. O. C. Glaser.
20. Nesting of Our Wild Birds. Jefferson Butler.
21. The Factors that Determine the Distribution of Boleosoma Nigrum in Douglas Lake, Cheboygan County, Mich. H. V. Heimburger.
22. Structure of the Olfactory Organs. E. W. Roberts.
23. A Method of Producing Cell-like Structures by Artificial Means. E. W. Roberts.
24. Some Notes on Rhizopods from Michigan. E. W. Roberts.
25. An Interesting Form of Protozoa. E. W. Roberts.
26. Oxygen and Carbonic Acid Contents of Douglas Lake, Cheboygan County, Mich. D. A. Tucker.
27. Some Observations on Asplanchna Amphora. D. A. Tucker.
28. Some Effects of Sunlight on the Starfish. H. M. MacCurdy.

29. Some Abnormalities Observed in Proteocephalid Cestodes. G. LaRue.
30. Note on a Cestode Found in a Garter Snake. G. LaRue.
31. Some Observations on Intestinal Villi. O. M. Cope.
32. Some Physiological Changes in the Lamprey Egg after Fertilization. P. Okkelberg.
33. A Collection of Fish from Houghton County, Mich. T. L. Hankinson.
34. The Lagoons and Ponds of Douglas Lake, Cheboygan County, Mich. H. B. Baker.
35. The Shiras Expeditions to Whitefish Point, Mich.
    1. Birds. N. A. Wood.
    2. Mammals. N. A. Wood.
    3. Amphibians and Reptiles. Crystal Thompson and Helen Thompson.
36. Notes on the Ornithology of Clay and Palo Alto Counties, Iowa. A. D. Tinker.
37. A Check-list of Michigan Mammals. N. A. Wood.
38. The Variations in the Number of Vertebrae and Ventral Scutes in the Genus Cegina. Crystal Thompson.
39. An Artificially Produced Increase in the Proportion of Male Producers in Hydatina Senta. A. F. Shull.
40. Seminiferous Tubules of Mammals. G. M. Curtis.
41. Paedogenetic Larvae of Insects. R. W. Hegner.

Fifteen minutes will be allowed for each paper unless otherwise specified. The time may be extended by vote of the members present.

Papers presented by persons not present at the meeting will be read by title only.

SECTION OF BOTANY.

Thursday, 9:00 a. m. and 1:30 p. m.

Biometric Studies in Oaks. 10 minutes. (With lantern). Carl Oberlin.
Biometric Studies in Oaks. 10 minutes. (With lantern). J. H. Ehlers.
The Origin of Capsella Arachnoidea. 40 minutes. (With lantern)..... ....Henri Hus.
The Antitoxic Action of Chloral Hydrate upon Copper Sulphate for Pea Seedlings. 15 minutes. ....R. P. Hibbard.
Improved Methods for the Quantitative Determination of Dilute Solutions of Electrolytes. 10 minutes. ....R. P. Hibbard.
Effect of Illumination on the Twining of Plants. 12 minutes.......... ....F. C. Newcomb.
Conditions for the Diageotropism of Asparagus Plumosus. 10 minutes. ....Margaretta Packard.
A Heteroprophic Mycorhiza. 10 minutes. (With lantern)........... ....Walter B. McDougall.
Some Notes on the Black Knot of Plums. 10 minutes..J. A. McClintock.
Some Further Observations on Sclerotinia. 10 minutes....J. B. Pollock.
A Sand-binding Fungus. 8 minutes. ....J. B. Pollock.
The Relic Dunes of Little Point Sable. 8 minutes. (With lantern)... ....W. E. Praeger.

The Pine Hills at Lowell, Mich. 10 minutes. (With lantern)......... ....Bert E. Quick.
Plants Observed on Mackinac Island in 1912. 5 minutes...C. K. Dodge.
The Flora of Parkedale Farm, Rochester, Mich. 10 minutes........ ....O. A. Farwell.
The Early Extent of Prairies in Southern Michigan. 6 minutes...... ....H. A. Gleason.
Notes on a Few Plants from the Vicinity of Ann Arbor. 5 minutes ....H. A. Gleason.
Car-window Notes on the Vegetation of the Upper Peninsula. 8 minutes. Read by H. A. Gleason............................R. M. Harper.
Permanent Vegetation Quadrats at Douglas Lake. 10 minutes........ ....Ada K. Dietz.
Role of Vegetation of a Mill Pond. 8 minutes. (With lantern)........ ....F. A. Loew.
Key to the Species and Varieties of Solidago in Michigan. 5 minutes. ....C. H. Otis.
An Easy Formula for Obtaining Alcohols of any Strength. 3 minutes. ....Richard de Zeeuw.
Lipolytic Action in a Rust. 5 minutes..................G. H. Coons.
Soft Rot of the Hyacinth. 10 minutes...................G. H. Coons.
Some Interesting Plants from the Vicinity of Douglas Lake........... ....H. A. Gleason.

ORIGIN OF CONTINENTAL FORMS. IV.

DISCUSSION OF MR. TAYLOR'S THEORY.

There are at least five main theories of the origin of continental forms:

1. Unequal radial contraction of a cooling earth.
2. Prof. Chamberlin's theory of the leaching out of basic materials from exposed land and their deposition in the sea.
3. Prof. Suess' theory of the foundering of portions of the earth's crust into the interior of the planet.
4. Mr. Taylor's theory of crustal creep.
5. The theory of the terrestrial loss of mass, developed from the suggestions of Rev. Osmund Fisher, which I have heretofore presented in outline before this section.

There are certain leading facts which any satisfactory theory must take into consideration. For example the following:

1. The present forms of the continents and the low density of their materials.
2. That the margins of the continents exhibit fracture.
3. That many of the fractured borders may be matched together so as to produce a consistent pattern.
4. That when they are so matched together the surface geology in several significant places also forms a consistent pattern.
5. That the Pacific border structures are set in a radial or rotating arrangement.
6. That the Atlantic fractures date from the end of Mesozoic time.

These facts I hold to be fatal to the first three theories mentioned, viz.: contraction, leaching and foundering, and, for the present, their discussion will be postponed in order to take up the theory of crustal creep. Not that unequal contraction and leaching are wholly excluded as possible factors, but they have not been dominant factors.

In 1908, Mr. F. B. Taylor presented in abstract before the Geological Society of America a paper on the "Bearing of the Tertiary Mountain Belt on the Origin of the Earth's Plan." It was published in full in the bulletin of the society in 1910. Briefly summarized, this paper presents the theory that during Tertiary time, possibly in part earlier, the continental sheets of North and South America, Eurasia and Australia experienced slow lateral motion which Mr. Taylor calls "crustal creep." This movement resulted in mountain building along the anterior borders of the moving sheets, thus explaining the peculiar distribution of the Tertiary mountains. North America is thought to have moved southwest away from Greenland, Eurasia southeast from Greenland but for the most part south, South America mainly northwest, and Australia northeast. Africa is thought to have moved eastward but only slight folding and slight elevation toward the eastward are cited. The author believes in crustal creep away from both poles, and is inclined to look for the explanation in some form of tidal force.

Compared with the theory of terrestrial loss of mass as I have developed it, following Fisher and Pickering, Mr. Taylor's theory presents some resemblances and some contrasts. Both recognize certain coastal affinities between the opposite sides of the Atlantic oceans. Both explain these affinities on the basis of former continuity and fracture with separation. Under both, the Atlantic ocean is thus a widened crack, rent, or rift in the earth's superficial materials.

Then come the contrasts. Mr. Taylor's motion is slow, that of the rival theory rapid. Mr. Taylor's is mainly Tertiary in time, my development of the other theory makes the principal motion determine the division between Mesozoic and Tertiary time. Mr. Taylor's theory goes a long way toward explaining the formation of the Atlantic and Arctic oceans, the other would explain the formation of all the oceans. Mr. Taylor's theory harmonizes with current geological sentiment, its rival is a startling and doubtless an unwelcome, reversion to catastrophic violence.

Mr. Taylor's theory has many elements of strength, resting as it does upon analysis of observed facts. Granting the Tertiary age of the mountain belts which border the Americas and, though less regularly, the mass of Eurasia, and granting, what seems clear, that these ranges have been produced by lateral movement due to pressure, we have exceedingly strong grounds for belief in widespread crustal creep of the general nature claimed. Granting further, that the folding is toward the oceans, and that coastal affinities exist, as claimed, on the borders which are not folded, the conclusion seems reasonable that there was crustal creep in the continental sheets away from Greenland and toward the folded margins. The mountains were doubtless slowly, probably intermittently formed, so the creep must have been timed accordingly and not all accomplished in one comparatively brief action.

In the Tertiary mountain belt, two peculiar features are pointed out which strongly support Mr. Taylor's conclusions,—two "mountain knots," one in Alaska, the other in Peru, where convergences of crustal creep are advanced in explanation of excessive and tumultuous mountain building. These seem to be excellent evidence. Also, in addition to mountain ranges, he is able to point to numerous overthrusts, a few of considerable extent, the most notable example being one of a hundred kilometers in Scandinavia.

While the theory rests upon Prof. Suess' views of mountain structure, to which some may not give unqualified approval, still on the whole this is probably much more an element of strength than one of weakness.

Lines of rifting and parting to the east and west of Greenland are indicated by the coastal contours, less upon the east side, Mr. Taylor's illustration of those on the west of Greenland, his figures 4 and 5, being especially striking.

I cannot admit that the coasts of Africa and South America fit into the outlines of the mid-Atlantic ridge, as he claims, but as I have previously demonstrated, these two borders fit into *each other* in a most surprising manner if we can bring ourselves to disregard that ridge, and a line of parting is indicated which argues as strongly for Mr. Taylor's theory as do the para-Greenland rifts. As I understand it, the mid-Atlantic ridge is not an essential part of his theory, he merely tries to accommodate it.

Among the "many bonds of union" which, as Mr. Taylor says, show that Africa and South America were formerly united, is the faunal and floral evidence in favor of a former land connection between Africa and Europe and northern South America, along some such lines as have been proposed by von Ihering, Ortmann, Scharff and others. While this instance is only one of several, it is particularly applicable in the present discussion and I have developed this phase of the subject in a separate paper.

But Mr. Taylor's theory is unsatisfactory in several ways.

For instance, I cannot see that there is any place in it for coastal matching together between Africa and North America. As I have demonstrated, and it is easy to verify, the convex northwestern coast of Africa fits into the concave southeastern coast of North America in a manner not less significant than the matching together that is possible between North America and Greenland on the one hand and Africa and South America on the other. There are no mountain structures available to take care of crustal creep in this particular instance. We may pass over related difficulties on small scale in Madagascar, Borneo and other islands, confining our attention to the major features.

In the Atlantic, if we could overlook the above objection, the general evidences of separation might be held to favor his theory almost as much as they do that of loss of mass, but, on a broader view, a seemingly insurmountable difficulty arises in the peculiarly reciprocal conditions in the Atlantic and Pacific. In the latter, we find the coastal evidences of movement set in a radial or rotating arrangement with the Australian focus as a centre and everything indicates converging crustal movement toward that centre as contrasted with the separations, the widening of the Atlantic rift, which lie opposite to it upon the globe. Mr. Taylor believes that, associated with a change in the earth's oblateness, there was outflow of mass from high latitudes toward low the world around, but the lines of motion that he figures, if depicted upon the globe would do about as well for convergence toward the Australian focus as my own. The flow of mass was not alone away from the Greenland horst and from the south polar regions toward the north, it was away from the whole Atlantic ocean north and south and toward the focus mentioned. His theory makes no provision for this peculiar distribution of deforming force and it does not seem as if anything can explain it so efficiently as does the loss of mass in the region toward which the continental sheets moved. If there is nothing more involved than what he says, all of those peculiar features which I have pointed out in the Pacific hemisphere in this connection have to be disregarded.

There still remains the broad objection that crustal corrugations and overthrusts are inadequate to account for the amount of crustal movement indicated on the globe.

Suppose we take the case which is easiest for the theory, the 560 miles of separation between Greenland and Labrador. Draw a representative line southwest from Greenland, on a great circle, in the direction of the crustal creep of North America. Prolonged, this line strikes the Australian focus. It might be claimed that we have the whole distance from Labrador to the Australian coast in which to account for the 560 miles of creep. Reference to Mr. Taylor's figure 7, however, discloses the fact that he concedes that the foldings from the

Australian coast to the Solomon Islands are attributable to pressure *from* that continent instead of *toward* it. As to the mid-Pacific ridges he is in doubt but leans toward a southwesterly, that is an Australian, source for the corrugating pressure. That would restrict us to the space between Labrador and the mid-Pacific islands. Now, since the central portion of North America is known to have remained free from major deformation through Mesozoic and Tertiary time, the Pacific border of this continent is about all there is left to fall back upon. Let us see what measure of crustal shortening may reasonably be assigned to that region.

The amount of crustal shortening in the Laramide range of the Canadian northwest was given by McConnell in 1887 as 25 miles in 50. That is, 50 miles of surface had been gathered into 25. This includes a thrust of Cambrian over Cretaceous of about 7 miles. Taking this into consideration, Dana, 1896, assigns to the Pacific border of North, "Laramide and other systems later than the Archæan, not over 75 miles."

In the Appalachians, Claypole, 1885, found 153 miles (in Pennsylvania) shortened to 65, a difference of 88 miles.

Willis, 1893, in Tennessee, found 72 miles shortened to 54, difference 18, which measure he considers "accordant" with Claypole's results in Pennsylvania.

For the Alps, Heim, 1874, found 74 miles of shortening, about the same as that given for our Pacific border.

In regard to overthrusts more particularly, although many are included in the above measurements, a few examples may serve to acquaint us with the general run of values; such are, one in the Laramide range (McConnell) 7 miles; one in Utah, 4 miles and more (Blackwelder); in Montana one of 5 to 7 miles (Willis); Georgia, 11 miles (Hayes); in Scotland, one of 10 miles (Peach); numerous small ones in Europe and one in Scandinavia of 62½ miles (Suess). The last is exceptionally large. Overthrusts are abundant in various regions but they are generally small.

To be liberal with the theory, let us grant that there is much more shortening hidden in the Pacific border of North America than has hitherto been supposed. Let us say that we will concede for that one region, in addition to Dana's allowance of 75 miles, Claypole's 88 for the Appalachians and Heim's 74 for the Alps. We secure a total of 237 miles, which is a fraction over 42% of the 560 miles of crustal creep of North America which we have to account for. More than half, 323 miles, is still missing, so to take care of that we have still to introduce somewhere between Labrador and the Solomon Islands the shortening equivalent of four such mountain regions as the average, (79 miles) of the Alps, Appalachians, and Pacific Border of North America. Recourse must doubtless be had to enormous theoretical thrusts, of the existence of which we have no knowledge whatsoever. I have selected this particular case, because it seems more favorable to the theory than any other. Between the Labrador coast and the Solomon Islands, we have something like 9000 miles in which to find 560 miles of crustal puckering. We do not find it.

If we take the case of western Eurasia, we have not over 2500 miles in which to take care of over 1000 miles of crustal creep. Reference to Mr. Taylor's figure 7 shows how few mountain ranges there are between the British Isles and Africa-Arabia, even including those which run in the line of creep and which were formed by pressures at right angles to it. The great Scandinavian overthrust is not available for western Europe and the Alps are the main reliance. To get upwards of 1000 miles of crustal shortening in between Scotland and Africa-Arabia, or more properly between the English Channel and those southern limits, since England has no Tertiary mountains, certainly seems more than can be reasonably granted.

Take South America and Africa. The evidence is that their coasts match together and the inference is that they have moved apart at least 2500 miles between Guinea and Brazil and upwards of 1000 miles more than that further south. Mr. Taylor thinks they only parted from the mid-Atlantic ridge, which would give each an excursion of about 1000 miles. Now the case of South America is radically different from that of North America in that the Pacific ridges are not even a little available in explanation of the creep, and he is, I believe, compelled to rely to an undue extent upon the deformation of the western border of the continent. The width of the sheet diminishes toward the south so that the conditions become increasingly difficult. Whereas just below the equator, there is something like 2500 miles in which to place 1000 miles of shortening, further south there is only half that width. Unless the eastern Pacific bottom, and the ocean is very deep for a long distance off the coast of South America, can come to the rescue with an improbable amount of crustal overthrust, we must be prepared to concede to South America as much puckering as that assigned to the Pacific border of North America, 75 miles, the Appalachian 88, the Alps 74, all added together and the total multiplied by 4!

For Africa, it seems necessary to grant also 1000 miles of crustal creep (toward the east) and the whole can be accounted for only by very great foldings and thrusts which have not yet been found in the African land. It is true that exploration is not yet complete enough to settle such a point, but the great resistance offered by the Indo-African mass against the southward pressure of Eurasia, which resistance would be necessary to produce the observed Tertiary foldings along the southern border of the creeping sheet, this great resistance of itself presupposes that same great stability and rigidity that is indicated by what is known of Indo-African geology. Such a rigidity is to be reconciled with an undue amount of hypothetical thrusting and shortening, if it is to be granted that Africa crept slowly away from the mid-Atlantic ridge in Tertiary time. In fact, Mr. Taylor does not claim that. He hopes to avoid the difficulty by placing the (eastward) drifting of Africa, before the Mesozoic. How to show the untenability of that position in few words would be very difficult, but it becomes perfectly clear when these crustal movements are regarded broadly in the light of all the facts that I have heretofore presented, that Africa's principal excursion had to be simultaneous with those of all the other continents. I must refer to all the evidence I have compiled and reaffirm that the crustal sheet which is now Africa was up to the end of Mesozoic time structurally continuous with both the Americas whose coast-lines match with it like fragments of broken slate. The general stratigraphical arrangement of its borders corresponds, the surface geology corresponds, and the plants and animals, in general, correspond, (albeit roughly) up to the end of Mesozoic time.

So, as a conclusion from the foregoing investigation, Mr. Taylor's theory that the Tertiary mountain belt and crustal overthrusts explain the crustal movement indicated upon the globe may be said to be quantitatively inadequate. Just how inadequate it is, we have seen in a general way; known foldings and thrusts and probable foldings and thrusts (such as those that may be thought to be submerged in the sea and those that are yet undiscovered on the land) such foldings and thrusts are capable of accounting for only a small fraction of the separation that is indicated by coastal parallelisms. But it is no less important to note that *the theory is adequate for that small fraction.*

I conclude (1) that taken broadly Mr. Taylor's theory is a most valuable contribution to the study of the origin of continental forms.

(2) That it is true that slow crustal creep occurred in Tertiary time and resulted in mountain building substantially as described.

(3) That Mr. Taylor's theory is qualitatively insufficient to accommodate lateral crustal movement as shown by certain coastal parallelisms and by the Pacific convergences.

(4) That it is quantitatively insufficient to account for more than a small fraction of the lateral crustal movement which can be shown to have occurred.

(5) That Mr. Taylor's theory, far from being an argument against or a substitute for the theory of separation of mass from the earth at the end of Mesozoic time, forms a most acceptable extension of it.

What he really shows is how, throughout Tertiary time, the earth's superficial structures went on slowly completing an adjustment, approaching a new equilibrium after the destruction of the old; how the earth literally healed itself, filling in and closing up to a wonderful degree the huge Pacific depression.

See how his story corroborates the other! and see how loss of mass, in turn, supplies him with one adequate first cause which his facts demand!

The various crustal sheets moved, crept, toward the Australian focus, and, if this was due to the existence of a depression there, then clearly, terrestrial gravitation was at the bottom of the matter. Nevertheless there must have been other forces at work too, agitating or releasing forces which became intermittently active through Tertiary time. For mountain building seems not to have been a uniformly continuous process; it was intermittent. It took force to break the continental sheets loose and set them free to move as he shows that they did move; new rifts with separation had to accompany and permit Mr. Taylor's crustal creep; and these events were intermittent, with periods of comparative quiet between. In explanation of this aspect of the problem, I can quote with full approval the closing words of his paper and say that "one is inclined to reject all internal causes and to look to some form of tidal force as the only possible agency."

Just as I have argued that the Tertiary age was ushered in by the removal of mass from the earth and that this separation of mass was caused by extraterrestrial gravitation, to be, for the present, no more explicit, so in the end, Mr. Taylor's crustal creep works out to the same result, *intra*terrestrial gravitation plus "some form of tidal force" as he puts it, which is to say, plus *extra*terrestrial gravitation.

Mr. Taylor has taken a most significant step in daring thus to give expression to a belief that geology must look to extraterrestrial force for the explanation of one of its major problems.

What matters it at this time in what precise form we may severally picture to ourselves this deformation? The grand conception is stated that the greatest deformation of the earth mass since the close of Mesozoic time, the corrugation of the earth's surface with the Tertiary mountain belt, was produced through the action of extramundane force! Even if it be shown, as I believe it can be, that the Tertiary events resulted from the (pre-Tertiary) removal of earth mass, this merely transfers a part of the cause backward in point of time, it does not eliminate it, and so, after all, the conception loses none of its suggestiveness.

HOWARD B. BAKER.

THE SAGINAW OIL FIELD.

BY R. A. SMITH, ASSISTANT STATE GEOLOGIST.

Some years ago Dr. A. C. Lane, then State Geologist of Michigan, wrote an article upon the oil and gas prospects in Saginaw Valley. This article appeared in the Michigan Miner of Saginaw, and created not a little stir in the state at the time, especially at Saginaw. Nothing came of it, however, and the article was forgotten until a reprint of the article fell into the hands of some Saginaw business men in the winter of 1912. They became very much interested in the oil and gas possibilities of Saginaw Valley as portrayed by Dr. Lane and soon interested other business men of Saginaw to the extent that a company, the Saginaw Development Company, was organized for the purpose of putting down three wells, two of which were to be sunk down to the Berea grit, and a third to a depth of 3500 feet or more, unless oil or gas should be struck in quantity before that depth was reached.

Representatives of the company came to Lansing to confer with the Geological Survey concerning all of the available information relating to oil and gas, or other mineral prospects in and around Saginaw. At their request, a compilation and interpretation of the evidence was made, which, though not at all conclusive, was deemed sufficient to warrant a thorough test of the Saginaw territory. Most of the evidence, indicating favorable structural conditions for the occurrence of oil and gas in quantity in the underlying rocks of the region, was derived from the numerous and comparatively shallow drillings for salt along Saginaw river. More or less indirect evidence was also furnished by drillings at Midland, Alcona, Caseville, Blackmar, Flint, Owosso, St. Charles, etc. The two deep wells at Bay City, especially that of the North American Chemical Co., were of great value in giving a general idea of the probable nature and thickness of the deeper lying formations.

The rock strata of Michigan lie one upon the other like a pile of very shallow warped basins, each successively higher basin being smaller than the one immediately below. This basin like structure is known as the Michigan Basin. Obviously it follows that in general the rock layers should dip gently toward the center of the basin which appears to lie somewhere in Midland and Isabella counties. Saginaw and Bay City are to the east of the center, therefore, one should expect the strata on the whole to dip westward. As the general dip in the eastern part of the basin is about 20 feet per mile to the west, corresponding strata at Saginaw should be considerably deeper than at Bay City.

Upon platting the salt wells, it was seen at once that the salt horizons of the Napoleon, instead of being deeper at Saginaw, are fully 200-300 feet higher than at Bay City. In section, the top of the brine horizon of the Napoleon sandstone is seen to rise gradually from a depth of 840-900 feet or more in Bay City to about 610 feet in the Wylie well near Bristol St. Bridge in Saginaw, where they again deepen rapidly to the southwest and west being found at 800-900 feet at St. Charles and more than 1200 feet at Midland. Southeast of Saginaw the Marshall and the Berea also appeared to be much higher. To the north of Saginaw, there is a pronounced upward fold in the Coal Measures as observed in the Ralston well (Sec. 4, T. 13 N., R. 4 E.). The Marshall and the Coldwater also appear to be somewhat higher in the Page Oil and Gas Co. well (Sec. 26, T. 14 N., R. 4 E.) than they are farther east along Saginaw river. At Kawkawlin, the brine horizons occur between 700-800 feet or considerably shallower than in Bay City. From the foregoing evidence, it seemed fairly certain that a pronounced anticlinal fold existed in the rock strata down to the Marshall at least, and presumably much deeper. Apparently this fold should run slightly west of north through Saginaw near Bristol St. Bridge to a point two or three miles west of Kawkawlin. To the southeast of Saginaw at Blackmar, the Marshall and Berea were apparently struck at 360 and 1545 feet and at Flint, 170 and 1200 feet respectively. As this is considerably higher than at points to the east or west of these places, the anticline appears to turn more to the southeast toward Blackmar and Flint, but the evidence is not definite or conclusive, as the records of the drillings at these places are very imperfect. As the Marshall appeared to be only about 360 feet deep at Blackmar, 610 feet at Saginaw and about 700 feet at Kawkawlin, the structure apparently pitched gently to the north. On the whole, the evidence was fairly conclusive that an anticlinal structure existed, but its exact position and direction were not so clearly indicated.

The first well was put down by the Saginaw Development Company near the SE. Cor. of the NW. 1/4 of NW. 1/4 of Sec. 27, T. 13 N., R. 5 E., Buena Vista township, Saginaw county, although from the evidence then at hand, this location appeared to be considerably to the east of the supposed anticlinal. In this well, known as the Mundy-Fifield, the Marshall was found at 780 feet or 40 feet higher than in the South Bay City well (Sec. 5, T. 13 N., R. 5 E.) but fully 170 feet lower than the supposed depth to the Napoleon near the Old Wylie well on Niagara St. about 800 feet north of Bristol St. Bridge. The Berea was struck at 2070 feet or 30 feet higher than in the South Bay City well. All of the underlying formations were correspondingly higher than the respective ones in the Bay City wells and much lower than at Saginaw, as was afterwards shown by later drillings. From the first it was obvious that the well was located well down the east limb of the anticline. The Berea yielded some brine and a little gas, but no show of oil. At the depth of 2246 feet the drilling was abandoned, but afterwards it was deepened to the Traverse oil horizon, which was struck at 2520 feet or 90 feet higher than at Bay City and 200 feet lower than at Saginaw. There was about 20 feet of the "sand" but no oil or gas. The well is now being drilled to the Dundee but the chances for finding oil and gas do not seem at all favorable. The well is located too far from the anticline.

Another well was started near the site of the old Wylie Bros. well on what is known as the Garey-Casamer lease. Here the Upper Marshall or Napoleon was found at 510 feet or 170 feet higher than in the Mundy-Fifield well and 210 feet higher than in the South Bay City. The Berea was encountered at 1835 feet or 235 feet higher than in the Mundy-Fifield and 265 feet higher than at Bay City. These drillings not only conclusively proved the supposition that an anticlinal undoubtedly exists in the rocks down to the Berea but also that it even becomes more pronounced with depth. Of course, due allowance must be made for thickening of some of the formations.

Here, as in the Mundy-Fifield well, the Berea proved to be a small yielder of brine, perhaps 25 or 30 barrels per day, and of gas. Drilling was continued with the idea of going on down to the Dundee, supposed to be 900-1000 feet below. At 2305 feet the Traverse limestone was entered and oil of the finest grade was struck at 2317 feet in a sandy or cherty limestone. The so-called "sand," since called the "Saginaw Sand," was very thin, being probably not much more than two feet.

The well made two flows of some 40 to 50 barrels of oil altogether. The indications were that a 25 to 30 barrel well had been struck. The well was shot with 100 quarts of nitro-glycerin. As soon as pumping began, however, it was found that the casing was leaking, and after the first 75-80 barrels, the production of oil fell off rapidly until the well made only about three or four barrels of oil per day with about 25 barrels of water. After many attempts the water was finally shut off through the use of rubber packers, but the production was not materially increased. Finally the well was reshot with 20 quarts of nitro, but the casing was loosened, so that water was again troublesome. The well can hardly be said to have had a fair chance to develop its possibilities.

The next well, No. 3, was drilled on the Jackson-Church property near the west end of Bristol Street Bridge on the west side of Niagara Street and about 600 feet west of south from the Garey-Casamer well. The Marshall, Berea, and the Traverse were approximately at the same depth as in the latter well, but there was no porous sandy limestone or oil "sand" in the top of the Traverse. The "Saginaw Sand," as the oil horizon in the Garey-Casamer well had been called, appeared to have pinched out, and there was not the slightest show of oil or gas at this horizon.

The well was drilled down to the Dundee which was found at about 2900 feet. At 2935 feet there was a show of oil which did not show much increase until at 2945 feet where the greatest showing was made up to 2955 feet. The drilling was stopped at 3080 feet where some brine was struck. This was plugged off and the well shot with 120 quarts of nitroglycerine. The first pumping is said to have yielded some 50 barrels of very good oil and then the production rapidly fell off to about 2 to 3 barrels per day.

A fourth well, about 1200 feet south of east from the Garey-Casamer, was sunk to the Dundee just at the east end of Bristol Street Bridge on the Cresswell property. The formations in all three of these wells in Saginaw were at approximately the same height. In the Cresswell well, a showing of oil was struck in the "Saginaw Sand," another about 100 feet lower in the Traverse, and a third toward the base of the formation. The oils in the second and third horizons were dark and heavy, and of much lower grade. None of these showings were deemed to be worth testing and the well was deepened to 3060 feet, the Dundee being struck at 2886 feet and a showing of oil found down to 2942 feet. The oil was high grade, being similar to that fooound in the Jackson-Church well.

Although the well has been drilled in for some time, it has not been shot owing to some difficulty over the responsibility for the public safety. The appearances seem to indicate a small pumper similar to the Jackson-Church.

Well No. 5, 3068 feet deep, was drilled on the Watson farm near the SE. Cor. of the SW. 1/4 of SE. 1/4 of Sec. 17, T. 12 N., R. 5 E., Buena Vista township, just about a half mile east of the city close to the intersection of the highway and the new electric railway from Saginaw to Bay City. There was a small show of gas in the Berea, but no showing of either oil or gas was reported in the Traverse. Oil was struck in the Dundee, but in such small quantity, that after standing six days, there was only a few gallons of oil in the well and about 180 feet of water. The well which was at once abandoned without shooting was plugged to protect the Marshall brines from contamination and also to prevent leakage of gas which was made in considerable though not commercially important quantity from the Berea. The latter also yielded some very strong brine, perhaps 25 to 30 barrels, per day. The brine constantly flowed over the top of the casing in a small stream.

The Upper Marshall or Napoleon was struck at 600 feet or slightly higher than near the Bristol Street Bridge drillings. The Berea was struck at 1835 feet or practically the same depth, but the Dundee was 2928 feet or about 28 feet deeper. The structure appears to be that of a structural bench or terrace for the upper formations and that of an asymmetrical anticline for the lower. In the latter case, the western limb is very much steeper than the eastern which dips but 28 feet from the Jackson-Church to the Watson well, a distance of 2½ miles. From the Watson east to the C. G. McClure well, recently put down to about 3000 feet near Gera in Sec. 8, Frankenmuth township, the rocks seem to be nearly flat, as the formations are reported to be at practically the same depth. Farther east the rocks must begin to rise up the side of the basin, as, at Reese, Tuscola County, the Napoleon is probably less than 500 feet from the surface. The broad flat depression in the Berea to the east of Saginaw evidently dips toward the north and becomes much more pronounced as the top of the Berea drops from 1850 feet in the Watson to 2035 feet in the Mundy-Fifield. The syncline in the Dundee becomes still more pronounced in the same direction.

Well No. 6 or the Green Point well was located on the Globe-Blaisdell farm nearly opposite from the East Saginaw waterworks plant. This well is situated a little south of west from the Garey-Casamer and about 2¼ miles distant. The formations were reported to be 100-150 feet deeper than in Saginaw and there was not the slightest show of oil at any of the horizons, even though the well was apparently drilled nearly to the base of the Dundee, where much water was encountered.

Well No. 7 was located near Lawndale some four miles northwest of the No. 2 well in the NE. Cor. of Sec. 5, T. 12 N., R. 4 E. This well was also located at considerable distance to the west of the supposed crest of the anticlinal and as drilling progressed, this proved to be the fact for all of the formations were reported to be practically at the same depths as in the Mundy-Fifield. The Berea, Saginaw sand, and the Dundee would therefore be found respectively at about 2070, 2520 and 3150 feet.

THE OIL HORIZONS.

From the data assembled before drilling began, it appeared that the Berea was the most promising horizon to test for oil and gas. At Bay City, there were strong signs just above the horizon and also, in the Blackmar well, considerable gas was yielded from this formation. A favorable structure seemed to be the only thing lacking for an accumulation of commercial size. It was a keen disappointment when the Berea in most of the wells yielded only a small quantity of gas, which, however, increased considerably with time. In some wells, the gas was not noticed for some time after the Berea brine was cased off. The latter, though apparently very strong was also deficient in quantity,—there never being a flow of much more than about 30 barrels per day. For some time, it was a puzzle why this formation did not yield a greater abundance of brine, as it was so thick and well represented. An examination of the samples showed that the Berea is a very fine and close grained gray to white sandstone. In some phases, the sand grains are too fine to be readily distinguished by the naked eye. It is this fine to exceedingly fine grain of the rock which not only limits the flow of brine but also that of the gas. A heavy charge of nitro-glycerine might possibly loosen up the rock enough so that a considerable flow of gas could be obtained from the Watson well or from some of the other wells. The head of brine might overpower it, however.

The so-called "Saginaw Sand" appears to be a sandy or cherty limestone. There seems to be some doubt as to the exact nature of the oil horizon, but all of the samples examined by the writer have proved to be true limestones though often cherty or sandy, effervescing very vigorously and leaving a comparatively small residue of sand and chert. At any rate, the "sand" is thin and pinches out wholly to the southwest in the Jackson-Church well. In the Cresswell or No. 4 well, the sand was represented by two sands,—that is, two cherty limestones separated by a shaly layer. In the Watson well, there was a cherty or sandy pyritous limestone filled with black micaceous particles from 2325 to 3469 feet.

The Dundee oil horizon appears to be some 35 feet below the top of the formation and is a light gray to buff and brown granular limestone effervescing violently with dilute hydrochloric acid. A fragment of the limestone shot out of the Jackson-Church well was a gray granular porous limestone, the pores being readily seen by the naked eye. The oil horizon appears to be free from water, but, lower down at no great depth, there is an abundance as shown in the Jackson-Church, the Watson, and the Green Point wells.

EXPLORATION.

Of the eight wells now completed in the Saginaw field, including Mr. C. McClure's Gera well, only three (Nos. 2, 3 and 4) appear to be on the anticline and these three, perhaps significantly, yield oil and gas in considerable even if not commercially important quantities at two different horizons. The Cresswell hole showed four oil producing horizons. The other wells were all located from about half to three or four miles distant from the apparent crest of the anticline and made little or no showing of either oil or gas. The Watson or No. 5 perhaps may be excepted as this well yielded considerable gas at the Berea horizon. This well, however, is very close to the anticline,—so close that apparently it ought to have made better showings of oil than it did.

The three wells yielding the most oil are within a radius of 1200 feet, near the Bristol Street Bridge. The indicated anticline is 25 to 30 miles long so that the three drillings near its crest in no way have tested the possibilities of the structure. Since the drillings at some distance from the anticline have been so barren of any encouraging results, it seems most logical that future prospecting should be along the supposed axis of the structure. Oil may not be found in quantity along its crest but, most certainly, the chances are presumably greater in its immediate vicinity than elsewhere.

Lansing, Mich.

A GEOGRAPHIC STUDY OF THE GROWTH AND DISTRIBUTION OF POPULATION IN MICHIGAN.

BY O. W. FREEMAN.

The history of a nation or state is largely the result of its own and its environment's geography. A study of Michigan's history, and of the reasons for the distribution of its population at different times, shows that certain geographical factors have influenced the history and settlement of Michigan far more than any designs or purposes of man. This paper is devoted to a brief discussion of the factors which influenced the distribution of population in our state.

Michigan was the first of the North Central States to be explored and to have permanent settlements established. These early settlements were mere missions or trading posts, whose location was determined by the presence of the abundant waterways of the state, which served for cheap and easy transit of trading goods and furs, and accounted for the founding of Detroit, St. Ignace, Sault Sainte Marie, and Fort Miami on the St. Joseph River near what is now Niles.

Although explored so early, there was no influx of an agricultural population until after about 1818. There were several causes for this, chief among them being (1) Michigan's earliest settlers were fur traders; fur trade and agriculture never go together; (2) The rich easily broken lands along the tributaries of the Ohio would attract farmers first; (3) Erroneous reports were abroad to the effect that Michigan's surface was largely swamps and pine barrens, and, until more careful surveys were made about 1820, this idea, fostered perhaps by the fur companies, may have helped to turn settlers elsewhere; (4) Distance to markets made farming unprofitable. These geographical factors then proved sufficient to prevent any increase in Michigan's population for over a century after the founding of Detroit. In 1820 almost the entire population of Michigan was restricted to a narrow belt close to Detroit and Lake Erie. In 1825 the Erie Canal was opened; this formed a water route to markets. By 1830 the districts around Detroit became more densely populated, and settlements spread toward the North and West. For a few years, the Kankakee-St. Joseph river route served to encourage the settlement of the extreme Southwestern part of the state and some adjacent portions of Indiana, although the aréa about them was an unexplored wilderness. An early fort near Niles, in addition to prairies of a few miles in extent, may have helped to decide settlers to locate there. At first then, the distribution of population was controlled by trade routes, and these outlets to market were simply natural waterways except the Erie Canal.

Michigan became a state in 1837 and her boundaries definitely fixed. By 1840 settlers had ceased to go North along Lake Huron, being little attracted by the marshes of the Thumb, but instead had spread west mostly south of a line connecting Port Huron and Grand Rapids. A new means for the transit of goods, the railroad, now began to help affect the distribution of population so that inland regions, if they possessed good soil, could support a dense farming population, as a route to market had now been provided. Three railroads were projected, to be built by the state. Since water routes to market had hitherto been so important in the settlement of Michigan, it is natural that no north and south lines were planned, but only east and west ones to connect quickly with lake ports. These roads were to connect Detroit and St. Joseph, Monroe and New Buffalo, and Port Huron and Grand Haven.

The next ten years were simply a story of steadily increasing population supported by agriculture in the southern four tiers of counties, and a comparatively slight migration to the North.

Up to 1850, soil suitable for farming and routes to market had chiefly controlled the distribution of Michigan's population. After 1860, however, the distribution of population became more irregular through the influence of certain other geographical factors, the results of which were not very evident until then. Among these are (1) Effect of topography and climate; (2) Effect of natural resources, i. e. soil, forests and ores; (3) Relationship to other geographical provinces.

We know that the great ice sheets by the formation of the Great Lakes have profoundly influenced the climate of much of Michigan, and, besides serving as a source for fish, have caused by their use as trade routes the building and the growth of many cities, as Port Huron and Detroit. The ice sheet also was the cause for the state's swamps, hills, lakes, water power, and sandy plains, while, indirectly, it determined the location of clay, marl and peat deposits. The ice sheet also was very important in determining the character of the forest growth and the areas for farming, lumbering, shipping and manufacturing.

The "Soo" canal was finished in 1855, and we naturally find by 1860 a considerable population in the Houghton and Marquette mining districts. The settled districts of the southern peninsula spread north, most rapidly along the shores of Lake Michigan and Saginaw Bay. Certain sandy areas, for example, in western Allegan and Van Buren Counties were thinly settled. The same was true of the extensive marshes in the Thumb. Of late years, the favorable climate along Lake Michigan permits of fruit raising on these sandy areas, while the Thumb marshes after draining prove very valuable for the growing of sugar beets. Other swamps in Kalamazoo, Van Buren, Ottawa, and Kent counties are now equally valuable for the raising of celery and peppermint, and permit Michigan to lead in their production. The draining of marsh land, however, was not undertaken until after the supply of other lands more easily prepared for cultivation was exhausted, so that, up to about 1890, the population of such areas was rather small.

By 1870, the lumber industry, which before 1860 was of no importance, had grown until Michigan was the chief lumbering state, a preeminence which it maintained well into the nineties. In general, the best white pine was north of Saginaw and Grand Rapids and south of Alpena, therefore, in addition to these cities, others in between, as Muskegon and Manistee, sprang up directly dependent on the lumber industry. The population of these lumber sawing districts was chiefly located about the mouths of rivers, affording means of running the logs to the mills and a harbor for shipping the product on the Great Lakes. The salt industry naturally went with the lumber sawing, as the waste from the latter could be used to evaporate the salt. In the mean time, other cities were growing up in the state, there being in 1870 no less than fifteen in the southern peninsula compared with five in 1860.

Railroad building in Michigan is easy, there being no very great differences in topography. We find by 1880 many roads completed and others under construction. These opened up the interior regions by furnishing routes to market. This is especially noticeable along the line of the Grand Rapids and Indiana Railway, where the population along its line is very much denser than back from it. A study of a railroad map of Michigan shows that three out of the five northern built roads bend decidedly toward the west. This is true in the case of the Michigan Central, Detroit and Mackinaw, and Ann Arbor, but is not evident in the case of the Pere Marquette and the Grand Rapids and Indiana, as they were already built so close to the west coast that there was no room to bend. Is it not probable that the bending resulted from the presence of the rich iron and copper ore of the upper peninsula, and the desire to exploit it?

At this time, only Oscoda and Montmorency Counties in the southern peninsula were unpopulated. In the northern peninsula, the discovery of new iron ore districts along the Wisconsin border encouraged the settlement of these regions. Ten years later in 1890, the whole of the southern and most of the northern peninsulas were settled, and the number of cities had greatly increased, there now being eight in the northern and twenty-three in the southern peninsula. Two of these cities, Big Rapids and Au Sable-Oscoda (classing the last two towns as one), which were founded on the lumber industry, are no longer cities of over 5000 population since, after the exhaustion of the lumber, other industries did not follow.

Since 1880, especially throughout the southern four tiers of counties, there has been a steady decrease in the rural population, accompanied by an increase in the urban population. The first regions to suffer were the hilly districts, for example in Barry Co. The lake region of northwest Washtenaw and the adjoining part of Livingston county have also never supported a dense population for the same reason.

The chief changes by 1900 were an increase in the rural population of the northern part of the state, and a corresponding decrease in the southern, while all over the state the urban population steadily increased. This increase of the urban at the expense of the rural population continued, there being in 1910 forty-nine cities of over 5000 in Michigan compared to forty-one in 1900. These new cities, moreover, except two in the upper peninsula mining districts, were all located where the rural population was on the decrease. Where railroad communication is poor, and the soil mediocre, as in Oscoda, Crawford, and Lake counties, the population is likewise small. The largest cities, in general, during the last ten years became much larger, but many of the smaller ones, as Port Huron, Manistee, Coldwater, and Ishpeming, lost in population.

Forty counties in Michigan have lost in rural population. (See Map 45 K) Allegan county, if the manufacturing villages of Otsego and Allegan, which increased 2500 in the last ten years, are excluded, would also be included in this list, as the true rural districts lost considerably in population. Including Allegan county just one-half of the eighty-two counties in the state have decreased in rural population, this decrease dating in the case of the southern four tiers of counties usually as far back as 1880. Should the urban population include all people living in towns of over 2500, as the census often does, this loss is still more evident, and would include Alger, Allegan, Charlevoix, Houghton, Isabella, and Presque Isle counties in addition, or all but thirty-seven counties in the state. Ottawa and Wayne counties only would show a gain. It will be noted that many of these counties show a considerable increase in total population, and the urban must be subtracted before it becomes evident that the rural districts have lost.

The cause of this loss in population of the rural districts, besides the younger generation leaving for the cities, seems to be due to a decrease in the average size and number of farmer families. In several counties, the number of acres per farm is increasing, while the number of farmers is decreasing. Since the rural population of Michigan increased only 2½% in the last ten years, while the urban increase was vastly greater, I think it highly probable that by 1920 Michigan's rural population will show a decrease as Ohio and Indiana already have done. The northern peninsula and the Northeastern part of the southern, and immediately around Detroit and Grand Rapids will probably show an increase; the rest, with some possible exceptions on the lake shore, will probably lose. The largest cities will grow still larger, but several of the smaller ones will undoubtedly lose in population.

I find then that the distribution of Michigan's population has been determined by routes to market, climate, topography, and relationship to other neighboring provinces. Cities have been built and their location determined by the presence of natural resources, as Marquette and Saginaw; aided by water power, as at Grand Rapids. Others like Escanaba and the "Soo" are places of transfer of goods from rail to water routes. The size of Detroit is due to its location on great trade routes, especially by water, while Jackson and the other inland cities depend entirely on railroads for their location as manufacturing centers.

While the cities have increased greatly in population, many of the rural districts have decreased. The decrease has progressed from the oldest settled regions to the newer, and it appears probable for some years at least that this readjustment of population will continue.

Ann Arbor, Mich.

Longitude West from Greenwich
1820
TOTAL POP.= 8765
Legend
Below 1 per sq mile=Blank
1-5 " " " = ooo
5-10 " " " = vvv
10-20 " " " = XXX


Longitude West from Greenwich
1830
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Legend.
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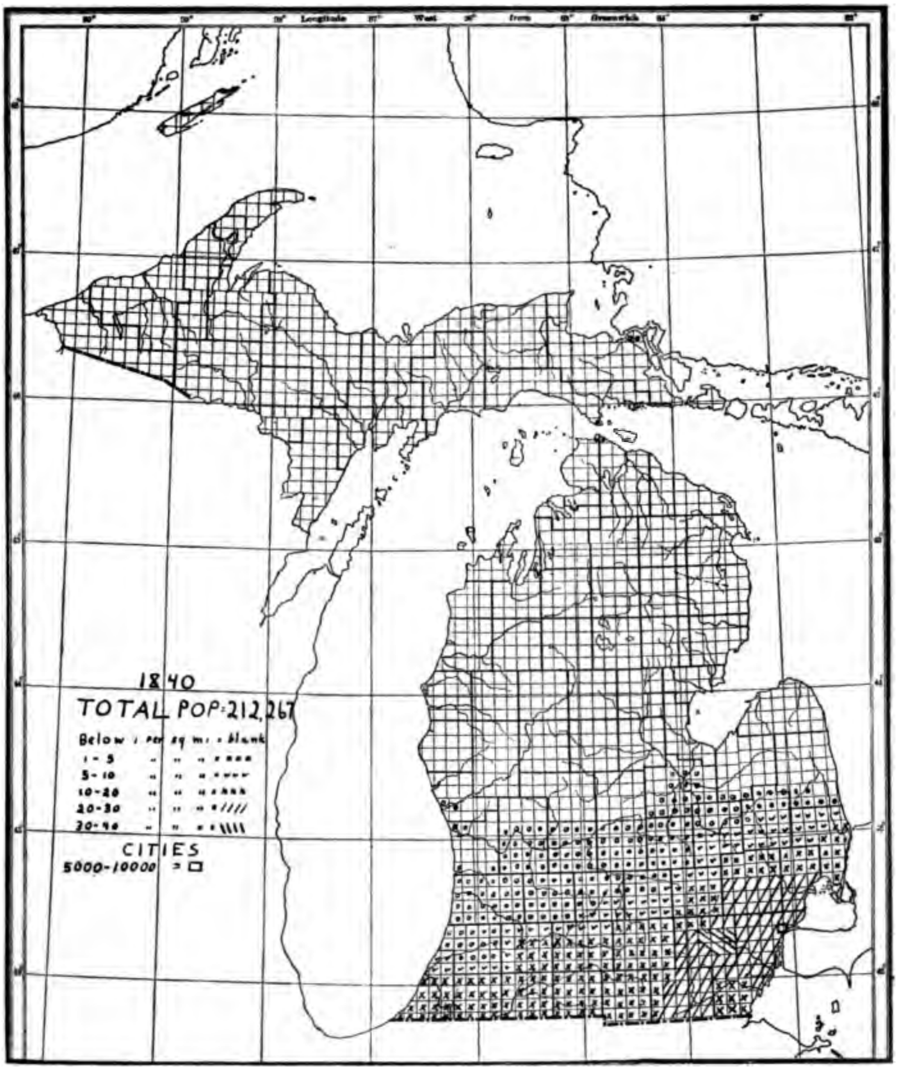
10-20 " " " = XXX


1840
TOTAL POP=212,267
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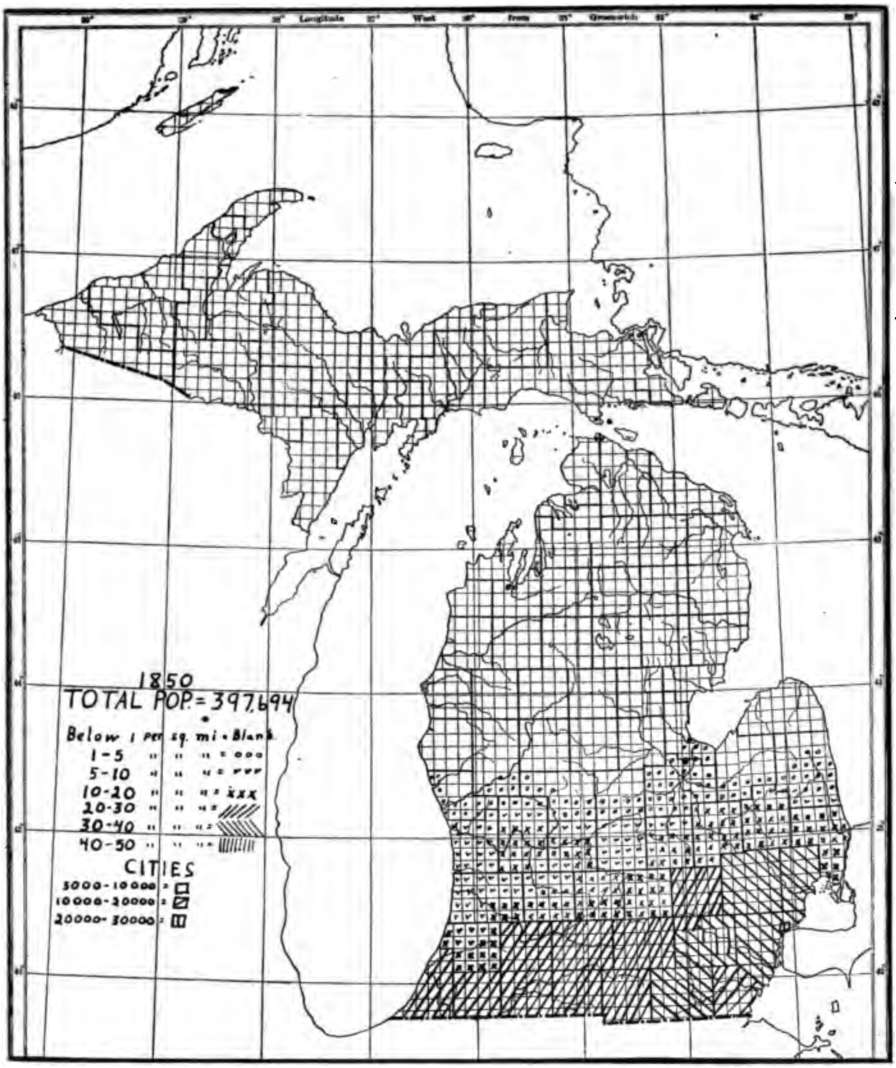
1-5
5-10
10-20
20-30
30-40
CITIES
5000-10000 = □


1850
TOTAL POP. = 397,694
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20-30 " " " =
30-40 " " " =
40-50 " " " =
CITIES
5000-10000 =
10000-20000 =
20000-30000 =

1860
POP = 749113
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5 - 10 " " " = vvv
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20 - 30 " " " =
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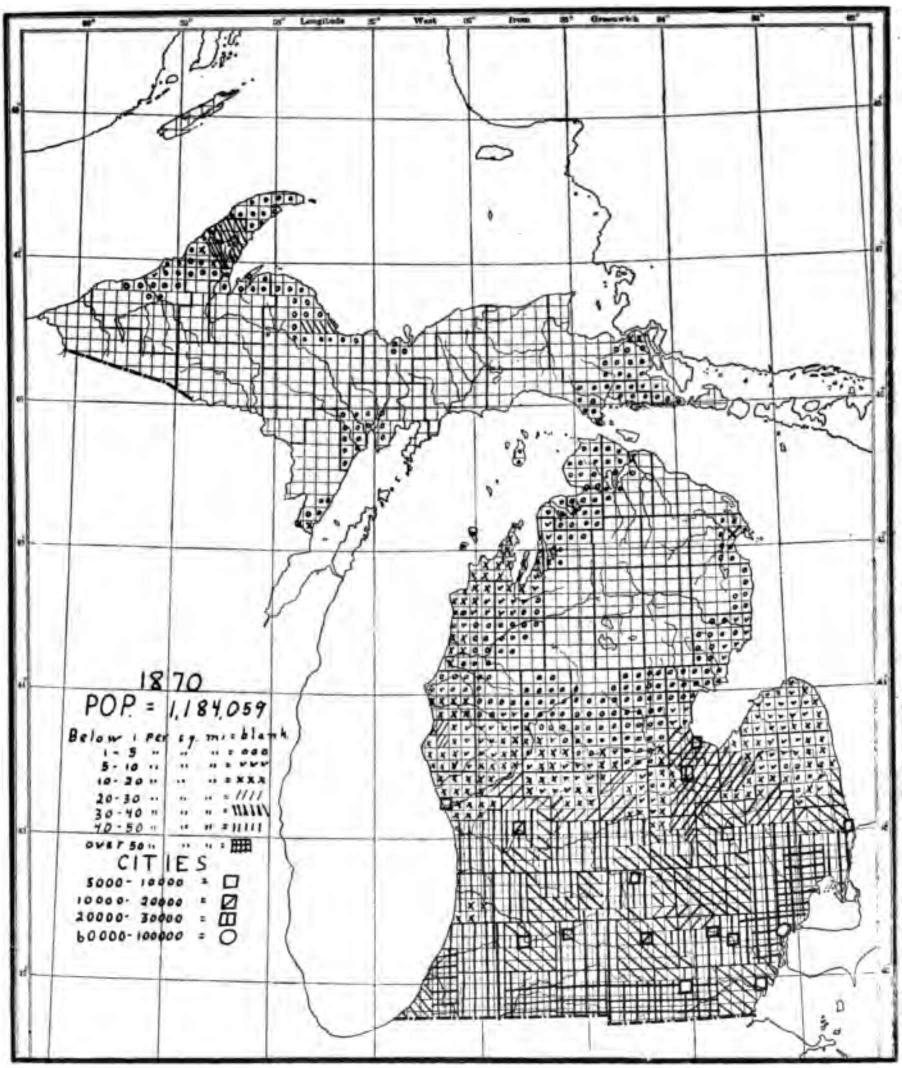
40 - 50 " " " =
CITIES
5000 - 10000 =
40000 - 60000 =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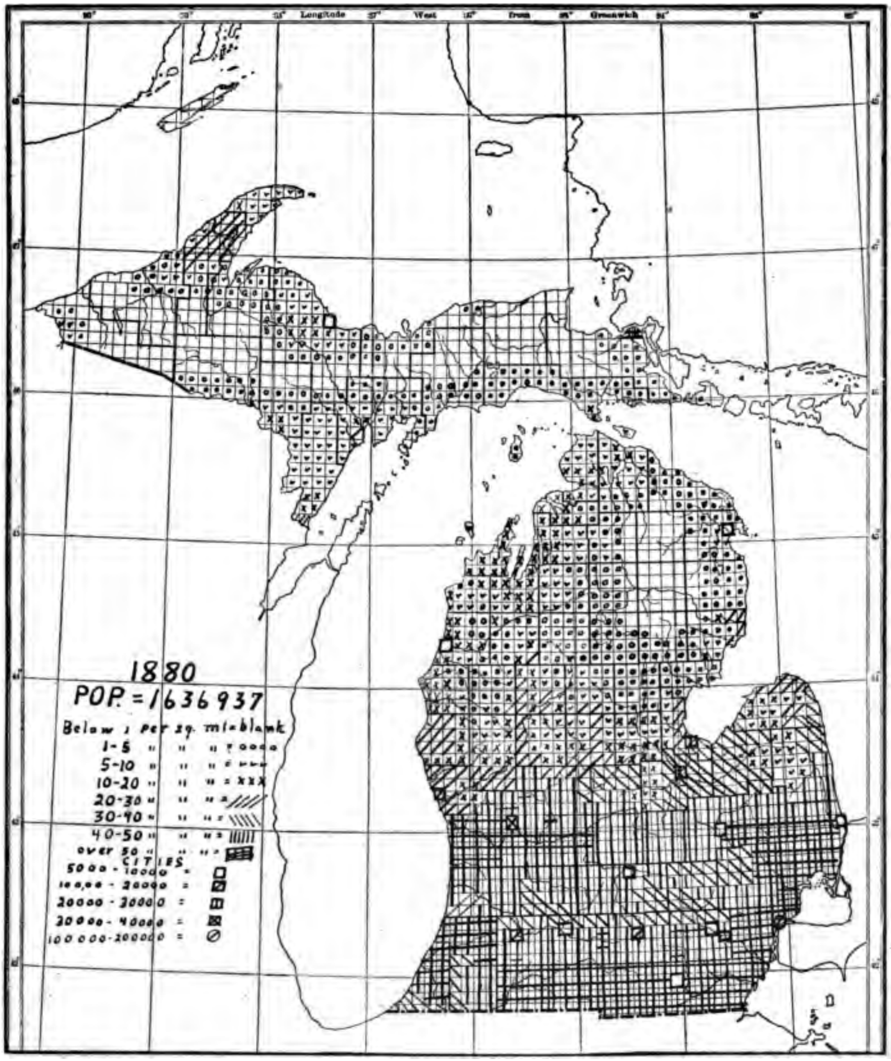
20 - 30 " " " = ////
30 - 40 " " " = \\\\\\
40 - 50 " " " = |||||
over 50 " " " =
CITIES
5000 - 10000 =
10000 - 20000 =
20000 - 30000 =
60000 - 100000 =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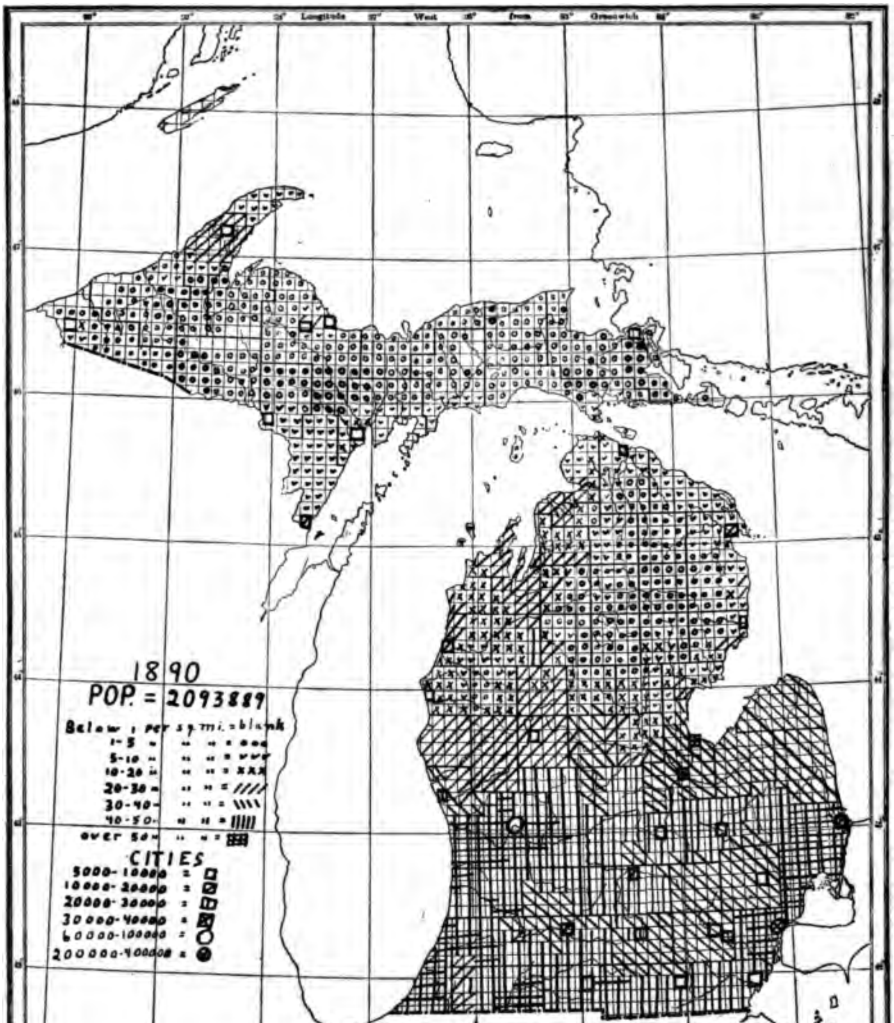
40-50 " " "
over 50 " " "
CITIES.
5000 - 10000 =
10,000 - 20000 =
20000 - 30000 =
30000 - 40000 =
100 000 - 200000 =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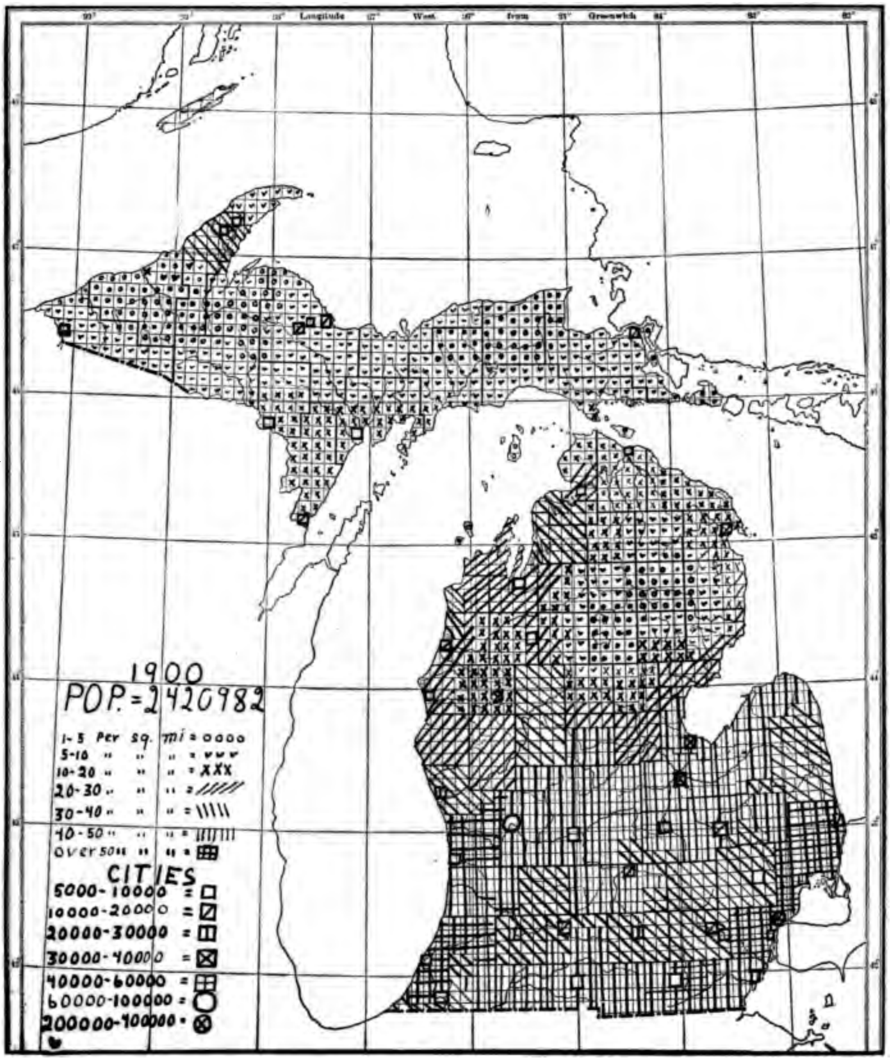
30-40 " " " = \\\\
40-50 " " " = |||||
over 50 " " " =
CITIES
5000-10000 =
10000-20000 =
20000-30000 =
30000-40000 =
60000-100000 =
200000-400000 =


Longitude West from Greenwich
1900
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10-20 " " " = XXX
20-30 " " " = //////
30-40 " " " = \\\\\
40-50 " " " = |||||||
over 50 " " " =
CITIES
5000-10000 =
10000-20000 =
20000-30000 =
30000-40000 =
40000-60000 =
60000-100000 =
200000-400000 =


Longitude West from Greenwich
1910
POP. = 2810173
1-5 Per sq mi : ooo
5-10 " " " :
10-20 " " " : XXX
20-30 " " " : ////
30-40 " " " : \\\\
40-50 " " " : ||||
OVER 50 " " " :
CITIES
5000-10000 =
10000-20000 =
20000-30000 =
30000-40000 =
40000-60000 =
100000-200000 =
400000-600000 =


Longitude West from Greenwich
THE DATE BY THE COUNTIES
NAMED IS THE YEAR IN
WHICH THE RURAL POP.
WAS A MAXIMUM, OMITTING
ALL CITIES ABOVE 5000.
A(X) MEANS POP. INCLUDING
CITIES IS LESS THAN FORMERLY.
ANTRIM 1900
GRAND TRAVERSE 1890
IOSCO 1900
ARENAC 1900
LAKE 1890
MECOSTA 1900
MIDLAND 1900
TUSCOLA 1900
SANILAC 1900
MONTCALM 1880
GRATIOT 1900
SAGINAW 1900
OTTAWA 1890
ST. CLAIR 1890
BARRY 1880
EATON 1870
INGHAM 1880
OAKLAND 1880
CALHOUN 1880
JACKSON 1880
WAYNE 1900
CASS 1880
BRANCH 1880
LENAWEE
MONROE

GOLD DEPOSITS OF PORCUPINE DISTRICT, ONTARIO.

BY REGINALD E. HORE, MICHIGAN COLLEGE OF MINES.

In the fall of 1909, important discoveries of gold were made in the Porcupine district, Ontario, about 100 miles northwest of Cobalt and 360 miles north of Toronto. Development work has proven some of the deposits to be large and of very profitable grade. Two mines, Dome and Hollinger are now producing on a large scale and several are contributing smaller amounts. About $2,000,000 was produced in 1912 and a much larger output is expected for 1913.

The ore is native gold in pyritic quartz. The quartz occurs[1] (1) as single fissure fillings or veins; (2) a series of fissure fillings running nearly parallel—vein system; (3) quartz-ferrodolomite lodes in which quartz veins penetrate bands of ferrodolomite or iron-calcium-magnesium carbonate; (4) quartz masses of irregular form, chimneys, kidneys, etc., and some more or less parallel, thick, lenticular masses.

The quartz is partly coarse grained, but much of it is very fine grained and has evidently been crushed. Granulation is indicated by the appearance of thin sections and strain phenomena are common. Some of the quartz shows a ribboned structure with banding in direction of the strike of the veins.

The gold is mostly in fine particles, but much also is in coarse grains and in the ore is frequently visible to the naked eye. Most of the visible gold is in parts of the quartz near the wall rock or masses of enclosed rock, and assays indicate a similar distribution for the invisible gold. Pyrite is almost always present in both quartz and wall rock and is more abundant in the latter. The gold is intimately associated with the pyrite and sometimes intergrown with it. Much of the visible gold near pyrite, however, is not actually in contact with it. There is some calcite in the ore, but it is not present in large quantity. Tourmaline, generally in aggregates of small crystals, is often found in the quartz. Scheelite has been found in a few veins.

MICROSCOPIC CHARACTERISTICS OF THE GOLD ORE.

The examination of numerous thin sections shows that there are certain differences in the ore from the several deposits, but these seem to be of a minor nature and the following description of gold-quartz from the Dome Mine may be taken as fairly typical of the Porcupine Mines.

The quartz is not uniform in grain and one may distinguish readily between the part that is coarse and the part that is fine. The coarser grains are commonly 0.5mm. to 1.0 mm. in diameter, while the finer are about 0.05mm. The coarse has numerous small cavities partially filled with liquid inclusions, and shows marked strain shadows; the fine has fewer inclusions and strain effects are not so marked. Fine grained

[1]Descriptions of four typical deposits were given in Canadian Mining Journal, Nov. 1, 1910, pp. 649-656.

quartz forms streaks running through the coarse grained. In some cases, two coarse grains are separated by a row of fine grains, which have apparently been derived from the former by crushing. In one specimen an area, 1.0 mm. in diameter, of fine grained quartz encloses an isolated coarse grain 0.2x0.4 mm. in diameter. The finely crystalline has apparently been formed largely by granulation of the larger grains. The small particles are firmly cemented together and there was evidently some solution and recrystallization though the cement is not distinguishable under the microscope.

In the fine grained portions there is a notable absence of large fluid inclusions and evidently some such fluid was able to move among the fine quartz particles. The presence of fluid inclusions in the quartz indicates that it was not when solidifying. The granulation of the quartz indicates that it was comparatively cold when crushed.

MODES OF OCCURRENCE OF GOLD IN DOME MINE QUARTZ.

1. Gold completely enclosed in one grain of coarsely crystalline quartz, e.g. One grain of quartz 0.5x0.8 mm. in the plane of the section completely encloses three isolated grains of gold. The small size of these gold grains makes it appear unlikely that they were not completely enveloped in the quartz, though there is a possibility that they were not. Another quartz grain 1.0 mm. in diameter enclosed three ragged grains of gold about 0.04 mm. in diameter and several gold particles 0.01 mm. or less in diameter.

2. Gold in spaces between grains of coarsely crystalline quartz, e.g. One U shaped area of gold 2 mm. long and 0.02 to 0.06 mm. wide forms a ragged band between coarse quartz grains. It forms a border for two-thirds the periphery of one quartz grain—hence the shape. In several sections, there is gold showing similar relation to coarse quartz grains.

3. Gold in crystals and grains of pyrite, e.g. One area of pyrite 0.5 mm.x1.0 mm. encloses several irregular patches of gold, most of which are less than 0.1 mm. in diameter. Four of these gold grains are completely within the pyrite, while a much greater number are partially enclosed by the pyrite and partially by quartz. A second and rectangular area of pyrite 0.5 mm.x0.1 mm. has along its middle portion five areas of gold. The string of gold particles continues from either end of the pyrite into clear quartz. Another specimen shows an area of gold 0.6x0.1 mm. which is four-fifths enclosed by pyrite, while the end projects into colorless minerals. The part of the gold not enclosed by pyrite is on one side in contact with calcite and on the other with a grain of quartz.

4. Gold grains in calcite, completely or partially enclosed. A twinned individual of calcite 1 mm.x0.5 mm. is enclosed chiefly by fine grained quartz, and one end is in contact with an area of pyrite 1 mm. in diameter. Around the edge of the calcite and in immediate contact with it, are nine distinct particles of gold. Within the calcite and arranged in a string roughly following a cleavage direction, are six grains of gold 0.02 to 0.03 mm. in diameter.

A second specimen shows an area of calcite 0.1 mm. x 1.0 mm., enclosing a number of small gold grains. This calcite is partially enclosed in fine quartz, but it also fills a fracture in one large quartz grain. This same specimen shows gold in quartz with no calcite in contact.

Another specimen shows a grain of calcite 0.5 mm. in diameter, which wholly or partially enclosed twenty ragged grains of gold. The gold is irregularly scattered through the calcite, but it is mostly at the edges. The calcite is surrounded by fine quartz 0.05 mm. in diameter.

5. Gold among grains of finely crystalline quartz, e.g. One very irregular area of gold, 1 mm. long and varying in width from 0.02 to 0.1 mm. is almost completely enclosed by fine grained quartz, the particles of which average 0.03 mm. in diameter. That part of the gold, not enclosed by quartz, is in contact with calcite. It is noteworthy that most sections, showing gold, show also fine (probably granulated) quartz and small amounts of calcite.

CHARACTERISTICS OF THE WALL ROCKS.

The gold quartz occurs in rocks of the Keewatin and Huronian series. The Keewatin is composed largely of igneous with some sedimentary rocks. The Huronian is largely sedimentary. Most of the deposits are in altered quartz porphyry, others in more basic rocks—porphyrites, basalts, etc.—conveniently called greenstones. Some are in conglomerate and greywacke-slate.

Mr. A. G. Burrows, who has mapped the area for the Ontario Bureau of Mines, gives the following succession of formations for the district:

"*Pleistocene.*—Post Glacial—stratified clay, sand and peat.
Glacial—boulder clay.

Pre-Cambrian.—*Later Intrusives*—quartz-diabase, olivine, diabase, etc.

Igneous contact:

Cobalt Series—conglomerate.

Unconformity:

Temiskaming Series—conglomerate, greywacke, quartzite, slate or delicately banded greywacke.

Unconformity:

Laurentian—A complex of granites older than the Cobalt series. It intrudes the Keewatin, but its relationship to the Temiskaming is not definitely known; it may be in part older and in part younger than the Temiskaming series.

Igneous contact:

Keewatin—The series consists chiefly of basic to acid volcanics, much decomposed, and generally schistose; amygdaloid basalts, serpentine, diabase, quartz or feldspar porphyry, felsite, iron formation, rusty weathering carbonates, and other rocks have been recognized."

The Cobalt and Temiskaming Series referred to by Mr. Burrows are divisions of the Huronian corresponding to those made by Dr. W. G. Miller at Cobalt and by Mr. Robert Harvie[2] in the area east of Lake Temiskaming. Mr. Harvie calls the lower sediments "the Fabre series."

The gold is found in quartz occurring in the several types of rock comprising the Keewatin and Temiskaming series, but it is noteworthy that the wall rocks of all the ore bodies, while probably originally quite different, have remarkably similar composition. This similarity is due to alteration, by which the minerals have been replaced by sericite, car-

[2]Geology of a portion of Fabre Township, Quebec Mines Branch, 1911.

bonates, quartz and chlorite. The light colored wall rocks[3] are largely made up of the first three minerals. In the darker ones, there is much chlorite. Pyrite occurs abundantly and is commonly well crystalized. The wall rocks are commonly not highly auriferous except where penetrated by quartz stringers. Where thus silicified, the rocks sometimes contain payable quantities of gold.

ORIGIN OF THE DEPOSITS.

We have in the Porcupine district pyritic gold quartz deposits enclosed in rocks characterized by an abundance of ferrodolomite, sericite and pyrite. The nature of the ore and the wall rocks suggest that the gold was introduced into the fissures along with the chief constituents of the minerals mentioned. The solution,* which contained the gold, probably contained also in some form, iron, sulphur, silica, potassium, and carbon dioxide. From the solution, practically all the potassium and carbon dioxide escaped into the wall rocks and aided in the formation of sericite and ferrodolomite. Part of the iron and sulphur also escaped into the wall rocks and there formed pyrite crystals and contributed iron to the formation of ferrodolomite. Part of the iron and sulphur and nearly all of the gold and silica was deposited in the fissures themselves. It appears that the walls were more readily penetrated by some constituents than by the others,[4] and in this way much of the CO_2, S, and Fe escaped. In proportion as these constituents escaped, the solubility of the gold in the remaining solution would be decreased and the deposition therefore aided by removal of solvent as well as by lowering of temperature. The pyrite, first formed in the veins, was comparatively poorly crystallized and was probably formed quickly. The pyrite in the wall rocks and some pyrite in the veins, that is probably of secondary origin, is in well formed crystals and evidently formed slower, or at least, under some more favorable conditions than did the original auriferous pyrite of the quartz veins. The gold and pyrite were not evenly distributed originally. Evidently in the first crystallization, they tended to segregate here and there, and the especially favorable place for deposition was near the walls or around masses of enclosed rock.

After the filling of the fissures with quartz, gold and pyrite, the veins were shattered and the quartz granules strained or crushed. In the crushed zones, a secondary set of minerals including sericite, chlorite, calcite, ferrodolomite and pyrite and some gold were deposited. These probably originated in the vein and wall rocks. The gold thus formed is in coarse grains which probably grew by slow accretion of small particles by a process continued over a long period. It is probable that this coarse gold grew at the expense of the fine gold contained in the quartz in its immediate neighborhood, thus leaving much very low grade quartz in the vicinity of the spectacular specimens. The coarse gold, to which a secondary origin is here attributed, while showy, is

[3]Microscopic description of several of the rocks is given by C. W. Knight and A. G. Burrows in the Bureau of Mines report, 1911. Mr. John Stansfield described rocks and ores from Vipond Mine in Canadian Mining Journal, Feb. 15, 1911. The wall rocks of Dome, Hollinger and Rea mines were described by the writer in Trans Cen. Min. Inst., 1911, pp. 173-178.

*For discussion of transport of gold in solutions containing such constituents see Macaren Gold, pp. 105-107.

[4]Cf. Lindgren, Characteristic features of California gold quartz veins. Bull. Geol. Soc. Am., 1895.

usually quite subordinate in amount to the fine gold, much of which may well be still in the form in which it was first deposited with the pyrite and quartz. Some fine gold, however, is probably secondary, and there are cases in which the amount of secondary gold is greater than the amount of primary.

There is nothing to indicate that the character of the deposits has been changed to any considerable degree since the glaciers cleaned away the surface rocks, and there is therefore no reason for believing that the ore will show any appreciable dependence on the present surface. The secondary changes which have taken place are not surface alterations.

RIPPLE MARKED HURONIAN QUARTZITE AT NIPISSING MINE, COBALT, ONTARIO.

(With six plates).

BY REGINALD E. HORE, MICHIGAN COLLEGE OF MINES.

At the Nipissing Mine, an unusual method of surface prospecting has presented remarkably well exposed areas of Huronian and Keewatin rocks. In examining these areas recently, the writer found the well developed ripple marks shown in the accompanying photographs. Being very well preserved, the marks are of interest in themselves. As they occur in a series of rocks supposed to be largely of glacial origin, they have added interest.

Of the Huronian rocks at Cobalt, the most characteristic type is a coarse conglomerate, sometimes called the Cobalt conglomerate. The unusual characters of this rock were pointed out by Dr. A. P. Coleman, who showed[1] that the material was probably of glacial origin. In a subsequent paper in the Journal[2] the present writer gave additional information in support of Dr. Coleman's view. It was stated that, with the conglomerate, there is well stratified material, and to this was ascribed a glacio-fluvial origin. At the time of writing that paper, the writer had not seen any ripple marks; but the evidence of deposition of some of the material by water was regarded as quite conclusive. More recently ripple marks have been found in the rocks broken in mining the silver ore; but until the hydraulic work was done at the Nipissing, it was not possible to present photographs showing the marks on rock in place. In prospecting the surface at the Nipissing Mine, a powerful stream of water, 4800 gallons per minute from a 3½ inch nozzle, is directed against the glacial debris and the rocks washed bare. The photographs show Huronian rocks thus exposed. Fig. No. 1 shows an end view of the quartzite bed which has the rippled upper surface. Fig. No. 2 shows a thin layer of shaly mud rock lying on the ripple-marked quartzite. Fig. No. 3 shows a large boulder in the fine mud rock lying on the quartzite. Evidently, there were remarkable changes in local conditions, for these large boulders encased in fine mud rock, or shaly greywacke, lie immediately on top of the bed of uniformly grained quartzite. Fig. No. 4 shows, at the left, blocks of the mud-rock which overlies the quartzite. Figs. No. 5 and No. 6 show closer views of the quartzite.

[1] A. P. Coleman. Lower Huronian Ice Age. Jour. Geol. Vol. XVI, No. 2, pp. 149-158. 1908.
[2] Glacial Origin of Huronian Rocks of Nipissing. Jour. Geol. Vol. XVIII No. 5, pp. 459-467. 1910.

THE NATURE OF ENZYME ACTION.

BY JAMES GORDON CUMMING, M. D., IN CHARGE OF THE PASTEUR INSTITUTE OF THE UNIVERSITY OF MICHIGAN, ANN ARBOR.

One of the most striking characteristics of the living cell is the ease with which its products of metabolism split bodies of a highly stable nature. Soluble starch, for example, is hydrolyzed to the simple sugars by ptyalin. Egg-white is split into comparatively simple compounds by pepsin hydrochloric acid. Under ordinary laboratory conditions, on the other hand, powerful reagents and high temperature are required to accomplish these decompositions. The digestion of the food-stuffs is recognized as a process of fermentation or enzyme action. The enzymes have not as yet been isolated in pure form; consequently we have no definite knowledge concerning their chemical constitution, nor the exact character of their action.

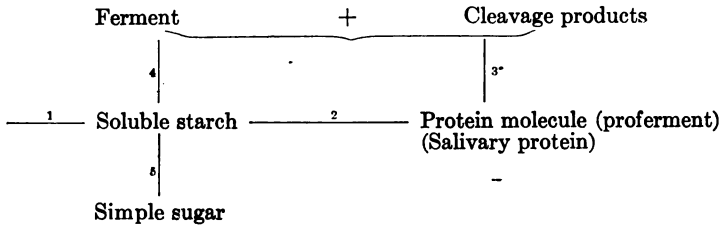
In seeking an explanation of ferment action one naturally turns to certain simple chemical reactions which are apparently similar in their essentials. These are termed catalytic reactions and were recognized as early as 1834 by Mitscherlich. He stated that the formation of ethyl ether and water from ethyl alcohol in the presence of sulphuric acid did not depend upon the dehydrating power of the acid nor upon the formation of an intermediate product, ethyl sulphuric acid, but that the acid facilitated the reaction by its mere presence without entering into it. He called this "contact action" a designation which is in every way as appropriate as catalysis, which term was suggested by Berzelius in 1835.

Let us consider briefly this phenomenon, contact action or catalysis. It is found that oxygen and hydrogen at ordinary temperatures combine so slowly that the production of water cannot be detected. But the presence of finely divided platinum is sufficient to cause combination to take place rapidly. Again, the oxidation effected by hydrogen peroxide proceeds in many cases at a very slow rate, but this can be enormously accelerated by traces of iron or manganese. The oxidation of sulphur dioxide to sulphur trioxide occurs but slowly. In the presence of oxides of nitrogen the velocity of the reaction is greatly accelerated. The contact process for the manufacture of sulphuric acid depends upon finely divided platinum or iron oxide as catalytic agents. The manufacture of glucose from starch depends upon dilute acids as catalyzers, and in the Deacon process copper chloride hastens the combination of hydrogen and chlorine to hydrochloric acid.

Although the work accomplished by these catalysts is strikingly similar to that of the ferments, yet it is not analogous in every respect. Exact proportions are not required between catalyst and substrate nor between enzyme and substrate. In extremely high dilutions of either catalyst or enzyme the reaction proceeds even though the rate may be slower than in more concentrated solutions. In these two respects they are similar.

The catalyst does not initiate a reaction, but merely increases the rate of one already in progress. On the other hand, ferments will initiate reaction which are not already in progress. Soluble starch, under suitable conditions, can be kept without appreciable cleavage, yet when treated with saliva a part of it is immediately split into the simple sugars. In this respect the catalysts and the enzymes are not alike, for the enzyme does not necessarily enter into a reaction already in progress, but actually initiates one.

Again, the catalyst does not enter into the reaction, but facilitates the final result by its presence. This would not appear to be so in regard to the starch splitting ferment of the saliva, for, in normal saliva we find about 5 parts of free ammonia per million. If, however, 10 cc. of saliva is treated with 25 cc. of a 1 per cent soluble starch solution the ammonia is increased by about 20 part per million. The experiment bearing on these findings consisted in the estimation of the ammonia content in 5 treated and 5 untreated specimens of saliva. In those untreated there were from 3 to 9 parts of free ammonia per million, while in those treated there were from 20 to 27. This increase in ammonia unquestionably has its origin from the protein molecule. As a further evidence of protein cleavage in the process of splitting starch, we find that untreated saliva does not readily conduct an electric current, while the treated saliva gives but little resistance; this is, of course, due to the increased ionic content. From these experiments it would seem that the cleavage of starch by ptyalin is not due to the mere presence of the ferment, but that there is an actual chemical reaction more than catalytic in nature. It is, possible, however, to account for the protein cleavage if we consider the starch splitting process one of autocatalysis. In applying this hypothesis it is necessary to assume that the active ferment—as such—does not exist in the untreated saliva, but is present as a component of the protein molecule in the proferment stage. To activate the ferment the soluble starch may act as a catalyzer. As a result of this catalytic action, the ferment is split from the protein of the saliva, and as other products of the reaction there is formed free ammonia, neutral salts, etc. Now, the free ferment being a product of this catalytic process, reacts autocatalytically as a starch splitting ferment. The double reaction may be represented as follows:



Cell ferments, in contradistinction to inorganic catalysts, are in general supposed to be destroyed by heat. Our experiments with saliva, however, show that the ferment is not destroyed by short exposures to high temperatures, although it is rendered inactive. If saliva is boiled for a short time, then dialyzed in distilled water, and at intervals a portion is removed and tested, it is found that it is reactivated in about two hours. The results of our experiment with heated saliva are as follows. Three specimens were each boiled for one minute; 2 of these were reactivated in 1 hour and 40 minutes; the third remained inactive. Four specimens were boiled for 2 minutes; two of these were reactivated in 1 hour and 20 minutes; one in 2 hours; and the fourth not at all. Five specimens were boiled for 4 minutes; one of these was partially reactivated in 2 hours and 30 minutes; none of the remaining four became active. Of five specimens boiled for five minutes none were reactivated by dialysis.

This inactivation by heat is not to be considered entirely as an actual destruction of the ferment, but rather due to the products of cleavage of the other components of the complex colloidal system of which the ferment forms only a part. Heat applied to a protein solution causes a cleavage of the protein molecule with the liberation of neutral salts, free alkali, and amino-acids. The addition of these products to any bio-chemical system markedly retards or entirely prevents its progress. If, however, they are removed by dialysis the system can in a few instances be reactivated.

It sometimes happens that one of the products of the reaction acts catalytically on the reaction. This is known as autocatalysis. It is common to metals which dissolve in acids. For instance, the action is slow when copper is added to pure nitric acid. Nitrous acid is a product of the reaction, and this acting catalytically greatly increases the velocity. Thus, this reaction increases in velocity as it proceeds. The characteristic course of a reaction involving autocatalysis is a velocity, small at first, ascending to a maximum, then descending. What we at first thought to be a typical example of autocatalysis is outlined in the following experiment. Cubes of egg-white and pepsin hydro-chloric acid were placed within a collodion sac, outside of the sac were hydrochloric acid of the same strength and egg-white cubes. This was set aside for a time at 38°C. There was almost complete digestion within the sac after an incubation of 35 hours, and the egg-white in the outside fluid was partially digested. Assuming that the pepsin could not pass through the sac we explained the digestion of the outside egg-white by the assumption that the dialyzed products of digestion exerted typical autocatalysis. Control experiments, however, showed that the pepsin was dialyzable through the membrane. The same findings were duplicated with ptyalin and starch, also with rennet and milk. These ferments are, then, diffusable through colodion sacs, in fact almost as readily so as are their products of cleavage.

That the associated components in a ferment mixture influence the dialysis of a ferment is shown in the following experiment: We find that if saliva is placed within a collodion sac and this surrounded by a soluble starch solution, glucose does not appear in the starch solution for at least 45 minutes after the beginning of the experiment. If, first, the saliva is filtered through Kieselguhr or a Berkefeld filter, which process if repeated several times does not appreciably lessen the ferment content, the enzyme dialyzes very quickly into the starch solution; the simple sugars appeared within 5 minutes in three experiments out of seven. Why should the ferment of the filtered saliva dialyze more rapidly than that of the unfiltered? All colloids are more or less adsorbed by surfaces, and in these experiments the membrane must become saturated before the ferment passes to the exterior. Inasmuch as the ferment of the filtered saliva dialyzes much more rapidly than that of the unfiltered we may conclude that the ferment itself is not so strongly colloidal in nature as are the other constituents of the saliva which are removed by filtration. This experiment though not at all proving the crystalloidal nature of the starch splitting ferment of the saliva, at least tends to show that after removal by filtration of certain salivary constituents the ferment more nearly resembles a crystalloidal compound than heretofore recognized.

Pepsin also may pass through a thin collodion sac. This fact may be proved by the following experiment: A solution of pepsin hydrochloric acid is placed inside a collodion sac; this is surrounded by a hydrochloric acid solution of the same strength. Cubes of boiled egg-white are then added to the outside solution. As control, egg-white cubes are placed in the same percentage of hydrochloric acid in a separate container. That the pepsin diffuses to the exterior is shown by the digestion of the egg-white in from 30 to 40 hours. The egg-white in the control remains intact. From the results of similar experiments Barendrecht advances the theory that enzymes are radio-active bodies, the chemical action being due to radiation. By a series of experiments, however, it is shown that the ferment penetrates the membrane.

The inorganic catalysts have the property of continuing a reaction to its completion. In contradistinction to this the ferments are active in their cleavage process, at least in vitro, only to a partial extent. Here we have a distinct difference between catalyst and enzyme. The one completes the process; the other does so only partially.

Another characteristic of ferments not manifested by catalysts is their property of causing a reversible action. For instance, although emulsin splits amygdalin, a plant glucoside, into benzaldehyde, hydrocyanic acid, and glucose, it is also capable, to a certain extent, of synthesizing these separate components into amygdalin. In eitnher case—analytic or synthetic—it is a question of approaching an equilibrium.

The action of fermentation may be explained by the supposition that the ferment solution is a specialized ionic arrangement which induces rapid autolysis of a complex molecule. The specific ionic content of the ferment solution may be responsible for an instantaneous break in the equilibrium of the complex molecule acted upon. As the character of the red blood cell is immediately lost—the hemoglobin going into solution—when treated with distilled water; and as the complexity of the protein molecule is partially lost—the neutral salt, alkali, and amino-acids splitting off—when small quantities of blood-serum, for instance, are treated with several times their volume of distilled water; so also can we assume that there is a similar relation—though far more complex in nature—between ferment and substrate?

May not, however, the real solution of this problem depend upon the isolation and thorough study of the ferment complex, if such exists.

A BACTERIAL DISEASE OF THE LARVAE OF THE JUNE BEETLE, *LACHNOSTERNA* SP.

BY ZAE NORTHRUP.

During the summer of 1912, the larvae of the June beetle, *Lachnosterna* sp. committed serious depredations to crops. Specimens sent in to the Entomological Department by the farmers were found to be diseased and were turned over to the bacteriological laboratory for the determination of the etiology of the infection, and, if practicable, to use the living parasite as a remedial measure.

This disease which is characterized by a blackening of the affected parts was found to be a micrococcus, which was found microscopically in smears and in sections from diseased tissue. This organism was isolated from the affected tissues of a living grub and liquid cultures were used for the inoculation of soil in which healthy larvae were then placed. Oftentimes infection occurred within a short time; the most marked infection occurred when an incision was made in the integument, a characteristic lesion developing within twenty-four hours.

It was discovered that an excessive amount of water in such inoculated soil favored the rapid progress of the disease. This seems to be one of the most important factors in determining the fatality of the infection.

This disease may be transmitted characteristically to larvae of the Southern U. S. June beetle, *Allorhina nitida* and to the American cockroach, *Periplaneta americana* but is non-pathogenic to rabbits and guineapigs.

The black pigment characterizing the disease is probably produced directly or indirectly by the activity of the bacterial cells within the larvae tissue; the cocci and the integument cells in which they are imbedded do not take the ordinary or the Gram stain but remain a dark brown in color.

It has not yet been possible to try out this organism as a remedial measure for the destruction of the white grub.

THE ENVIRONMENT OF SOIL BACTERIA.

BY DR. F. H. HESSELINK VAN SUCHTELEN.

In physiology we recognize the influence of environment on the single cell. Not only if we take the high water content of the living substance into consideration, but also if we consider metabolism as the phenomena of life, the importance of water in the life process is made clear. Without water there is no life. By adding to or diminishing the water of the living substance within certain limits, we increase, diminish, and limit the intensity of life processes. The environment of bacteria is water, and soil bacteria form no exception. There, where there is little or no water at their disposal, the metabolic processes are reduced to a minimum. Spores, cysts, and other defensive organs are the results of the dryness of the medium. In a former publication,* the author has tried to make a numerical comparison between the water content of the soil and the activity of the soil bacteria. As an indicator the carbon dioxide production in soils was chosen, a metabolic product that is formed in nearly all life processes in comparatively large quantities, and in easily detected form. Without going into detail with these experiments, I will say that if the soil contained only 4.4% of water, the soil bacteria would be unable to attack the easily broken down dextrose which was added to the soil. I take this as an example illustrating the overwhelming importance of the water content for the biochemical action in soils.

From the foregoing it is clear that water is the medium of soil bacteria. Although one cannot make in proxi a sharp distinction between the quantity and the nature of the water, I should like to cite the experiments of Beyerinck† as evidence of the influence of the nature of the water, on the microorganisms. His experiments deal chiefly with unicellular organisms, and let us say here that the Oecological Method proved to be of especial value, in the case of the lower organisms, because they are unicellular and expose in comparison with their content such an enormous surface, on which the medium can act.

In his classical investigations Beyerinck showed the dominating influence of the nature of the water environment on the behavior of the microorganisms. How uniform was the material with which he started must be noted, for it was in many cases the mud of the canal in Delft. By influencing intelligently the life conditions of bacteria, such as oxygen and food supply, temperature and many other factors, he was able to predict and to obtain with mathematical surety the predominating flora.

In such experiments as this on the nature of the water, Soil Bacteriological Science finds its greatest promise.

If we ask ourselves, "what is the ultimate aim of the applied science

*F. Hesselink van Suchtelen: Centr. Bl. f. Bakl. II Abt. Bd. 28 S. 45.
†F. Stockhausen: Oekologie Auhaüfungen nach Beyerinck.

of Soil Bacteriology," the answer must be: The aim of Soil Bacteriology (aside from the purely scientific interest) is to put the action of the soil bacteria in the service of Agriculture, to suppress the detrimental species and their action, and to encourage the beneficial bacteria like those which accumulate nitrogen, and such as make available those compounds of the soil, which are in a state not available for plant nourishment.

To accomplish this, or, in other words, to influence the microorganisms in the soils intelligently, presupposes the necessary knowledge of the environment of the bacteria, of those factors which are at our command, that can be varied as we desire, such as oxygen supply, water, reaction, etc.

Let us now consider the soil and let us treat it from the point of view of a medium for the micro-flora. Soil is composed of three states of material, solid material, water, and air; and these three states have a marked influence on each other. The soil bacteria are living in the soil water; but this soil water is influenced very markedly by the solid material and by the air. It is this that makes the soil a difficult medium to investigate. I might say here that I know of no medium that is so variable and complex as soil. If we consider milk in this respect, the air, and the solid substances, play only a very small role. It can also be said that the milk of different cows does not differ materially as a medium for the bacteria. On the other hand, we know how large are the differences in soils which must necessarily influence their micro-flora.

We encounter still another difficulty if we remember the fact that our medium (the soil) is very difficult to sterilize. Only by the action of powerful agents are we able to sterilize the soil, in fact, the changes, which are necessarily brought about by this sterilization process, are so marked that we doubt even if we may call this sterilized medium, soil.

This means that in the case of soils we are practically deprived of the opportunity of recording the action of single species of microorganisms. Further soil is especially characterized by enormous surfaces. To give an idea how great the soil surface is, I should like to cite the work of Alfred Mitscherlich* who came to the conclusion that the outer surface of one gram of quartz sand was 1.38 square meters and that of one gram of clay was 966.7 square meters. These enormous surfaces give us an idea of how closely the soil water can be in contact with the solid soil substance.

In regard to the permeability, I regret to say that we have but very little trustworthy data. The reason for this is evident, namely, that the many values obtained with air dried soil do not permit any conclusions for field conditions. We may say, however, that the permeability of the different soils is extremely variable.

From the foregoing, it is clear that, even in fine tertiary quartz sand, which has so great a surface, there is great possibility for action between the soil water and the absorbed substances on the soil grains.

On the question of, "What is the nature of these reactions between the soil water and the soil particles," the answer cannot be very satisfactory. Permit me, however, to draw your attention to some experi-

*A. Mitscherlich: Bodenkunde für Land und Forstwirte, 1905 p. 49-73.

ments which give us the right to suppose that these reactions are different from the reactions that occur in a beaker and test tube.

Aside from the phenomenon of selective absorption which we know takes place in soils, we have at our command a number of experiments performed by the most distinguished chemists showing that the amount and kind of surface possesses marked influence on the reactions. I cite here the work of van't Hoff who concludes that both the nature and the amount of surface exposed have an influence. The inversion of sugar is affected by the nature of the walls of the containing vessel, and its reduction by Fehling's solution is effected by the walls and the amount of cuprous oxide formed in the reaction. In the case of soils where we have so large a surface and such thin films, absorption, surface tension, and other not-well-defined molecular forces may and will play their role.*

It follows then that the addition of an excessive amount of water to soils (drainage) changes the conditions, i. e. salts that were not in solution in the soil solution will be found to be dissolved in the drainage water, and we have therefore, the right to suppose that the drainage water is different, in a qualitative and quantitive respect, from the film water which surrounds the soil particles. It is, therefore impossible to make any conclusion, from the analysis of drainage water on the soil solution as it exists in the soil, because the dissolving process is probably not proportional to the amount of water added.

On account of the importance of the environment of the soil bacteria, a knowledge of the solution as it exists in the soil becomes most urgent. And here we may add that this subject does not only concern the lower forms of life, but in the case of higher plants also, the study of the soil solution promises fruitful results.

So I have directed my study towards this theme and have been seeking a method which would furnish me some soil solution. Here, again, we meet with some difficulties which I should like to mention briefly.

It is absolutely impossible to obtain a comparison between the soil solution obtained and the total soil solution, because every method for securing the soil solution can give only a percentage of the total solution, as the last traces of soil water are held back tenaciously by great forces.

The method finally adopted consists of the displacement of the soil solution by means of paraffine oil. There is something depressing in the impossibility of being able to verify our obtained results with the reality.

With the kind assistance of Mr. Itano some experiments have been made. Sulphuric acid of known strength was added to carefully washed, dry quartz sand. After this paraffine oil was poured on the sand and by means of a suction pump the acid was regained. The titration showed that the so-obtained acid did not differ from the acid which was used in the experiment. I am perfectly aware of the fact that this experiment has practically little bearing on soil conditions. The fact, however, that our regained solution had the same composition as the original employed solution does not mean that our method is not permissible.

There must be considered, then, the nature of the medium with which

* F. K. Cameron, The Soil Solution.

we displace the soil solution. We may congratulate ourselves on the choice of paraffine oil as a medium. With the most refined instruments that were at our service, we were unable to detect any change in the solution when it was brought into intimate contact with the paraffine oil. We found then, that the inactive paraffine oil did not change the electrical conductivity of the soil solution, while the chemical analysis also showed that there was no change brought about by the action of the paraffine.

The third method which we employed was the measuring of the surface tension. We might expect that when only slight traces of the paraffine oil were dissolved in the soil solution, this would have its marked effect on the surface tension of this liquid. However, we were unable to detect any change in the surface tension of the liquid after it had stood for a long time covered with the paraffine oil. So far, the results obtained have demonstrated the permissibility of the use of the method employed.

In regard to the amount of the soil solution that can be extracted by the application of our method, I must say in advance that even slight modifications even of the apparent details of our process caused large variations in the amount of water obtained.

If we record only the values obtained, by the use of those conditions which we knew to be most satisfactory, then we must record the amount of solution obtained as a percentage of the total water capacity.

But, at present, there exists in a few fields of soil physics such conflicting interpretations of the meaning of the term "water capacity." In the different text and laboratory books, we find the most diverse definitions and the most conflicting methods for the determination of this total water capacity. Because we suspected that this value would vary quite markedly with the application of the differently devised methods, we undertook some experiments which proved that our supposition was correct. The total water capacities of the same soil as determined by the different methods varied over thirty per cent. From the soils containing the maximum water capacity we were able to extract over seventy per cent of the total water. As an example, I will cite in this connection the data of an average extraction.

From eight kilograms of soil (clay) which contained 14.3% water (figured on the basis of dry soil) was obtaned 330 cc. of soil solution. It is evident that such results can not be obtained by the use of a simple suction pump where the maximum difference of pressure is necessarily less than one atmosphere.

However, we have secured larger differences in pressure by using several hundred pounds of pressure by means of a hydraulic press.

We now have the soil solution and will analyze it. There are two ways in which we may investigate such a solution which require a short explanation.

I. The chemical analysis.

II. The physiological analysis.

A chemical analysis seeks through its results a determination of soil fertility. However one can not claim that this method has been successful. The only thing which we can say with surety about its results is that if a certain nutritive element is found to be not present in the soil, then it is lacking for the nutrition of the plant. The difficult problem between the relation of chemical analysis and availability still awaits solution.

The physiological analysis draws its conclusions from the vegetation itself. In other words, it is an attempt to put direct observation in the place of theoretical deduction. Since no definite results from the analysis of the soil solution have been so far obtained, and since one must recognize that the latter has no scientific value as a determination of soil fertility, the author has applied not only chemical analysis to the solution but in connection with this also a physico-chemical analysis.

We may suppose from analogy that the physico-chemical analysis of such a liquid may be of exceptional value. However, I must emphasize that in spite of all the various determinations I do not feel myself called upon to draw any definite conclusions from these analyses with reference to the exceedingly complex question of soil fertility. So far as chemical analysis is concerned we must keep before ourselves the all important fact, "corpora non agunt nisi soluta," in other words that only which is present in the soil solution can be taken up as a nutritive substance, but not every thing present need be taken up.

There still remain a few things which I should like to say. I will state the facts that were revealed by the application of our method. Complete results will appear in a publication of the near future.

This is not the place to discuss the details of the different analyses.

In many cases there was found in the soil solution a slime. This must be regarded as the first experimental proof of the presence of this substance in soil, and it is not impossible that much of the irregular behavior of the life in soil could be explained to some extent with a knowledge of this slime. If I may be permitted, I should like to call your attention to the possible effects of this substance on dessication, diffusion, and other processes.

(2) The specific gravity of the soil solution which influences the movement of the soil water was found to be higher than that of water.

(3) As to the viscosity of the soil solution which governs to a certain extent the rate of adjustment of soil water in the soil, we can say that it is relatively high.

(4) The surface tension, a property of liquids which is associated with adsorption and has an influence on the degree of capillarity, was found to be low in the case of the soil solution.

(5) In reference to the osmotic pressure of the soil solution, which on one hand is the indicator of the state of solubility, and has a bearing on the adjustment of the water in the soil, and on the other hand markedly influences the life in the soil, we can say that this pressure is low, a result which was to be expected from the comparatively high resistance of the liquid.

(6) Another thing noticed is the acid and basic binding capacity. This was found by the electrotitrimetric method. In general we may say that the neutrality was obtained by adding very small quantities of a normal 1000° alkali or acid.

(7) In regard to chemical analysis you will not be surprised to hear that all nutritive substances could be found in our soil solution to a certain degree. An astonishing fact, however, is the relatively large quantity of nitrites in some samples. With reference to the value of

the chemical analysis of the soil solution, I refer to that which I have already said.

Our work can by no means be looked upon as complete, but I dare say that the results are promising, and that I feel happy to be able to present to the reader the preliminary results which have been obtained by the application of the methods of Mr. Itano and myself.

THE INFLUENCE OF *BACT. LACTIC ACIDI* UPON THE CHANGES CAUSED IN MILK BY SOME OF THE COMMON MILK MICROORGANISMS.

BY CHAS. N. BROWN.

We know that in fresh milk bacteria of the *Bact. lactis acidi* type are usually greatly in minority: and, too, that in milk standing for 24 to 36 hours under the usual temperature environment common to most market milks the *Bact. lactis acidi* type gains majority. It can not be said that this transition is due entirely to their ability to multiply more rapidly than any of the other types, because it is not uncommon to find in milk other types which when transplanted to sterile milk will multiply at temperatures between 15° to 20°C. more rapidly than will *Bact. lactis acidi.*

The growth of *Bact. lactis acidi* may be stimulated or retarded by association with other microörganisms. Stimulation both in rapidity and duration occurs if in the medium is present some acid destroying or acid retaining compounds, as insoluble carbonates, casein, etc. For example, upon a plate made from a milk agar shake (25% sterile milk added to a tube of melted agar and shaken to mix) to which some sterile powdered calcium carbonate is added before pouring into the Petri dish and inoculated with a stroke on the surface will develop a superabundant growth, while upon a similar plate without the calcium carbonate will occur a very meager growth. The casein in a milk culture when compared with a whey culture, acts in a like manner.

A number of the types of microörganisms commonly met in milk produce, in pure milk cultures, compounds which react alkaline to litmus and phenolphthalin: and the lactic in association with any of these types usually manifests a stimulated growth. A visible stimulation may be seen upon a plate made from a milk agar shake heavily seeded with one of these types and inoculated with the lactic by stroking the surface.

Several yeasts isolated from milk and butter and inoculated into flasks of whey made 2½% acid by the addition of commercial lactic acid reduced the acidity in time to about 0.2% to 0.3%, thus showing that a number of microörganisms found in milk are in reality acid consumers. The growth and life of the lactic in association with these is greatly prolonged. Along this line considerable work has been done by Miss Zae Northrup of East Lansing.

A factor which may stimulate the growth of *Bact. lactis acidi* when growing in association with liquefying organisms is an increased supply of food made available by the proteolytic changes. Dr. Rahn now of the University of Illinois has formed experiments which conclude that the addition of peptone to a pure milk culture stimulates the growth of some of the strains of *Bact. lactis acidi.*

The metabolic products of many of the common milk organisms when growing in association with a lactic is not without an effect. Those organisms which have a stimulating effect upon the growth of the lactic may also greatly inhibit or prevent its growth. A milk agar shake of these organisms if stroked with *Bact. lactis acidi* immediately or within 20 to 30 hours generally gives a stimulated growth of the lactic; but, if 3 to 5 days pass before stroking the surface with the lactic, the growth is retarded or prevented. A number of microörganisms will be retarded from the first.

The growth of most of the organisms commonly found in milk may be stimulated or retarded by association with *Bact. lactis acidi.* At the beginning certain types of organisms growing in milk in association with a lactic exhibit a stimulated growth; while later, when the acid produced by the lactic has caused a rise of about 0.1% in the acidity of the milk, their growth is arrested. The greater rapidity of growth which manifests itself at first may occur because the first traces of acid or some metabolic products of the lactic act as a weak poison and stimulant. This action may be illustrated as follows: make a plate from a milk agar shake of the organism and inoculate the surface with a stroke of the lactic. The picture which presents itself is a normal or stimulated growth of the lactic surrounded by a narrow zone of apparently no growth and surrounding this a copious growth of the organism. Another factor which may cause or aid in causing this stimulated growth of the organism is a stimulated proteolysis, giving a more abundant supply of available food.

In association with a lactic the growth of many organisms is retarded. A retardation which likely is due to their inability to tolerate the increasing amounts of acid. Yet the growth of a number of organisms is inhibited and even prevented before the acid produced by the lactic is measurable by our present chemical methods. From this it seems that the metabolic products of the lactic even in small amounts have an inhibiting action.

The lactic in association with a few organisms, especially some of the torula and yeasts, is not able through either the accumulation of its metabolic products or its maximum acid production to exert to any marked degree a retarding effect.

The changes caused in milk by many microörganisms in pure culture are greatly retarded or prevented if at the beginning an equal number of *Bact. lactis acidi* is introduced: the organism alone producing its characteristic changes while in the association the changes produced are those characteristic of the lactic alone. If, however, the organism is given a lead before the lactic is introduced, it is able, usually, to make its changes detectable. A number of organisms known to be able to liquefy casein rapidly, when growing in association with a lactic are unable to make manifest their changes. And, too, a number of organisms regarded as non-liquefiers of casein because they will grow in milk in pure cultures for three to four weeks or longer without causing any visible proteolytic changes may become upon association with a lactic a rather rapid liquefier. It is safe to say that nearly every if not every microörganism during its life produces some type of proteolytic enzyme. If this type, however, be that resembling trypsin, then the presence of acid produced either by itself or by a lactic in association will prevent a visible manifestation of a proteolytic action. But if the enzyme resembles pepsin, the presence of a limited amount of acid will act as a catalyzer. An organism which produces a trypsin-like enzyme and at the same time forms acid in milk may be classified as a non-liquefier; but if a milk culture of such an organism be made neutral or slightly alkaline marked proteolytic changes occur. Again, an organism which produces a pepsin-like enzyme and during its growth in milk forms alkaline compounds may be unable to cause proteolytic changes. This organism in association with a lactic becomes a liquefier. Within the cell of organisms are entracellular enzymes which are not diffusable. Entracellular proteolytic enzymes of dead cells in old cultures are liberated through autolysis. And their behavior is similar to that of an extracellular enzyme of like nature.

Changes occurring in milk as a result of the associative growth of a lactic with another organism are influenced by the change in reaction, the accumulation of metabolic products of both the organism and the lactic, the temperature of growth, the accessible supply of oxygen, etc. However, the hindrance or encouragement in the production of enzymes offered by the lactic through its metabolic products to other organisms growing in association is a factor that cannot be overlooked.

Michigan Agricultural College,
East Lansing, Michigan.

OZONE AS A MEANS OF WATER PURIFICATION.

BY R. W. PRYER, M. S., ASSISTANT IN HYGIENE, UNIVERSITY OF MICHIGAN.

At the present day a safe water supply for a city is considered an absolute necessity, rather than a luxury as some people seem to think, and many schemes have been brought forward to purify a contaminated supply and place it above suspicion.

It is unnecessary in a paper of this kind, which is merely a review of the literature on the subject of ozone purification, to go into any of the other methods in use except merely for comparison purposes.

In the year 1891 ozone began to be used in Germany as a means of water purification and there are probably at the present time more of these plants in that country than in any other except France. One of the first plants of any considerable size to be installed and put into successful operation was that at St. Maur a dependency of Paris, France.

The contract was first taken by Tyndal in 1896 but the results obtained were mediocre and it was not until several years later (about 1905 I believe) when De Frise took up the contract and modified the plant in various ways that the system was considered as a success. The success of this plant and of those installed in Germany led to the installation of other plants and while I realize that this list is far from being complete it will serve to give one somewhat of an idea of the number of these plants that have been installed. France undoubtedly leads in the number of cities that have or have had all or part of their water supply purified in this way. Paris, Lille, Nice, Marseilles, Chartres and a few small towns make up the list for France. In Germany Paderborn, Wiesbaden, Munich and some smaller towns are using this system of water purification. Other cities that have all or part of their water supply purified in this way are Ginnekin, Holland, and St. Petersburg, Russia. The United States probably has a fewer number of these plants than any other country, unless it be England. Philadelphia, Penn., had at one time an ozone plant for treating part of the water supply but I am not sure whether this plant is in actual successful operation at the present time. Baltimore Co., Maryland, has a small plant which is said to be a success and there is a small plant at Great Falls, South Carolina, that is reported to be doing good work. In regard to the plant at Ann Arbor I wish to say that I have been testing this for some time but that my final report will not be ready for publication for a few weeks yet.

Mr. R. M. Leggett of the National Air and Water Purifying Company, Ann Arbor, Mich., in an address before the Central States Water Works Association in Detroit Sept. 24, 1912, made several statements with which I cannot agree. His address was published in "Water and Gas Review," Oct. and Nov. numbers and one of the points with which I wish to take exception is as follows: Mr. Leggett is quoted as saying, "There is also a plant at Ann Arbor, Mich., with a capacity of three million gallons of water daily. This plant was started in Dec., 1910, and has been in continual operation since that time. Tests of the tap water are made every week by the University of Michigan and have been declared safe every time. Previous to the installation of this plant notices were posted in the University buildings and in the daily paper to boil the water as it was contaminated." In looking back through the records I find that in July, 1911, and March, April and May of 1912, notices were posted on the campus advising the boiling of the water as it was contaminated.

There are other statements in Mr. Leggetts article with which I cannot agree but I will go into these later. However, there is one thing which while not connected in any way with this article of Mr. Leggetts I wish to bring up at this point. The report has reached me from several sources that Mr. Leggett has made the statement that I thoroughly approved of and had heartily indorsed the Model Machine that he has devised for water purification. This machine is in the offices of the National Air and Water Purifying Company here in Ann Arbor and is used for demonstration purposes. The following report speaks for itself and is a word for word copy of the one I gave the company at the time of the test.

Ann Arbor, Mich.,
Jan. 11, 1913.

Mr. R. M. Leggett,
Ann Arbor, Mich.

Dear Sir:—I hereby submit my report on the action of ozone on the Colon Bacillus as tested by me in your model ozonizing machine on Jan. 3d, 1913.

The growth on two twenty-four hour agar slant cultures of our laboratory stock culture of B.Coli was washed off with tap water and suspended in water in the first well of your ozonizing machine and the well filled with water from the overhead filter the other three wells being empty. Tap water from the filter was then turned into this first well and ozonized air turned through. As soon as water began flowing into the second well ozonized air was turned on here. Similarily when water began flowing into the third and fourth wells ozonized air was turned on in them.

Time period between turning ozonized air and water into the first well and purified water coming from the fourth well was four minutes.

One-tenth C.C. of water from the first well before turning on ozone, plated on Conradi-Drigalski media showed at the end of 48 hours in the incubator, acid reaction of the entire plate and colonies too numerous to count.

Thirty seconds after water began flowing from the fourth well or four and one-half minutes after starting ozone and water through the first well, one C.C. on media as above showed no growth. One C.C. samples plated at the end of one minute and seven minutes gave identical results.

I do not know the volume of water that will pass through this machine in a given time, neither do I know the volume of ozonized air used nor the ozone content of the same. The amount of organic matter used in this test was probably comparatively low as the water is said to come from the West Washington Street Station of the Ann Arbor Water Company.

Yours truly,
(Signed) R. W. PRYER,
Assistant in Hygiene, University of Mich.

BOILING WOULD DO THE SAME BUT WHAT OF THE COST.

There are several ways for the production of ozone but the only one of commercial importance is by means of an electric discharge. The production of an appreciable amount of ozone requires the use of from eight to ten thousand volts at the least and most plants operate at a much higher voltage. The essential principal is the same in all types of ozonizers, that is, one pole is grounded while the other is connected directly to the step up transformer. Between these two poles is a dielectric or nonconductor of air, glass, shellac, mica or some similar substance. When a high tension alternating current is turned through such an apparatus as I have roughly described the discharge takes place between these poles and through the dielectric and is usually referred to as the silent or brush discharge although just what this really is would be very hard to define. This discharge is characterized by a peculiar bluish-violet radiation and it is said that the production of ozone from the oxygen of the air, which passes between the poles and the dielectric, is due to the presence in this discharge of ultra-violet light.

It has been found by careful investigation that there are several factors that greatly influence the economical production of ozone.

1st. The concentration of ozone should not be carried too high because it takes more current proportionally to increase the concentration beyond three than it does to operate on a larger volume of air and to have a lower concentration of ozone. By concentration is meant the weight in gramms of actual ozone in a cubic meter of air.

2d. The air to be ozonized should be dry otherwise there will be some peroxide of hydrogen formed which would remain in the water and also the output of ozone for a given expenditure of electric energy is lowered.

3d. The temperature should be low in order to obtain maximum concentration with minimum current.

Ozone is practically insoluble in water and this fact makes it a good agent for purification because of the ease of removal but a poor one on account of the difficulties of obtaining a good mixture. Many schemes have been devised to secure a good mixture or emulsion among them being the De Frise sterilizing towers which are divided into sections by baffling plates with very small (1-140 of an inch) holes. In these towers the water usually comes in at the top and moves downward while the ozonized air comes in at the bottom and moves upward. In another system the towers are filled with small pebbles and the water is sprayed over the top while the ozonized air comes in at the bottom.

Another system, which I do not think has met with much success, depends upon an aspirater or water pump and sucks the ozonized air through by the aid of the water which is to be purified. Still another system depends on several treatments with ozonized air of a low concentration.

While there is no longer any doubt of the ability of ozone to purify water if conditions are right there is one factor that stands in the way of its very wide adoption at the present time. That is the consideration of the cost of operation. While an ozone plant could probably be installed as cheap if not somewhat cheaper than slow sand filters the cost of operation is many times higher and needless to say depreciation much greater.

The following table shows approximate maximum and minimum costs of installation and operation of the four leading types of water purification devices. The unit of quantity being one million gallons per day in each case.

	Slow sand filters.		Mechanical filters.		Ozone.		Hypochlorite.	
	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
Capital	$35,000	$50,000	$10,000	$25,000	$15,000	$25,000	$2,000	$4,000
Operation (not including interest)	$1 40	$3 00	$2 00	$4 00	$7 00	$15 00	$0 20	$0 70

Supposing Detroit which until recently at least had no system of water purification should adopt one of these methods what would be the effect on the meter rate. The meter rate as given a few months ago being $30.80 per million gallons—$1.75 for the first thirty thousand gallons and then three cents per thousand.

Without allowing for interest the rates would be something like this:

Slow Sand.—Minimum .... ($32.20) Maximum ($33.80) Per million.
Mechanical.—Minimum .... (32.80) Maximum (34.80) Per million.
Ozone.—Minimum .... (37.80) Maximum (45.80) Per million.
Hypochlorite.—Minimum .. (31.00) Maximum (31.20) Per million.

I do not doubt but that if some cheaper way, either chemical or electrical, for the production of ozone should be discovered that the process would find extensive application as a means of water purification. However, at the present time we have other methods that are very efficient and which are much more economical.

SECRET REMEDIES, NOSTRUMS AND FAKES.

BY W. S. HUBBARD.

We hear a great deal these days of the high cost of living and the cause. I think we will all agree that there are a number of causes. I wish to point out one to you which you may not have thought of in that light before.

Those of you who read in your daily papers such articles as: "How I Made My Hair Grow;" "The Model's Secret (A Story for Fat Folks);" "Don't Diet for Fat;" "The Doctor's Answers on Health and Beauty Questions;" "Beauty Hints;" "No More Wrinkles;" "Scranton Woman Makes Remarkable Discovery That Proves to be a Great Aid to Beauty." "Broad Minded and Liberal, she offers to give Particulars to all Who Write Absolutely Free." (Notice you write absolutely free.) And if you should write this woman you would obtain what to all appearance was a prescription from a specialist or perhaps a home remedy, but when you go to the drug store to obtain the ingredients you will find that one of them costs you at least five times and more than likely ten times more than any of the other ingredients. Take for instance "The Models Secret;" "The cloak Models Association has raised their calling to the status of a fine art." "The development and retention of a perfect figure is made the study of their lives, etc." Instead of dieting and exercise being their reliance the following mixture is asked to do the work of keeping these ladies professionally fit: ½ ounce Marmola, ½ ounce Fluid-extract Cascara Aromatic and 3½ ounces of Peppermint water. To most people there is nothing wrong in the above and it is surprising how many people, mostly stout ones of course, are taken in by this and spend their good money for it. You will find when you buy the Marmola that it costs you $.75, the Cascara $.05 and the peppermint water not more than $.05. Marmola was one of the first of these placed on the market and made its appearance about twelve years ago, and by the way is made in Detroit, the city which makes more of this class of articles than any other city. Marmola is a mixture of phenolphtalein, dried thyroid gland, salt, bladder wrack and oil of peppermint.

Eppotone, "Discovered by a Parisian Specialist," sold as a skin food is nothing more than Epsom salts colored pink with carmine, four ounces sells for $.50 and you never think of paying more than $.10 a pound for epsom salts when you take them internally. This preparation is also made or I should say, put up, in Detroit. Spurmax is the same thing except that it is put up by a firm in Chicago.

A supposed remedy for locomotor ataxia is "Bioplasm" and upon analysis proves to be nothing more than milk sugar with a fancy price.

One which contains 98% sugar flavored with some balsams, two ounces of which sells for $5.00, is known as "Hydrocine." This, if one believed the literature, will cure tuberculosis. One of the worst fakes on the market is made at Jackson and known as "Lung Germine." It is composed of alcohol 44%, sulphuric acid 4% and water 52%. Price,

$5.00 for two ounces. This, too, is sold to cure tuberculosis in the last stages.

The ones I have already spoken of have been on the market for some time, but there is a beauty preparation which has been at its heighth the past year known as "Mercolized Wax." I am told that here in Ann Arbor there are as many of the men students using it as there are Co-eds. Some of the reading notices say in speaking of powder and paint, "How foolish to seek artificial beauty of this sort, obnoxious from artistic and moral standpoint, when it is so easy to obtain a truly natural complexion by the use of ordinary mercolized wax." The only real way to improve a bad complexion is to actually remove it and let the young, fresh, beautiful skin beneath have a chance." This preparation proves to be an ointment containing 11% zinc oxide and 8.5% ammoniated mercury and sells for $.75 an ounce. The cost of manufacture is not more than $.75 per pound. Ammoniated mercury is considered as a rather dangerous and irritating drug if left in contact with the skin very long or applied very frequently. It is often used in skin diseases such as "Barber Itch," eczema, etc. Most of these preparations are harmless, except in price, however, "Mercolized Wax" can not be classed with the harmless. Another of the harmful kind is "Othine," two and ½ ounces of which sells for $2.00. This preparation is guaranteed to remove freckles or money refunded and it will do it too, but it does it by taking the skin along and of course the freckles return too. This preparation we have found to be ammoniated mercury and bismuth.

There is in Ann Arbor at the present time an agent for Robt. Blumers Egg Saver. It is a quarter pound package selling for $.25 and is claimed to be the equivalent of four dozen eggs. We have examined this and several other so-called "egg savers." Some are corn starch colored with an aniline dye, to give the yellow appearance, others are baking powder, containing of course starch, and one or two have been found which contain casein, an attempt you see to furnish something to supply the albumin. Why you can go down here anywhere and buy ten ounces of baking powder for ten cents and sour milk is not very expensive.

I wish to call your attention to just one more compound on the market Sal-Vet. You may have seen the large add in the evening paper lately. It gives the endorsement of many Michigan farmers. It is a stock conditioner and worm destroyer and as they say, "will destroy stomach and intestinal parasites and prevents infection from all parasites that enter the stomach." Sal-Vet they say is a wonderful medicated salt and they tell you to feed no salt. A very good reason for that for Sal-Vet is 93.5% common, ordinary salt with small amounts of iron sulphate and charcoal with indeterminable amounts of gentian, quassia and sulphur or in other words about enough to cover its identity. It sells for $5.00 a hundred pounds, rather expensive it seems to me for common salt and especially for stock. If we can believe it to be used as extensively as they claim, then is there any wonder the price of meat is high?

Ann Arbor, Michigan.

FARM ORGANIZATION AS A FACTOR IN AGRICULTURAL ECONOMICS.

BY W. O. HEDRICK.

Agriculture has shared but slightly in the great development which her sister occupations have enjoyed through the benefits of organization efficiencies. The fact of immovability on the part of the farm is named by Alfred Marshall as one of the reasons why farming can never benefit from the specialization and integration processes of which organization everywhere is the product. "The characteristic of manufacturing industries," says Professor Marshall, "which makes them offer generally the best illustrations of the advantages of production on a large scale—organization characteristics—is their power of choosing freely the locality in which they will do their work, as contrasted with agriculture and other extractive industries (mining, quarrying, fishing, etc.), the geographical distribution of which is determined by nature."

Agriculture's greatest disability, however, from the standpoint of organizational possibility arises from its limited opportunities for the use of capital. Most of the characteristics which make the use of capital so profitable in manufacturing seem absent from agriculture. No such a mass of capital could conceivably be used with profit for example in cultivating the soil enclosed within the area of a factory as is employed profitably within the factory itself since the quick limits within which the cultivation of the soil is profitable owing to its physical and chemical composition closely restricts the amount of capital which can be applied to any given area. But in addition to the early failure in agriculture of profits on account of the natural limitations of the soil, a large use of capital in this industry seems impracticable from other reasons. In comparison with the factory agricultural processes are not closely enough connected nor continuous enough to utilize much of a division of labor or machinery. Quoting from Professor Marshall again, "In agriculture there is not much division of labor for a so-called large farm does not employ the tenth part of the labor which is collected in a factory of moderate dimensions. This is largely due to natural causes, to the changes of the seasons, and to the difficulties of concentrating a large amount of labor in any one place." Almost continuous employment, in fact, seems necessary in a factory to develop employment, in fact, seems necessary in a factory to develope profits from an expensive machine, but a machine is used only in its proper season on a farm so that wide as is the revolution in agriculture which machinery has wrought true capitalistic production by this agency seems scarcely to be attainable. Underlying every possibility of using large capital in agriculture is the inability to successfully employ steam or other high class motor powers. As remarked by Professor Emerick, "The wealth concentrating power of steam is due to the fact that it has admitted in only a limited degree of direct application to agricultural production; the age of steam has given us a new urban life but has not directly transformed the country. Nothing indeed resembling the use made of high grade motive forces in manufacturing or transportation has yet been found for agriculture nor is it clear that they may ever be largely employed.

Widely different views concerning the merits of large scale farming seem to have been held two decades ago from those which have since become current. David A. Wells, writing in the early eighties comments interestingly on the great revolution in the business of agriculture which is yet to be effected by the cultivation of land in large tracts with the full use of machinery and under the factory system as a matter which only the future can reveal, but it cannot be doubted, he held, that the shiftless, wasteful method of agriculture now in practice over enormous areas of the earth's surface are altogether too barbarous to be much longer tolerated. Professor Liberty Bailey has given these views sympathetic endorsement—observing frequently, especially in recent addresses that the absence of entailment of large estates and the presence of popular suffrage in this country may be expected to be permanent safeguards against landlordism and he would be glad of the time when capital and skill should direct large rural enterprises at least in the remoter parts of the country. Indeed the basis for the belief that agriculture is to take on in the future thorough going business characteristics such as specialized laborers, power machinery, efficiency management, etc, etc., rest largely upon this assumption that farms are inevitably to become larger. Overhead organization, in fact, as it is called in industry can find out little place in agriculture until the farms have become of suitable size.

The transformation of agriculture into a business in this country is mentioned by Bogart as one of the many economic effects of the civil war and the chief characteristic of this transformed occupation is the production of commodities for the general market. The earlier type of agriculture, as everybody knows, was largely of the domestic sort but the agriculture of our own day does not in the least aim at independence and self sufficiency but quite as unreservedly as other industries, offers its out-put upon the market. It is this new point of view from which the activities of the farm are directed, this purveying of the farmer to the market, which undoubtedly gives to agriculture its fullest identification with the contemporary world of industry.

It is to emphasize this business point of view, to magnify it and to make it the supreme consideration in the carrying on of the farm which gives the study of farm organization its chief justification as a discipline in an agricultural college. On the other hand it is doubtless the desire for the economies which are to be found in organization and management, which the contemporary flourishing condition of agriculture has made worth while, that has given significance to the farm organization movement among practical working farmers and prompts the description from us which now follows.

The variable nature of agriculture which results from the fact which Marshall described, namely, that farms are strictly localized by climate, soil and other natural conditions presents a pronounced hindrance to the easy analysis of farm operations. There is no uniformity of product, indeed, from the farm so that no one can proceed from function to process in his analysis of farm management as would be done in other industries. The meaning of the term farming itself has not received the identical definitions from equally good authorities. To some this undertaking is a thing from which rather highly finished products should be put upon the market and the whole trend of the pursuit should be in the direction of perfecting this manufacturing aspect and away from the production of raw materials. Competing with this definition is a more commonly accepted one that farming has for its purposes the production of grains, forages, fibres and roots, and all other farm enterprises not identified with these are only significant to the extent that they preserve the soil and restore its fertility. Amid such diverse views in regard functions nothing can be established with regard to products except the rule that as many supplementary enterprises as possible should be conducted upon the farm and among the enterprises which are not supplementary to each other but which compete for the farmers' time, those always which are most profitable should have the preference.

This principle of the competitive and supplementary enterprises is largely the determinative one also in the establishment of the proper cropping or rotation systems. The chosen orders in which crops succeed each other from period to period and which constitute the device of crop rotation are multitudeness in number and, merits of almost every conceivable sort have been assigned to favored ones by their ardent supporters. But, similarly to the use of an established order in a different art from agriculture, the use of the sequence in either whist or farming is chiefly defensable on the grounds that in the *long* run it pays. The nature of the sequence in agriculture then is governed from the same standpoint as governs the choice of farm enterprises, namely, the selection of the products which in the long run will afford the greatest profits.

The student of agricultural development in the United States finds no other phase more interesting than the one in which the operation of this principle of profitableness or unprofitableness in determining the succession of different types of agriculture in different localities of the country is shown. A selective efficacy closely resembling in fact that of the Darwinian struggle for existence has determined the enterprises which shall survive in different localities and the misfits which shall go under. A somewhat superficial description of this situation asserts that within small areas the markets determine the type of agriculture which will be followed. Over large areas or natural divisions of the globe climatic and other natural conditions are in the main determinative.

The farm establishment itself as contrasted with the farm enterprises affords the real opportunity for organization. Here are found in their most elemental state, the land, labor and capital agents of our economic trinity, the varying divisions and combinations of which constitute the essentials of all economic organization. The tyranny with which its products controls the fate of human kind—the function of land as the limiting factor upon human development—or, in the words of Professor Bailey, as the spring source from which raw materials flow, has made the disposition and management of land resources supremely important to society from the start. The age long controversies over intensive or extensive, over tenant or proprietorship and over large or small farming, are similarly evidences of this great human dependency upon the proper use of land in connection with labor and machinery.

No other single principle is so widely useful in the organization of a farm as is the redirected law of diminishing returns which is beginning to be known as the law of proportionality. I refer here to that interpretation of the law of diminishing returns which has to do with the mal-proportionality of the factors toward each other rather than with the phase of the law which deals with limits. As commonly stated "a time arrives in the application of labor to land when a further application of labor will not yield proportionate results." In other words the two factors are wrongly adjusted to each other for the best returns, which is simply another way of describing that common phenomenon in a world of mis-fits, a mal-proportion. Avoiding the error of applying factors to each other in *wrong* proportions, which the law of diminishing returns so perfectly describes, and we exercise the law of proportionality—a law which Professor Fetter asserts is the "central and essential thought in Political Economy since it is the expression of the fundamental axiomatic truth that there is a *best* or *proper* adjustment throughout the world of means and ends." It is this law of proportionality therefore which draws the essential elements and processes of a farm into a proper system and furnishes us with the suitable basis for farm organization.

This order producing efficacy of proportionality, which we have pictured, needs little more than merely to be mentioned and our memories immediately furnish us with proofs innumerable from many fields of its ubiquity and potency.

Technologically there is no product which comes from the various crafts or trades or industries which is not indebted to this law of right proportioning. In art and music and literature proportion reigns supreme. In nature it is the balancing of the forces and elements, or their proper proportionality toward each other, which prevents chaos while in the moral world the ethical ideals of symmetry and harmony are under obligations to the law of proportions since they are said to be related to a wise observance of the "golden mean." A common book of recipes will give many thousands of formulae for combining things in their right proportions. The apothecaries art and that of the culinary expert is a matter of putting things together in their right proportions while the science of chemistry is so largely concerned with this subject that an entire variety of associative ratios goes by the name of chemical proportions.

A principle of such universal employment could scarcely fail of applicability to farming but it is the essentialness with which it applies to every aspect of this art which gives to it the prime importance as a law of agricultural organization. Upon this principle of proportionality, for example, rests the determination of the farm area—in what proportions it will be profitable to use land with a given amount of labor and capital and in what proportion it will not be profitable. The question too of intensive or extensive cultivation is the reverse side of the same problem and consequently is a problem in proportionality. The class significance of the suitable proportioning of land and labor which is involved in this question of big farms or little farms, is also of almost incalculable importance to the farmers. Is it the American ideal of what shall prevail that large returns shall be secured to the human farmer, or is it to be the ideal that large returns shall be secured for the acre of land, is the way in which this problem is usually offered. Other things being equal, intensive farming implies a reduced return per man to the cultivators of the soil; extensive farming, the reverse. Shall not the vision of the American public policy look rather to the large returns to the individual farmer as is the case from the broad acres of the English type of agriculture rather than to the large returns from the individual acre as is the case in the peasant type of agriculture as practiced in Belgium and elsewhere on the continent of Europe?

The law of proportionality is also applicable to almost all of the operations carried on upon the farm. The original allotment o different parts of the land to different purposes for example, requires a proportional distribution between the farmstead on one hand and those areas on the other which become the fields and the avenues of communication. It is also determinative, as is the case in every other business, of the relations which shall subsist between fixed capital and the amounts which shall be used for running expenses and also of the general problem of the gross amounts and the particular kinds of machines, auxiliary farm enterprises, stock and other equipments which shall prevail.

In no other sphere of farm organization does a better opportunity exist for the proper proportioning of things than is the case in the establishment of the relations of motive power to the different vehicles with which it is to be employed. A vital point in the rivalry, which is now taking place, between tractor power and animal power for dominancy upon the farm, is said to be the comparative facility of each in being readily serviceable in a great variety of proportions for use by the farmer. The multiples and divisions of horse power which can be obtained upon the farm by combining or separating teams is said not to be practicable when motor tractors are used, and an almost insuperable obstacle in this way is interposed to the serviceableness of the latter. The arrangement and number of farm buildings can scarcely be satisfactorily accomplished either without a reference to this law of proportionality and in the miner aspects of the agricultural art, such as the compounding of fertilizers and the arrangement of feeding rations and the providing of general farm conveniences, the law of proportionality is everywhere supreme. From these illustrations, of which the economy of the farm would present an almost infinite number did not space forbid, it may be readily seen how largely the strategy of this occupation involves the law of proportionality and how concisely all of the operations of this undertaking may be organized and administered from this standpoint.

From a pedigogical standpoint, this principle of proportionality is meritorious through the many problems of proportioning drawn from agricultural life which it furnishes for solution. The supporter of the problem method of teaching economics finds here an exhaustless field of problems, drawn from actual life, from which he may illustrate equally well numerous economic principles and also excellent farm practices. The doctrine of proportionality, since it implies coördination, develops admirably the notion of the business standpoint as applied to the operation of farms especially to the extent that this necessitates the unifying of farm operations. Agricultural education is now given on each of its sides by a series of many specialists and it should be the function of some discipline in the school corriculum to correlate these various sides and trace the way by which a profit can be made from the general handling of the whole farm. The fact that proportionality may be developed from different standpoints furnishes an admirable means for teaching this lesson and your time-worn patience is solicited while this last usefulness of this great law is explained.

A mere glance at the matter of proportioning things shows at once that this may be done from the standpoint of the technological perfection which shall result, or from the standpoint of the cheapest way in which the factors may be put together to secure results. This last may be called economic proportionality, while the former may be designated as the technological. Nothing indeed seems more certain than the fact that a natural or ideal adjustment of factors to each other is a practicable truth with regard to every product which is the result of combination and upon this basis rests the notion just described of a technological proportionality.

In chemistry, for example, the proportions according to which elements will join together are indeed unalterable and two units of hydrogen must be united with one of oxygen to procure any results what so ever. In almost all other fields of combination, however, the relations of the different factors to each other are not so immutable, and we have a possibility in these fields, if different prices prevail for different factors, of making choices which will give acceptable results though at a much reduced cost for the whole. This, in fact, is the field in which the great principle of substitutions with which we are all familiar, has its most efficient opportunity.

The two standpoints from which the proportioning of things upon the farm may be carried out are now easy to perceive. Farm agents and farm processes may be proportioned from the standpoint of technological excellency—that is from a standpoint which may be wholly disadvantageous to the development of any profits. These results in many instances in the so-called model farms. On the other hand the principles which control the proportioning of farm agents and processes from an economical standpoint differ pronouncedly from those used in proportionings of the other sort. The principle of applying one factor to another until the returns though not *ideally* proportional are never the less profitable, may be brought into use to govern farm organization from the economical standpoint while this principle would not be made use of to the slightest extent if a farm organization were to be conducted from a model farm and technologically perfect standpoint. Remarkable as it may seem, the distinction which is here made as to the standpoints from which a farm may be organized is not wholly an academic one. A somewhat extended reading of agricultural authorities during the past year or two has shown not infrequently such statements as the following: "Many farmers are producing much larger crops than they can afford to produce." "The average farmer pursues certain traditions as to what constitutes agricultural excellence whether he finds it profitable or not;" and "there is reason to believe that the majority of farmers are really living on the interest of their investments rather than on the profits of their farms." Each and all of these statements are corroborative of the fact that the economic standpoint is not the one from which the law of proportioning in these cases was applied and each is a justification of the study which we have described for the purpose of giving the proper point of view. We may say in conclusion that the whole scheme of farm organization as well as that of any other business organization requires a system of costs keeping and accounting by which its details will be kept track of and its deficiencies repaired.

THE PSYCHOLOGICAL ANTITHESIS OF SOCIALISM.

BY HERBERT ADOLPHUS MILLER.

My first socialist was a fellow student in college something like fifteen years ago. He was not one of those fully assured, rampant propangandist socialists students such as one often meets now, but for a New England college he was a good deal of a curiosity. I was most interested when he told me about government ownership of railroads, for I had a goodly portion of Wanderlust at that time and I was eager for any system that promised free rides over the world, and of course the more international the area of socialism, the wider would be my travels. One of the most awe inspiring facts about solialism as it has been developing in these later years has been its international character. Soon after my introduction to the subject, the psychological rather than the economic difficulties began to present themselves to me. And they still present themselves, for the practical problem of socialism is psychological; the economic is quite simple. In the many books that one may read about socialism, however, one rarely finds any space given to the psychological intricacies involved. Whenever a definition of socialism is attempted it fails to be universally satisfying because there is still the most important question lurking in the background. At a recent meeting of the American Economic Association, after a half day's discussion, it was almost unanimously agreed by the members that they did not know what it was, and they were almost willing to deny that there was such a thing. Metaphysically I do not take kindly to pragmatism, but practically the proof of socialism may be discovered in the shaking of the orthodox economic and political order.

Socialism proposes both a radical change in the distribution of wealth and the relationship of men. It sounds well to all of us, but the question constantly recurs as to how people will take it. We know how they act under existing conditions, but when we make the conditions quite different we have no criterion to judge what will happen. We might wait and prove the pudding in the eating, but we have a good deal of material that might be wasted. We may, however, catch some signs along the way which indicate how masses of people will react to whole social situations. In those ancient days of social ideas—fifteen years ago—I was told that socialism would overthrow individuality, and I had to balance this catastrophy against free rides and I confess that the attractions of travel diminished. If we were all to have an equal share in the world's goods at the expense of total subordination to the political organization there would not be much fun in living. It was as hard to come out of my courses in sociology and economics with any concession to socialism as it is for a student of economics to believe in a high tariff. Time has gone on, and socialism has grown from a mere idea to be tremendous factor in world politics, but it has had to concede that man shall be allowed some private symbols of individuality, such as the privacy of his house, and the choice of his wife, though eugenics is on the high road to deny him this privilege.

It seemed perfectly obvious to me that the rapid spread of the consciousness of common interests across national boundaries would make socialism the ultimate direct means of eliminating war. Their creed teaches the artificiality of boundaries, and that producers of different nations are much closer together than the diverse interests within a nation. The people at large have not realized the spread of this movement as it has not had the sympathy of the "capitalist press," but along with half a dozen other movements claiming the same thing it has been the most remarkable fact of the last decade. Just as I was beginning to make my disarmament speeches more violent through my conviction of the inevitableness of this socialistic eventuation, I happened to run across another movement arising from almost the same revolt that has caused socialism, and as great in area and psychological force. It has come so rapidly that it has hardly been recognized as one of the most potent of the present states of social consciousness. For want of a better name we call it National Feeling. It is class consciousness for a common language or traditions. It does not correspond to present national boundaries, but rather to historical or even imaginary boundaries. It is really a struggle to get national individuality. Just as socialism has been a revolt from the coercive control of men by wealth or arbitrary government, so this national feeling is a revolt against the control of a people by any power which tended to diminish its race consciousness. The people are doing on a large scale what persons do on a small scale when they fear the deindividualizing effect of socialism. We know that whatever social changes may take place they must prove to be harmonious with the spirit, and the growth of national feeling seems to me to be a development of the spirit that is quite antithetical to socialism. The socialist motto, "workingmen of the world unite," has a powerful purpose in it, but I think there are definite limits beyond which it cannot at present be carried.

Socialism began to make progress about fifty years ago, but has made its marvelous advance within the last decade. The development of national feeling has been almost contemporaneous in both respects. Labor has been oppressed since war first made slaves, and nations have been oppressed since war first made some groups conquerors and others subjects, and until very recent times no one thought anything else possible. The policy of Europe has been the control of various areas and peoples by several great powers. Of late years there has been relatively much less war, and much strengthening through internal organization. Thus the German empire was consolidated rather peaceably. Austria has established its domination over it heterogeneous aggregation of Germans, Poles, Bohemians, Slovaks, Slovenes, Croations, Bosnians, Dalmations and Italians. Russia has increased its control over Finland and Poland. Italy has become strong through the union of small kingdoms. But I venture to assert that there was never a time when there was so little assimilation. I do not know Germany so well as Austria and Russia, but I am sure that Bavaria and Saxony love Prussia no better than before they became integral parts of the German empire. I anticipate that the time is not far distant when disintegrations and relignments will become general. They are likely to be made peaceably if it becomes evident that they are psychologically inevitable, and it seems to me that the indications are so clear that he who runs may read, even though he be the Czar of all the Russias.

The beginning has already been made in Sweden and Norway. Here were two countries with similar people, language, traditions and geography, but Norway felt a restraint on its individuality and in 1905 there was a peaceable disunion. My Swedish cousin had not visited Norway before this time, and she expresses an attitude commonly held when she assumes that she can never go now and retain her self respect. These two countries are both very democratic with a very large socialist vote, but a Swede is a Swede, and a Norwegian is a Norwegian first.

The case of Finland is rather more complex. For six and a half centuries the Finns were subjects of Sweden, but in 1809 their country became a possession of Russia, and the efforts at russification have been continuous. The population is eighty-five per cent Finnish and twelve per cent Swedish. The culture has been continuously Swedish. I found last summer that at the University of Helsingfors where twenty-five years ago all the work was done in Swedish, now more that half of it is in Finnish, and the Finnish spirit is increasing by leaps and bounds. Seven and a half centuries of Swedish culture with no Finnish education has had no effect except to stimulate the growth of Finnish national feeling. The two people live amicable together. The Swedes and Russians conduct most of the business and have the social standing, both Finns and Swedes are Lutheran and in the official church the services alternate in the two languages. Finland is very democratic—equal suffrage has prevailed for some time. Socialism has been very strong among them. In Chicago they have the largest proportional membership in the party of any of the foreigners. But in Finland the socialist votes are beginning to diminish slightly. The children in school must study Swedish, Finnish and Russian, and the government is thoroughly Russian, but there are absolutely no signs of assimilation. Helsingfors, and the other Finnish cities I visited are much more like Detroit than like St. Petersburg, though Russia has been working a full century upon them.

It is very near a paradox that this movement towards national individualism, and the socialistic movement should arise from almost the same motive. Whatever may be our fears about the loss of individuality in a socialistic state, there is no doubt but that many people embrace it as a revolt against having their individuality swallowed up by the oppression of those who hold the power through more or less unjust economic conditions. They feel the artificiality of the conditions. In like manner this national feeling is a revolt against an oppression. And since one's individuality is so largely social in its source the nearest and dearest thing to the heart of a man is that social group in which he identifies his spiritual reality. Both movements are conspicuously unselfish, and the devotion to them is distinctly religious in its character. But they become antagonistic—one puts up boundaries which the other tries to pull down. Nationalism tends to look backward and socialism forward. Both movements thrive in the same country and are beginning to be recognized as more or less hostile to each other. We have had nothing conspicuous of the kind in this country because it has not had a chance to develop. But in those countries in Europe where there are the strongest influences against it socialism thrives best, while in America it is relatively unnecessary as our democracy is fairly free, but in those same countries nationalism is strongest. To make this more clear I shall give several further illustrations.

Poland was never particularly conspicuous in art literature or government, but something over a hundred years ago it was an independent country. Now Germany, Austria and Russia have divided it up and with absolute ignorance of sociological principles are trying to absorb it, but if there was ever a case of imperial indigestion, Poland is causing three chronic attacks. Bismark's policy of forbidding the Polish language, and forcing German in its place, and Russia's similar policy with Russian has made the preservation of the language a religion, and martyrdom for it a glorification. At the present time undoubtedly Poland has the hardest attack of nationalism, unless it be Ireland, but its revolutionary work has been closely connected with socialism. Socialist papers are smuggled from Cracow to Warsaw daily. The strong hold of the catholic church upon the Poles makes it hard for socialism to make much headway, but while the Poles think that their love of the church is piety, they are really good catholics because their real religion is Poland, and catholicism is a Polish protest against Russia. It has seemed to me, when walking with a Pole that after passing a Russian church he would increase his zeal in crossing himself when we passed a catholic church. Every sign of Russia says, "be a devout catholic." As I shall try to make clear later, any particular religious form is never so strong as the spirit of nationalism, of which it may often be merely a symbol. One may safely say of the Pole that his backward look becomes more intense every day, and psychologically if not temporally the day of ultimate socialism is farther off the nearer we approach it.

In the midst of Poland is the Lithuanian movement. Several centuries ago a prince and princess of the two countries married each other and the government became one, with the culture Polish. There was no Lithuanian literature of education. The language was preserved by the peasants as was the case among the Finns and Hungarians. Poles and Germans were the landholders and the Lithuanians almost altogether the laborers or serfs. Within the last decade the Lithuanian consciousness has burst into a conflagration. A man fully Polish in interests and culture possessing a little Lithuanian blood becomes entirely Lithuanian in spirit learning the language from the peasants, and chooses them for associates rather than the cultured Pole with whom he was identified ten years ago. After the revolution of 1905 the privilege was granted to the students in the gymnasia to adopt Russian, Polish or Lithuanian for religious instruction, whereas previously only Russian was allowed. In a gymnasium in Vilna where there had been thirty in a class who spoke Polish only three chose Lithuanian. Now out of the same number at least twenty will take Lithuanian, and that increase about indicates the growth of the movement among the people. I have had two Lithuanian students who speak Polish as a mother tongue, and Lithuanian with relative difficulty. One is half Polish in blood, and has learned to read Lithuanian since coming to America three years ago, though he is a graduate of the gymnasium. In 1905 he chose Polish as his language, but his fourteen year old brother in the gymnasium speaks nothing but Lithuanian when possible, though his mother does not know it at all, and his father only slightly. When the older brother came to America he allied himself with Lithuanians although there are very few of his class here and the Poles would have welcomed him gladly. Although an aristocrat in training, he feels closer to the Lithuanian peasant than to the Pole of his own social position with whom he has associated all his life. We see in this case, and that of the other student is similar, that national consciousness has broken down class lines exactly as socialism seeks to do, but entirely within the nation, and thus raises a barrier to one of the purposes of socialism. The wall is raised between people of the same class across the borders. An interesting thing about both the Lithuanians and Finns is that they are primarily revolting against culture authority rather than the political authority of Russia. This is because in both cases the nationalizing people feel their individuality to be the more swamped by the culture group than by the political group. A union between the working classes of Poles and Lithuanians, Swedes and Finns must overcome a much greater resistance today than would have been necessary ten years ago, although both movements represent a similar revolt. In Chicago the nationalists and socialists are divided into two nearly equal camps, and practically all Lithuanians belong to one or the other. The nationalists resist Americanization. Within the Russian border, Swede, Finn, Pole, Lithuanian and Russian are farther apart than they ever were before.

It seems with any particular nation that its peculiar reasons are sufficient to account for its development of national feeling, but this really is practically a world movement, and whether it develops because conditions allow it or simply through imitation I cannot say, but it certainly is general in its force though peculiar in its manifestations.

Let us consider the Bohemians as a further example, forgetting, however, the popular notion of Bohemian which has nothing whatever to do with the people of Bohemia. The Bohemians, as the Poles, are members of the great slavic division of the human race. In 1415 John Hus, a Bohemian protestant leader, a century before Luther, was burned at the stake. He became the personification of the Bohemian spirit, but in 1620 the Thirty Years War began the extermination of protestantism in Bohemia, and for more than a hundred and fifty years Jews were the only exceptions to catholicism within the boundaries of Austria. The language became officially and practically German, and the official church has continued catholic. About fifty years ago several Bohemian writers were bold enough to write in the Bohemian language and the Bohemian spirit began to grow, and the hostility to German became a passion though somewhat different in form from the Polish movement. The Bohemians present several contrasts to the Poles. The rank and file of Poles are entirely uneducated, while the Bohemians have fewer illiterates than the Germans. This is also in part at least a manifestation of the same national feeling, for the other Bohemian hero beside Hus was the great educator Commenius. A large proportion of the Bohemians are skilled workmen. They are just the sort of people to furnish a large portion of socialists. To be sure there are in Bohemia a great many members of the socialist party. They have nineteen papers including three dailies; 1500 locals with 130,000 members and at the last election 400,000 votes were cast. They are socialists because that is against the government and the church, but when they get to this country they do not stick very well. And there are in Bohemia, and some other countries already two socialist parties—nationalists and internationalists and the nationalists are growing rapidly. A generation ago there were almost no schools in Bohemia except German and all business was done in German. Now where there is a majority of Bohemians in a district there are Bohemian schools supported at public expense, but in minority towns only German schools are provided. To meet this there is a great educational organization for collecting money and maintaining private Bohemian schools in all minority towns and villages. On our ship going to Bohemia we took two collections for this organization. In the restaurants in Prague the head waiter or proprietor has a collection box which he passes to the patrons for this "mother of schools" as it is called. The result of all these activities is that German is gradually being driven out of the country. One rarely hears Bohemian on the streets of Prague whereas it is said that ten years ago one heard little else. Fathers were raised to speak German but teach their children Bohemian instead. I heard of one business man last summer who expressed great pride in the fact that he had been a successful business man and did not know any German, thus proving the change that had taken place. A German cannot get food in a Bohemian restaurant unless he speaks Bohemian, though all the waiters know German. All older people speak German equally as well as Bohemian, but the younger very little, and even at the University of Prague where until 1882 the work was all German, now the graduates do not know German well, and the Bohemian part of the University is more than twice as large as the German. It is unquestionably a disadvantage for a country of less than seven millions to cut itself off from the advantages of German literature and science, but those who appreciate the disadvantage are as hostile to German as the more emotional, and deliberately assume the cost for the freedom of the spirit. When we remember that the prestige is on the side of the German we see in this movement the same indifference to personal success and devotion that characterizes the socialist. While Bohemians make good American citizens, they bring their traditions with them. No child would dare to answer its parents in anything but Bohemian. I have found this to be universally the case. With German children much more English is used. Perhaps the most striking development in America is the organized propaganda of freethinking. Ninety-seven per cent of the Bohemians are nominal catholics when they arrive, but at least sixty-six per cent of those in the country are militant freethinkers. Their attitude towards religion, especially the catholic church is very similar to that of the socialists, but that does not make them any more sympathetic with each other. A year ago I was invited to give a lecture in Chicago on Commenius in a Presbyterian church. I was very widely advertised, but neither the freethinker daily nor the socialist daily would give any notice of it, because it was to be in a church, though I knew the editors of both personally, and the freethinker, who is a graduate of the University of Michigan attended the lecture. I repeated the lecture in a public school hall and both advertised me.

Bohemian freethinking is altogether too general to be philosophical, but is an expression of the historical protest against catholic Austria, and as such differs in no respect from catholic Poland and Orthodox Russia, or catholic Ireland and protestant England. Just as the sight of a Russian church makes a Pole pious so the sight of any church makes a Bohemian a freethinker. In the city of Chicago a year ago there were 27,000 Bohemians who made a quarterly payment for the support of schools on Saturday and Sunday to teach the Bohemian language and freethought.

A larger and more comprehensive movement than these I have mentioned is the rapidly developing pan-slavic feeling. Last summer I attended an international slavic gymnastic meet in Prague. More than twenty thousand persons took part, at one time eleven thousand men speaking several different languages were doing calisthenic exercises together. With the exception of the Poles who would not compete because Russians were invited, there were representatives of all the slavic divisions: Slovaks, Slovenes, Serbs, Croatians, Bulgarians, Montenegrins, Ruthenians, Moravians, Bohemians and Russians. The keynote of every speech was "Slavie, Slavie," and when it was uttered the crowds would go wild. There were quarter of a million visitors in the city, and the illustrated reports of the exhibitions went to the ends of the Slavic world. I saw some of them pasted on the wall of a peasant's factory in the back district of Moscow. But the German daily which was the only one I could read ignored the meet completely, and no self respecting German could attend, just as my cousin cannot now visit Norway. The streets were everywhere decorated with flags but never did one see the Austrian flag. Those whose judgment I accept told me that the meet indicated a very rapid development of the pan-slavic feeling over a very few years ago.

At the recent outbreak of hostilities in the Balkan states there was a pretty general fear that there might be wars, especially between Austria and Russia, and Austria and Servia. The latter seemed very imminent at one time. We were given to understand that diplomacy had reached a high plane and held the wars off. We did hear that there was a great socialist meeting to protest against making workmen of one country fight workmen of other countries. Some of us, I am sure, believed that this demonstration helped the diplomats make their decisions even though the reports of the socialist proceedings were censored in Austria. But I suspected that we were not getting all the possible news from Vienna, and I inquired from my Bohemian friends. I had said that I did not believe it would be possible for Austria to make war on Servia as almost two-thirds of the population of Austria is slavic. My surmise had been correct for I learned that when the Bohemians were being entrained from their garrisons for mobilization on the Austrian border they were singing the slavic song which a few years ago was forbidden throughout Austria. Any man who might be appointed a diplomat would know enough to take this fact into consideration, as well as the socialist attitude. Much the same feeling exists toward Russia, though the average Russian soldier has not yet reached the point of feeling anything at all in the matter. However, the military future of Europe must take all this into account just as it must reckon with the brotherhood idea of socialism. When a war does come which raises a conflict between these motives, I anticipate that the national feeling will be predominant. In other words there is a very definite barrier to socialism which cannot be lifted until the spirit of national individuality shall have had the opportunity to get itself entirely free from any coercion which attempts to crush it. I am convinced that any people that shows this spirit manifests desirable elements of character, and the time is not far off when the rulers of the world will realize that the way to arouse it is to try to crush it. When the group shall find no restraint whatever upon it as a group, then the brotherhood idea of socialism stands a good chance of encircling the earth, but in the meantime, the human soul in its common life feels that it must be assured of its own identity.

To these illustrations I have given, enough more could be added to prove that it is a world movement. Hungary is just becoming conscious of itself. India is teaming with nationalism. The history of Ireland has been a continuous struggle for the same thing, and the reciprocity treaty was repudiated by Canada for the same reason. My sympathy is with socialism, but the coming of the great day must wait upon the nature of man.

Olivet College.

THE TAXATION OF LOCAL PUBLIC UTILITY CORPORATIONS IN MICHIGAN.

BY EDWARD H. RYDER.

The purpose of this paper is to discuss the taxation of local public utility corporations. This excludes from consideration the corporations of the utility type now under the authority of the State Board of Assessors, and confines our attention to electric light and power companies, gas companies, and street railway and interurban companies, whose organization and activities are largely local in nature.

That corporations of this type should receive special treatment from taxing authorities is not new to students of taxation. For instance, Dr. Adams in his work on Finance says.

> "The fourth class of industries that should receive special treatment at the hands of the revenue system is composed of municipal monopolies, such as street railways, gas companies, lighting companies and the like."

Adams Finance p. 453.

An equally pertinent observation to be made in this connection is that these economists have not as yet attained any unanimity as to the best method of treatment. Consequently, it is no matter of surprise that legislatures hesitate to attack a problem of such insoluble difficulties.

No time will be taken in this paper for the discussion of reasons for this special treatment of monopolistic utilities. Territory so thoroughly explored needs no attention before this body. We shall at once approach the subject which is the occasion of this paper, and shall treat this matter under three subdivisions—(a) What is the present method of taxing this type of property in Michigan; (b) What are other states doing with this problem; (c) What procedure ought to be taken in Michigan today.

(a) Present Michigan Methods: Local public utility corporations today are subject to the general property tax of the state as administered in the various territorial taxing units which means that they are assessed in fractional parts as found in the different taxing areas, rather than as industrial units, and, consequently with little or no regard for any element of value other than the tangible asset.

The only effort thus far made toward instituting a change in policy is that of the Special Commission of Inquiry whose report is familiar to all of us. The only possible agency clothed with any authority and possessing the necessary competency to effect any change in method is the State Tax Commission which through its power to review the local assessments might fix a valuation comprehending both tangible and intangible values. The very limited activities of this body in this particular capacity—thus far, three counties have been reviewed—is scarcely sufficient to reveal what their policy may be: but the accompanying tabulation (No. 1) is presented for the purpose of showing the changes made by the Commission in the valuations of local utility corporations in three cities of said counties. The fact that these properties are located in growing centers where both the valuation of these properties and extent of business have been rapidly expanding, taken together with the fact that the review has been made at a period succeeding a very marked advance in all values, leads to the conclusion that the commission has not given a satisfactory estimate to the intangible assets of such corporations. A comparison of these figures with similar data for non-utility corporations and private property seems to justify our conclusion.

Are we justified in assuming these corporations to be undertaxed? The data from which to answer such an inquiry satisfactorily and conclusively is not available to the unofficial investigator for the reason that the state at the present time has not provided means whereby the necessary data can be collected. The law requires every corporation to file an annual report with the Secretary of State, but this report is so limited in scope and reported under such diversified systems of accountancy that it is of little value for answering this inquiry. The only other source of information is to be found in the annual reports of street and interurban railways made to the State Railroad Commission. These reports, so far as they extend, are valuable and reliable.

Light has been shed upon this question by the report of our Special Commission of Inquiry. In fact, this is the only reliable evidence, aside from that found in Railway Commission records, that we possess. This body was confronted with this situation, and had it not been for the data made available to them by the Commissioner of Internal Revenue, but not put at the disposal of private parties, they scarcely could have made a report on these matters—at least, not without an investigation of the private accounts.

Utilizing the little data available in the state records, let us examine the information at our disposal. Table No. 2 will give items gathered from the Railroad Commission's records. Columns 1, 2, 3 and 5 are records, while 4, 6, 7 and 8 are computed from the former. The net earnings capitalized at 7% gives a valuation upon which these corporations pay a tax of approximately $8.25 per thousand. A comparison of the taxes paid with gross and net earnings shows a per cent of 4 and 10.49 respectively. Table No. 3 is taken from the report of the Commission of Inquiry and shows similar items with reference to steam roads. Table No. 4, taken from the same source, shows the rate per thousand tax upon different types of property in the state. Inspection of these tables confirms the belief that the corporations under consideration receive income from a value which is not reached under the present system of taxation.

(b) What are other states doing in this field? An authoritative compilation of the tax laws for the northern states, published in recent months by the Commissioner of Corporations, Department of Commerce, becomes the source of information for this topic. These reports authorize the following statements.

First. There is no uniformity discernible in the method of taxing public utility corporations of any description. This is much more marked in the case of local public utility corporations than for the more general types. Yet there is clearly evident a tendency in varying degrees to subject these local corporations to a tax other than the general property tax, a tendency especially marked in the North Atlantic and Middle Western States.

Second. Among the forms of tax employed, either as supplementary to, or in lieu of, the general property tax, the gross earnings tax finds place in some extent in eight states—Ohio, New York, Pennsylvania, New Jersey, Maine (street railway), Vermont (street railway), Rhode Island (street railway), and Minnesota (street railway). Eight states employ a tax upon the corporate excess. These fall into two groups: One, composed of western states—Minnesota (exc. st. railways), North Dakota, South Dakota, Iowa—attempts to reach a corporate excess through local assessors in connection with the general property tax. These laws have proved dead letters. Another group—Massachusetts, Connecticut, Indiana, Illinois—applies this principle through some form of state authority with success. A small group of states—Nebraska, Kansas, Missouri—make use of a special franchise tax.

Third. There is a noticeable tendency in the states which have really made some effective progress in these affairs to inaugurate some state authority—board or commission—to whom is entrusted the assessment of the property and the administration of the law. At least six states have active commissions.

Fourth. The disposition of funds derived from corporate taxation offers another instance of the lack of uniformity of policy. Whether such income shall be used for state purposes, be divided between state and locality, or be left to the locality, is no doubt largely determined by the policy of each state in respect to other sources of income.

(c) What policy ought to be adopted in Michigan? First of all, and fundamental to any wise, comprehensive plan of dealing with these corporations, we need some plan of securing annually reliable data concerning corporations of this type. The state authorities ought to possess records pertaining to capitalization, earnings, and taxation, and many other items, if for no other reason than to know whether the various species of property as well as individual interests are being dealt with equitably in legislative and administrative procedure. For instance, in the present investigation of the Pere Marquette, a witness has asserted that the two-cent rate is unjust to that railroad. The state must be the judge in a contention of this kind, and can expect to deal justly only through the possession of complete authoritative facts.

This argument is augmented when we note the tendency to enlarge the field of activities of our Railroad Commission. The scope of its powers has been materially enlarged by each legislature since the present Commission was established in 1907, and at present, members of this body are favorable to the extension of its powers to the various local public utility corporations of the state. This amounts to transforming the present commission into a full fledged public utilities commission. If this policy is to prevail, then the aforesaid information becomes imperative for such a purpose. The foregoing views do not comprehend a system of taxation on the part of the state, but, whatever policy the state may see fit to adopt in this connection, the data would be indispensable to the administration of any adequate system and would be at the disposal of the authority entrusted with the immediate problem of taxation.

This brings us to the question of taxation. Obviously, there must be a choice made from several possible policies as we find them suggested by our financiers. This choice can be made from at least three methods —corporate excess, gross earnings or receipts, or the ad valorem principle applied to both kinds of value. Doubtless, we are thoroughly convinced of the defects of our present plan and are ready to modify it; but are we equally of one mind as to what shall be substituted. It seems to the writer that the particular policy to be adopted ought to be determined somewhat by the taxing systems already in use in the state. Too radical departure from existing methods might not only be difficult to bring about through our legislature but might prove disastrous if attained because, if the state subjects different property to unlike methods of taxation, there my result more rather than less inequality, a condition sure to produce discontent. Inasmuch, then, as we have adopted a definite principle—ad valorem for both tangible and intangible elements of value—for particular public utility corporations, and have created the machinery for its administration, it would seem wise to extend this existing machinery of the state to the taxation of the corporations in question. As a method of solving this problem, we would advocate that a campaign be instituted to persuade our legislature of the wisdom of clothing our state Tax Commission with the power to determine the taxable value, both tangible and intangible, of our local public utilities.

Thus far in this suggestion we are following the existing law. At this point we would depart from it in that we would advocate having the Commission apportion these valuations to the various taxing districts in which the various corporations perform their services. This procedure would necessitate some equitable basis of distribution and should be done with the proviso that the local assessor shall accept this valuation for his tax roll and shall apply to it the local rate of taxation.

This feature both creates and solves problems. At once the query arises, What shall be the basis of distribution? The previous suggestion that distribution shall be to the districts where the tangible property is found, would mean that such property shall be considered realty and not personalty, and therefore the plan of distribution must be in keeping with this view. Without question, this plan of distribution is a difficulty, but no one conceives it to be beyond solution. It may necessitate modifying the special plan for each type of corporation. In some cases the relative shares of these valuations may be determined by the distribution of the tangible portions of the property. Again, possibly the income from service may offer a solution. Surely some method can be devised which shall approximate justice to the localities justly laying claim to participate in such distribution.

On the other hand, the plan being suggested would seem to dispose of troubles likely to arise over the average rate. Such a rate can be defended for property of wide distribution in the state and whose earnings are derived from a multitude of widely scattered sources, but for property whose owners are local residents, and whose earnings are chiefly local in origin, it seems much less likely to create disaffection to apply the local rate by which neighboring property is taxed and which in some degree is within the control of local residents.

Again, this plan would escape any objections which might arise over the attempt to have the state appropriate the taxes for its own use. Unless the state should adopt the policy of segregation of taxes, it would doubtless invite trouble from the local tax payers to attempt the plan of removing these corporate properties from the local rolls. The devotion of this income to the defrayment of state expenditures would decrease the state tax on all property, but without segregation it would mean reduction at the expense of localities possessing public utility property.

Furthermore, leaving the funds to the locality avoids the inevitable question of what use the state could make of the income. Present constitutional limitations would direct the tax to the Primary School Interest Fund, and the only way to make it available for general purposes would be through amendment. The futility of this expedient is apparent to all. Granting that our citizens might consent to modify the school fund clause of the constitution, the state might then find it necessary to segregate its taxes. A few years ago such a prospect would have been welcome as a highly acceptable reform in state finance, but today we view it with hesitation and are scarcely ready to accept it as a part of our financial policy.

In submitting these proposals, the writer is fully conscious that he is not wholly in accord with the modern trend in taxation, which is toward a gross earnings form of tax. *Herbert Knox Smith, Commissioner of Corporations, writes in a governmental report: "There is a tendency toward an abandonment of property as a basis of taxation in favor of a tax levied upon gross receipts."

**Allen R. Foote, in an address before the Providence Conference for Good City Government, said: "Upon a properly devised and administered system of state regulation, the basis of taxation for public service corporations will be shifted from valuation to earnings."

These statements are based upon facts which can not be evaded. We must acknowledge in the gross earnings tax certain advantageous features. For instance, it is easy to apply; it avoids the necessity of adjusting the relative values of tangible and intangible property; it is presumed to reflect ability to pay upon the part of the tax payer. On the other hand, all of us are equally conversant with certain well known defects of this tax. It does not measure ability to pay with exactness; it never is the equivalent of the general property tax because the rate is arbitrarily fixed and can not be coordinated with other rates.

As for the only other plan we need note—the corporate excess—it seems that the Michigan plan possesses the one essential virtue, of that which is to bring intangible values within the domain of effectual taxation.

Finally, for Michigan to adopt another plan would mean to establish within our state two different methods of treating the same type of property. This is objectionable. Our hope for the achievement of desirable reforms and the attainment of a satisfactory system lies in keeping close to a single policy. Thus do we justify the suggestions presented in this paper.

*Bureau of Corporations, Reports; Vol. 1, p. 14.
**Providence Conference for Good City Govt.; 1907; p. 267.

TABLE NO. 1.

These figures are taken from the books of the State Tax Commission for public utility properties in Ingham, Genesee and Kalamazoo counties.

Board of Review.					Tax Commission.				
Realty.	Personalty.	Total.	Rate per $1000.	Tax.	Realty.	Personalty.	Total.	Rate per $1000.	Tax.
$163,500	$125,600	$289,100	$29.9528	$8,659 36	$421,200	$250,800	$672,000	$15.1972	$10,212 51
108,600	142,150	250,750	29.9528	7,510 66	370,900	111,700	482,600	15.1972	7,334 17
7,500	13,000	20,500	29.9528	614 03	10,300	45,000	55,300	15.1972	840 41
28,000	103,875	131,875	29.9528	3,950 03	43,700	262,000	305,700	15.1972	4,645 78
18,500	275,000	293,500	26.3765	7,741 50	44,500	475,000	519,500	14.1784	17,365 67
30,000	120,000	150,000	26.3765	3,956 48	70,000	240,000	310,000	14.1784	4,395 30
....	100,000	100,000	26.3765	2,637 65	....	240,000	240,000	14.1784	3,402 82
6,000	15,000	21,000	26.3765	553 91	10,000	20,000	30,000	14.1784	425 35
115,000	360,000	475,000	26.3765	2,528 84	190,000	460,000	650,000	14.1784	9,215 96
225,000	2,000	227,000	22.4215	5,089 68	500,000	3,750	503,750	16.1182	8,119 54
100,000	....	100,000	22.4215	2,242 15	125,000	....	125,000	16.1182	2,014 78
62,300	225,000	287,300	22.4215	6,441 70	126,600	300,000	426,600	16.1182	6,876 02

TABLE NO. 1.—SUPPLEMENT.

Non-public utility corporations in Ingham county—Figures are taken from records of the State Tax Commission.

Board of Review.		Tax Commission.	
Realty.	Personalty.	Realty.	Personalty.
$27,000	$20,000	$32,150	$120,000
5,300	9,200	13,950	29,000
14,000	2,000	51,000	4,000
20,000	44,000	60,000	65,000
3,300	500,000	4,160	1,250,000
42,000	55,000	100,000	250,000
206,200	350,000	443,200	1,500,000
14,000	11,000	30,000	60,000

City residence property in Ingham county—Figures are taken from records of city treasurer, Lansing, Mich.

Board of review.		Tax Commission.	
Realty.	Realty.	Realty.	Tax.
$1,650	$1,650	$2,450	$37 84
3,500	3,500	5,000	76 54
5,500	5,500	11,500	176 86
7,800	7,800	15,000	227 50
3,300	3,300	4,750	73 02
5,000	5,000	7,500	114 32
6,300	6,300	9,500	146 89
2,000	2,000	4,000	60 48
3,500	3,500	6,250	94 51
6,800	6,800	14,000	220 90
13,500	13,500	30,000	459 68

TABLE NO. 2.*

Year.	Gross earnings from operation.	Operating expenses.	Net earnings from operation.	Net earnings less taxes.	Tax levied.	Rate per $1000.	Per cent of tax to gross.	Per cent of tax to net.	Capitalized valuation at seven per cent.
1909	$10,467,214 10	$6,360,623 53	$4,106,590 57	$3,739,130 40	$367,460 17	6.87	3.51	8.81	$53,416,148 57
1910	12,691,883 15	7,783,019 83	4,782,420 89	4,313,001 38	469,419 51	8.78	3.69	9.88	67,353,867 38
1911	13,831,643 62	8,658,285 36	5,173,358 26	4,511,383 88	661,974 38	9.37	4.78	12.79	69,405,905 84

*Data is gathered from records of State Railroad Commission.

TABLE NO. 3.*—STEAM ROADS.

Year ending June 30.	Gross earnings from operation.	Operating expenses.	Net earnings from operation.	Net earnings less taxes.	Assessed valuation.	Tax levied.	Per cent of tax to gross.	Per cent of tax to to net.
1902	$45,820,215	$35,510,219	$10,309,996	$8,826,090	$198,641,000	$3,288,162	7.17	31.90
1903	51,559,605	40,588,230	10,971,375	7,683,213	222,106,000	3,756,149	7.28	34.24
1904	51,715,342	41,615,736	10,099,606	6,343,457	196,795,000	3,330,350	6.44	32.97
1905	54,741,979	44,549,709	10,192,270	6,861,920	202,651,000	3,527,059	6.44	34.60
1906	60,458,895	47,824,590	12,634,305	9,107,246	207,068,000	3,409,915	5.64	26.99
1907	66,259,937	53,981,051	12,278,886	8,868,971	207,130,500	3,650,132	5.51	29.75
1908	63,235,347	50,007,804	13,227,543	9,577,411	207,305,000	3,713,155	5.87	28.07
1909	63,667,477	48,646,151	15,021,326	11,288,171	211,764,500	4,377,871	6.88	29.14
1910	72,025,499	53,839,115	18,186,384	13,808,513	211,716,000	4,346,841	6.03	23.90

*Table is from Report of Commission of Inquiry on Taxation—p. 15.

TABLE NO. 4.*

The following table gives the rate of taxes per thousand of actual value for farms, banks, residences, railroads, manufacturing corporations, public service corporations and mines. It also gives a comparison of the value and taxes paid by each of these classes except residences.

	Value.	Basis of computation.	Tax.	Rate per $1,000
City real estate..........	....	Examination of verified sales, 38,000 pieces in 90 cities. Taxes at actual rate for each locality..	....	$14 85
Farms..................	$1,000,000,000	Census reports, also examination of over 32,000 descriptions.....	$10,000,000	10 00
Banks and Trust Co's....	75,000,000	Reports to Banking Commissioner and Comptroller of Currency. Basis, net earnings also capital, surplus and undivided profits...	1,250,000	17 00
Railroads...............	212,000,000	State Board of Assessors, 1909....	4,378,000	20 65
Sleeping car, express, car loaning, and telephone and telegraph companies	24,000,000	State Board of Assessors, 1909....	493,000	20 67
Manufactures...........	750,000,000	Reports to U. S. Commissioner of Internal revenue.............	3,938,000	5 3
Mines..................	250,000,000	....	1,750,000	7 00
Electric railway, power, heat, light, and gas companies............	130,000,000	Reports to U. S. Commissioner of Int. Revenue and Mich. R. R. Commission..................	990,000	7 00

*Taken from Commission of Inquiry Report—p 15.

THE BREEDING HABITS OF THE LOG-PERCH (PERCINA CAPRODES).

BY JACOB REIGHARD, PRELIMINARY ACCOUNT.

Hitherto the breeding habits of the darters have remained practically unknown except in the case of the rainbow darter, Etheostoma coeruleum, which was studied at Ann Arbor by Miss Reeves.

The log-perch is rarely seen in Douglas Lake and seems to be an inhabitant of the deeper waters, though a few individuals have been seen by Mr. Heimburger on the bottom in three or four feet of water. During the eleven days beginning June 29, the fish were breeding on the pure sand bottom near the camp in water from four to twelve inches deep. About 150 fish were under observation. Sexes are distinguishable when the fish are at liberty by the darker coloration and by the behavior of the male, and in captivity by the larger anal fin of the male.

The breeding males are found in groups of 15 or less. Among these are a few females, but most of the females are seen waiting in deeper water or about the borders of the group. When a female enters the group she is at once pursued by one or more males, usually by many. She continues for some time to flee in a tortuous course back and forth through the group in its neighborhood. The female finally settles to the bottom and a male takes position over her with his pelvic fins clasping her head and his tail at the side of hers. A rapid vibration of the tail, pectoral and pelvic fins of both fish then follows and lasts about four seconds. This sends backward a whirl of sand and excavates a little pit in the sand beneath the fish. During this time, the eggs are emitted and fertilized and are usually buried in the sand, some in the pit, others behind it. Each egg is weighted by a coating of adhering sand grains. The spawning pair is usually enveloped by a group of supernumerary males, which are attempting to supplant the pairing male. When the spawning is completed, the spawning fish leave the pit or at least the female does so. She repeats the spawning in many other pits. When the spawning is finished at a pit the supernumerary males (and perhaps the pairing male) at once surround the pit and devour such eggs as they can get. The eggs were found in their stomachs. The eggs and young receive no care from their parents, but these, when the spawning period is ended, go into deeper water and are not again seen. The spawning behavior of this darter is more generalized than that of *Etheostoma coeruleum,* since each male ranges over the whole spawning ground, while in E. coeruleum, each restricts his activities to a small part of the ground, from which he excludes the others.

The spawning behavior is further of interest because it furnishes an instance in which sexual dimorphism in color occurs, and yet this difference is not the basis on which the fish themselves discriminate between the sexes. Young males in full color were often pursued by other males, and were apparently distinguished from them only by their failure to stop and behave like females. By the experimental substitution of a male for a female it was shown that if such a male were moved rapidly and then stopped on the bottom it was treated by other males as a female.

University of Michigan.

AN ADULT DIEMYCTYLUS VIRIDESCENS WITH BIFURCATED TAIL.

(With one plate.)

BY BERTRAM G. SMITH.

From a pond near Ann Arbor, Michigan, the writer captured an adult male Diemyctylus viridescens having the tail forked at the extremity in a vertical plane, each ramus of the forked portion having a distinct vertebral column. The general appearance is shown by the accompanying photograph (Fig. 1). Perhaps it would be more accurate to say that the ventral portion branches off from the main axis of the tail.

Sections show that the bifurcation is truly vertical, and that each branch possesses well developed vertebrae and a spinal cord. The spinal cord of the ventral ramus is not continuous with that of the dorsal ramus, but is perhaps connected with it by nerve fibers.

This is apparently not a case of "spina bifida" in the usual sense, for in spina bifida of the type familiar to embryologists the tail is divided in a horizontal plane. It seems more likely that the condition in this specimen is the result of injury with subsequent regeneration, as described in the experiments of Tornier.[1]

Tornier inflicted a double injury in the caudal region of a newt (Triton). The more posterior of the two injuries was effected by cutting off the tip of the tail, either completely or so nearly that it afterwards dropped off. The more anterior of the two injuries was just sufficient to expose a vertebral process, either dorsal or ventral. The tip of the tail was regenerated, while a second caudal lobe grew from the more anterior injury. Tornier characterizes the production of the anterior lobe as a process of "super-regeneration," induced by the more posterior injury. From his account it does not appear that an actual vertebral column developed in the regenerated region, but only a cartilaginous or bony axis; possibly the former might have occurred had the experiment been given sufficient time.

Zoological Laboratory,
State Normal College,
Ypsilanti, Michigan.

[1]Tornier, Gustav. Uber experimentell erzeugte dreischwanzige Eidechsen und Doppelgliedmassen von Molchen. Zoologischer Anzeiger, 20, 1897, pp. 356-362.

A SARCOPTID MITE IN THE CAT.

BY HAROLD CUMMINS.

The genus Notoedres is composed of mites parasitic on cats and rabbits; it is one of the eight better-known genera in the family Sarcoptidae. The disease produced is known as scabies or mange. There are relatively few records as to the distribution of these forms, so it would seem advisable to report them when found.

On the first of February of this year (1913) an adult male cat was brought to the Zoölogical laboratory for class work. It was found to be heavily infested with mites. These have been identified by Mr. Nathan Banks as Notoedres cati Hering. The top and sides of neck and shoulders and almost entire head were affected. The hair was sparse and contained flakes of loosened epidermis. The surface of the skin in these regions was rough and scaly. This condition extended even around the eyes; the cat could hardly open them fully, probably on account of their stiffened and encrusted lids.

According to Banks (in letter) this species is "known in Europe, and several times recorded from America as affecting cats."

Ann Arbor,

ORIGIN OF CONTINENTAL FORMS III.

BY HOWARD B. BAKER.

1. THE THEORY.

In previous papers I have outlined the theory that the present continents are the fragmentary remains of the crust of the Mesozoic earth. I have modified and developed the theory of the loss of earth mass first put forward by the Reverend Osmund Fisher and later by Professor Pickering, and have recorded certain conclusions prominent among which are the following:

1. The present geographical plan is the result, primarily, of the separation of mass from the earth.
2. This separation marked the close of the Mesozoic division of geological time as determined by the sedimentary series of southern France.
3. The separation was caused by extraterrestrial gravitation.
4. It was brief.

The theory as thus built up rests upon a large mass of geological data. General physical considerations, the evidence in favor of the former existence of extensive lands now lost, the fractured margins on the Atlantic ocean and the fact that opposite fractures may be fitted one to another upon the globe, these and many other lines of evidence go together to support the conclusions arrived at. At the same time the theory has biological aspects which are scarcely second in importance. It receives much support from both botany and zoology, and in return it offers to supply a new and a comparatively simple basis for pretertiary zoögeography.

2. SURVIVAL OF LIFE.

One of the numerous objections which the theory has to meet is the biological one that in a world-catastrophy of the nature claimed so much heat must needs be liberated that no life could survive.

In reply to this we may say that the geological evidence is so strongly to the effect that the continental sheets separated at the time mentioned and we are so sure that life did survive from the Mesozoic into the Tertiary that a purely a priori objection has less force than it would otherwise have. Moreover, we know that at the end of the Cretaceous period there was great and widespread extinction of species of both animals and plants.

To account for the survival of life we may observe that precipitation, altitude and atmospheric circulation would all combine to prevent unduly high temperatures over the lands of the earth. The smaller the land area the greater would we expect to be the destruction of life, and there is considerable reason for believing that such was the case.

Upon the first rifting in the old crust, under the tidal distortion of the planet, water would pour down upon the hot material below, being vaporized at once. This vaporization must have continued throughout the action and condensation of the vapor in the upper atmosphere would produce rain in abundance and this rain must fall upon the crustal plateaus.

The fragments of crust, standing two and a half or three miles high above the level of the hot denuded surfaces of the globe which are now the ocean bottoms would experience barometric changes which are difficult to predicate, but it seems clear that such altitude must have operated to lower the temperature very much as we observe it to do today.

With the denuded areas hot and upward currents being engendered in the atmosphere the continental plateaus being meanwhile high and cool, it follows that the return currents would descend upon the plateaus bringing them rain and cold from the upper atmosphere. It is even supposable that snow might fall on peaks in the interior of a continental plateau notwithstanding the enormous amount of heat actually liberated from the denuded earth. So we see that there are three good reasons why life might survive. We are quite sure that it did survive and the objection would thus seem to be not a fatal one against the theory.

3. LAND CONNECTIONS.

Land connections where none now exist have long been postulated to account for numerous and curious relationships between widely separated groups of animals and plants. As long ago as 1853 Dr. Hooker insisted upon connections of Australia and New Zealand with Africa and South America to explain the distribution of southern plants and from that time on such connections have been largely introduced in all parts of the world. Heretofore it has been necessary to postulate numerous and extensive vertical movements of the earth's crust often without any real geological basis and even in spite of geological opposition, and we must concede that such land connections as may have linked western Australia to South Africa, or South America to tropical Africa, or Spain to America, that these and similar examples are distinctly opposed to what is known of isostatic geology. So it becomes of interest to inquire what effect this theory of the loss of earth mass may have on the conception of lost land connections the world over.

Since in time the event is sharply localized to the end of the Cretaceous and the beginning of the Tertiary periods, and since it resulted in substantially the present arrangement of the continents, clearly its principal effect is upon pretertiary geography. It is capable of explaining many of the distributional peculiarities of Tertiary and later time, but surely prior to that it involves a radical change in the globe upon which we may attempt to depict the relations of land and sea.

So numerous and so difficult properly to weigh are individual instances of floral and faunal relationship that it seems best for me not to attempt to present and discuss any catalogue of such examples, striving rather to deal in summaries by comparing current opinions with the new basis afforded by the theory to learn to what extent they may modify each other.

The mechanical difficulties to be overcome have been found to be troublesome and the scheme herewith presented is put forward with some misgivings on account of its manifest crudity, but it serves to bring out important points and is therefore in use pending the devising of a better method or a better carrying out of this one.

Briefly it is this: Mercator charts being found to be unsatisfactory on account of the distortion, and spherical projections being almost impossible to draw, the continents have been moved about upon a globe and in the rearrangement photographed. From the photograph the continental outlines have been traced so that we secure a result somewhat similar to a spherical projection. Upon this tracing as a basis the paleogeographic ideas of any author may be set forth.

Herewith are presented adaptations on this basis of the views of von Ihering and Ortmann, and, as well as I have been able to interpret, of Scharff. These maps are submitted without argument, being intended to introduce the method and to gain some idea of the general relations of land and sea without too great reliance on detail either of time or of conformation. The land connections are variously correlated by different authors. Ortmann would retain some form of connection between Europe, Greenland and America throughout Tertiary time. He would have South America united to Antarctica in the lower Tertiary. von Ihering would connect Brazil and Africa in the Eocene. Matthew terminates all trans-Atlantic connections before the Tertiary and cuts off South America from Antarctica by the middle of the Eocene.

Hardly a feature of zoögeography or of geology rests upon a less satisfactory basis than intercontinental correlation and until the element of time can be more positively determined this must remain one of the difficulties of the theory, but it is precisely in this matter of correlation that the theory offers a new basis and a new hope for the future.

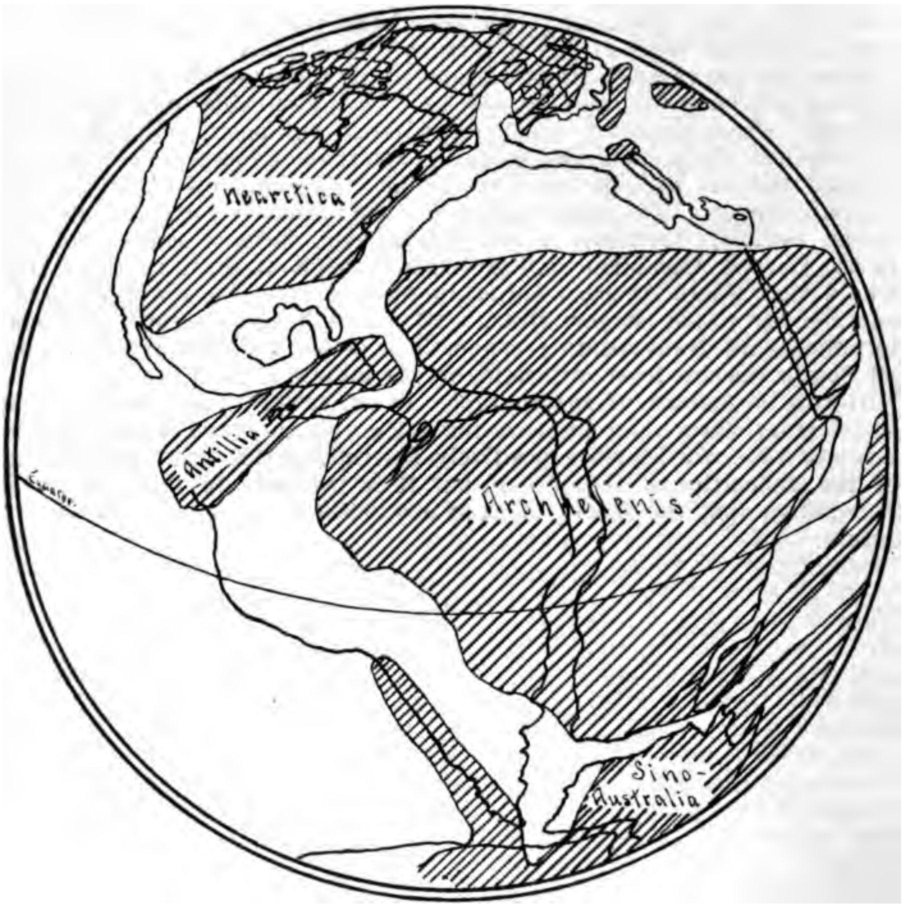


Fig. 1.—Lower Cretaceous. After Ortmann 1902.

Fig. 2.—Upper Cretaceous. After Ortmann 1902.

Fig. 3.—Land and Sea, "Eocene" time. After von Ihering 1907.

Fig. 4.—Adapting the ideas of Scharff, 1912, on the relationships of American life.

NOTES ON MORTALITY OF YOUNG OF WILD BIRDS UNDER NATURAL NESTING CONDITIONS AND UNDER ARTIFICIAL OR PROTECTED STATES.

BY JEFFERSON BUTLER, PRESIDENT MICHIGAN AUDUBON SOCIETY.

For a number of years I have been interested in the study of bird life. This study has been confined almost wholly to the living bird mainly because of the strong appeal of these creatures to the nature lover. Also because the dead bird had had considerable attention and the living had, it seemed to me, been in many phases of its life neglected. The taking of birds for records in geographical distribution has probably occupied the attention of more ornithologists than any other branch of bird study. Of course much time has been necessarily given to the structure in order to properly classify our birds as well as to general habits, nidification and means of identification.

The study of migration and economic ornithology has but lately received attention and the life history of birds is of comparatively recent origin. The question of the balance in nature in regard to bird life is due to receive much greater attention than in the past. After 15 years of effort in identifying our common birds through the opera glass I turned my attention to the question of the bird's struggle with nature. I endeavored to learn the experience of ornithologists in regard to the loss of eggs and young of our wild birds without obtaining more than very meagre results, but with sufficient to lead me to believe that the loss of bird life was heavy. It may be possible that we shall learn after the publication of this article that some other person has done this work with such thoroughness as to give us reliable statistics. Recently I wrote Mr. W. L. McAtee, Assistant Biologist of the U. S. Biological Survey, and received the following letter:

"I regret to inform you that none of our publications contain any particular information about the percentage of destruction of the eggs or nests of birds. While studying at the University of Indiana, Bloomington, I kept some statistics on this point one year. I found in all 22 nests in a certain orchard, and 18 of them were destroyed by various agencies, principally cats and boys. In few instances I imagine, is the destruction less than 50 per cent and often it is more. I enclose some extracts from a paper by Joseph Grinnell bearing on this subject."

Mr. Grinnell's observation was made in the San Bernardino Mountains, Cal. He estimated that there was about half a million birds in an area of 394 square miles. After taking all the accidents and fatalities during the nesting season into account he places the number of young at half a million. He recalls the fact that though some species increase in favorable years others decrease and that the population remains constant. This he says would mean the destruction of half a million birds for the year after the young are matured and would mean, I presume the loss through accidents in migration and death through disease and old age. He does not make an estimate of the loss of young during the nesting season.

When I began to keep a record of nesting birds I gave more or less attention to such questions as protective coloration, ruses of the parent birds to direct attention to themselves and away from the nest, to the question whether the male offered himself as a martyr by assuming a conspicuous place in showing his colors and giving his song and the physical ability of each species to protect its nest. I shall not attempt to give any observations on these matters. The question of protective coloration has been in sharp controversy by Mr. Roosevelt and Mr. Thayer which shows that the matter is a debatable one. If Mr. Roosevelt is correct in maintaining that birds do not depend upon protective coloration but on the instincts that command silence, hiding and activity when trouble presents itself then the majority of our popular books of birds and insects should be revised.

During the year 1911 I made statistics of the nesting of Song (Melospiza fasciata), Chipping, (Spizella socialis) and Field (Spizella pusilla), Sparrows; the Robin (Merula migratoria) and Catbird (Galeoscoptes carolinensis). These were selected because they were more abundant in the locality along the Rouge River, north of Dearborn, Mich., where I took my tramps, than other species and the nests were more easily located than in any other district with which I was acquainted. Though other species were under observation yet they did not offer as good material for comparison but will be referred to later.

In 1912 my observations were confined mainly to the Meadowlark (Sturnella magna), Bobolink (Dolichonyx oryzivorus), Brown Thrasher (Toxostoma rufum) and the Yellow Warbler (Dendroica astiva), with observations on two nests of the Indigo Bunting (Passerina cyanea). I found the nests of the ground builders more difficult to locate than those that build in trees. The purpose of my investigations was to note the mortality of bird life during the nesting period under natural conditions and to later compare them under artificial or protective states such as in the use of nesting boxes and with their natural and other enemies removed.

Of the Song Sparrows' nests found, seven in all, four were in bushes averaging from one to four feet, above ground and the other three were on the ground. Those nesting on the ground lost the first entire set of eggs in each nest. In two of those nests the second set of eggs were destroyed, probably by ground animals. The third was successful in hatching but the young never lived to fly. In other words there was a total loss of 100 per cent for the season as these observations were carried up to the 20th of June. As I was unable to locate the nests of any of this species after that date with eggs I presume they did not nest again. These nests had a total of twenty-five eggs, five of which hatched but none of which lived.

The four nests in bushes fared better and yet their history does not make pleasant reading. One nest was destroyed by a storm, and the birds, if they ever built again, selected a new locality. The other three pairs fared as follows: one had two young in the nest and an infertile egg, the second had three young, and the third four young and an unhatched Cowbird's (Molothrus ater) egg. The two first named got their young out in safety, whether they lived to mature I am unable to say.

One of the young was crowded out of the nest of the last mentioned and the other three young were seen in the trees two days after leaving the nest. The parent birds did not use any of the tree nests again. The net results of the seven pair of Song Sparrows were nine young. These birds nested on a farm where cats are excluded in every way possible, 20 having been taken on the farm that year.

The nests of four Chipping Sparrows were located. Knowing from previous experiences the sensitiveness of this species I was careful not to touch the nest or eggs. Two nested in crataegus and brought their young out. One had two young and the other, three. One of the other nests was abandoned after two eggs had been laid and the other was drenched in a rain storm and water soaked. One nest was in a willow and the other a poplar. These eight birds had a total of 5 young.

The nests of 5 Field Sparrows were found on the ground near woods. A red squirrel devoured the eggs in one nest. Of the other nests one had 5 young, another 4 and the third three and an infertile egg. No. 3 had its young at 4 p. m. one evening but by six-thirty next morning they were gone. As they had not feathered I knew they had been devoured. I saw a weasel in the locality and gave him the blame. The two largest families escaped, making 9 young for the 10 parents.

The nests of four Robins were located, one inside a shed, another on a porch and two in trees. The one in the shed had a family of 5 which were taken away by the parents successfully. Four young at the top of the porch were devoured by a cat, one in a tree 8 feet from the ground was robbed by boys and the other 20 feet from the ground had 4 young. The parents, with my help successfully drove away a red squirrel and later I was informed the squirrel was shot. However, I found one of these young dead. The total was seven young from the eight parents.

The nesting of three Catbirds were found. Each had four sets of eggs. One egg in each of two nests was broken, how I do not know. All these nests were in trees, averaging from eight to twelve feet above the ground. The others all hatched successfully, making ten young for nine parents. The same year I observed the nest of a Redstart (Setophaga ruticilla), with three young, one of which died from a fall, making two for that nest. A yellow-bill Cuckoo's (Coccyzus Americanus) nest with two eggs was abandoned because of frequent visits by humans. Two nests of the Wood Thrush (Hylocichla Mustelina) were found each with four eggs. Some weeks later, the nests were empty. It may be they hatched all the eggs and reared all their young. Though nests of the Veery (Hylocichla Fuscescens), Redeyed (Vireo Olivaceus) and Warbling Vireo (Vireo Gilvus), the King bird (Tyrannus tyrannus) and American Gold Finch (Astralaginus trestis) were found; in all there were only a partial set of eggs and the locations were not convenient for visits at the proper time.

During 1912, six nests of the Meadow Lark were found. They were all on the ground. Three nests had four (4) eggs each, two five (5) each and one with three (3). The eggs in all were taken by a weasel. The eggs of another were carried off by some creature. Three brought out their young, each of which I hope escaped. I did not see them when they left the nest. The six (6) nests covered a large range of territory. The nests of these birds have for me been very difficult to locate. To follow up work of this character requires considerable time as well as patience. The sixth nest had four (4) eggs and I expected to see a family. This was on Ford farm, Dearborn, where visitors go for amusement and occasionally for bird study. I showed a number visiting one day the nest of this last mentioned Meadow Lark. The grass was tramped down, which was probably responsible for what one of the men on the farm claimed was a Gopher coming within half AN hour and taking the eggs. I saw the marks of the teeth in the last remaining egg. Taking it for granted that the three with young each brought the latter to maturity, it would make nine (9) for the twelve (12) birds.

Four nests of the brown Thrasher all in trees averaging from one to three feet above ground, two with three (3) young and two with four (4) were located. A cat got one of the young of the last mentioned, but so far as I could keep track of them the other youngsters survived, which would make thirteen birds for eight (8) parents. Three nests of the yellow Warbler were located, two with four eggs. Subsequently one of these had four (4) young and the other three (3). I found an egg on the ground and presumed it rolled out sometime when the bird was suddenly flushed. Of the other two (2) nests one had three eggs of the Warbler and one egg of the Cowbird. I removed the latter and subsequently there were three (3) young which left the nest successfully. The fourth nest had two young when discovered and they left the nest in condition to fight the battle of life. That made twelve (12) young for the eight parents. These nests were from four to six feet above ground. Two nests were in cratægus. These two latter both brought out the young successfully. The foliage on these trees is very dense and the thorns keep out intruders and if eighteen (18) nests of small birds found in cratægus trees not one contained a Cowbird's egg, making them the most ideal nesting places found. I have reference to the smaller species of cratægus growing not more than six feet in height.

Three nests of the Indigo Bunting had a total of thirteen (13) eggs, four in two and five in one. They were in trees averaging from four to nine feet above ground. They all successfully hatched but the young of the top most were destroyed. Two king birds nests were watched, one twenty feet and the other thirty above ground. One was destroyed by some climbing animal and the other had five young. A Chickadee (Parus atricapillus), nesting in a hollow ironwood tree and the White-breasted Nuthatch (Sitta Carolinensis) each brought out six and five young respectively.

Summarizing results I concluded that birds have no infallible protective of instincts and that evolution is such a slow process that a species is liable to diminish greatly in changing habits to meet new conditions, such as the destruction of our forests, naturally impose. Many of the young birds do not have a fair start, coming out of the nest before they are in condition to wage the fierce battle necessary. Undoubtedly many are crowded out of the nest before they can fly and fall a prey to rats, mice, snakes and cats. It is my impression that many of the nests are too small for the family the bird attempts to rear. The dews no doubt kill many that cannot fly. Altogether the destruction is appalling to the bird lover. So great is it under natural conditions that I hesitate to seek for nests less I make the destruction greater.

It would look as if the birds nesting in low growing trees, barring interference by men, have the better chance to produce young. Those in the higher places have climbing animals, strong winds, and predatory birds to contend with in larger numbers, though the ground nesters have a better scheme of coloration and their nests are more difficult for man to locate. Those nesting in trees appear on the whole to have a better chance than the ground nesters; and those using holes in trees apparently are better off than ones nesting outside. I, however, wish it understood that I do not claim the above deductions as indisputable facts. My study of the subject is insufficient to base a rule.

Taking it for granted that the deductions are true, what can man do to assist our wild birds? In 1912, the purple Martins (Progne subis) visited a house erected for them on the Farm, but after staying three days deserted and nested instead in a hole formerly used by a Red-headed Woodpecker in a telegraph pole. As near as I could learn, they had eight (8) young. Three of those were found dead on the ground, making just five for the eight pair of birds living in that colony. Another Martin box had sixteen (16) pairs and brought out forty (40) young from a scientifically built nesting box. Not one of these young were destroyed so far as we could learn. Twenty Bluebird boxes were given by the Michigan Audubon Society in 1910 to prize winners in various parts of the State, and every one was reported as occupied by Bluebirds (Sialia Sialis). Fourteen wrote that these birds were successful in rearing their young and one brood was reported as destroyed by a cat. No definite information could be obtained as to the other five.

From reports of thirty-two house Wren (Troglodytes Ædon) boxes used last year, (1912) twenty-seven successfully reared their young, three abandoned their nest, one was found with young dead in the box and a cat destroyed the other brood. These reports were from Detroit, Grand Rapids, Saginaw and Toledo. Of four boxes taken by Tree Swallows (Tridoprocne bicolor) three reared their young and the cat got the fourth. I located two House Wrens nesting on Belle Isle in the Detroit River last year, but the eggs in both nests were destroyed. It stands to reason that the chances of hatching the eggs in a nesting box is more certain than in the open where they are a prey to animals, wind storms and rain. Therefore it would appear that man, by putting out bird houses, and keeping control of the cat, could materially aid in increasing at least some of our desirable birds. The study of bird houses is also essential. I erected a Martin box above my barn in 1911. That year a number of young Martins were killed by falling, because the porch outside the nesting hole was too narrow. This was remedied in 1912 and none perished in this way. Mr. Baskette in his book entitled, "The Story of the Birds," says: "Few things are so destructive of little birds as their premature escape from the nest." The young birds in natural nesting conditions appear to take flight earlier than from nesting boxes. Of course many of our wild birds will not nest in boxes, but other protective methods can be provided. The United States Biological Survey and other agencies studying wild birds keep placing a higher estimate on their economic value and if their estimates are correct, it would be but patriotic for our citizens to further the protection of these friends.

Occasionally I am introduced to an audience as one who knows all about bird boxes. I am obliged to correct this, as the bird box question is comparatively new, and the next decade may change many notions held in the past. Each year a bird or two is added to the box nesters and no one can predict where it may end. It is an experiment well worth trying. The United States Biological Survey is collecting data on the question which will be published in a bulletin during the coming autumn.

NOTE.—I have records of the following wild birds nesting in boxes Wood Duck, Sparrow Hawk, Screech Owl, Downy Woodpecker, Flicker, Crested Flycatcher, Phoebe, Song Sparrow, Tree Swallow House Wren, Chickadee, Tufted Titmouse, White Breasted Nuthatch, Robin and Bluebird.

THE FACTORS THAT DETERMINE THE DISTRIBUTION OF BOLEOSOMA NIGRUM IN DOUGLAS LAKE, CHEBOYGAN COUNTY, MICHIGAN.

BY H. V. HEIMBURGER.

This paper is a brief account of a piece of work done during July and August, 1912, at the University of Michigan Biological Station.

By means of a careful survey of the lake, it was found that Boleosoma nigrum was confined to water less than thirty inches in depth. Thirteen localities were found, in eight of which both young and adult of the species were aboundant. In five habitats only immature specimens were found.

It is known that the breeding habits and the food habits of animals play an important part in the determination of the local habitat. The breeding habits of Boleosoma nigrum have been described by Hankinson and by Forbes. These authors state that the eggs of Boleosoma are attached to stones, mussel shells and sticks which lie loosely on the bottom. Spawning occurs in April and May.

I have found by examination of the contents of twenty-one stomachs that the food of adult Boleosoma consists, as was found by Hankinson at Walnut Lake, almost wholly of the larvae of Chironomidae; Chironomus prevailing. The young Boleosoma subsist very largely upon Entomostraca, but eat correspondingly larger proportions of Chironomus as they themselves grow larger.

The larvae of Chironomus and other midges occur plentifully wherever there is an abundance of decayed vegetable matter on the bottom. The eggs of midges are deposited on the floating leaves of such plants as Potomageton, Nymphaea, etc., whence the larvae find their way to the muck of the bottom.

An analysis of the habitats in Douglas Lake shows them to have the following features in common:

(1) Mussel shells, small stones and sticks on the bottom.

(2) Quiet water, protected from violent wave action, allowing a thin deposit of muck to accumulate in patches over the sand.

(3) Absence of thick muck deposit in the shallow water. There are always patches of sand, stones, etc., not covered by the muck. A deep deposit of muck is usually found in the deeper water near by.

(4) Masses of Potomageton or other aquatic plants with floating leaves, are found in the immediate vicinity.

These characters of the habitat are shown to be directly connected with the food habits or the spawning habits of Boleosoma and may be regarded as physical features that determine the distribution of the species.

THE OXYGEN CONTENT OF THE WATERS OF DOUGLAS LAKE, MICHIGAN.

BY DAVID A. TUCKER, JR.

The analysis of the oxygen and carbon dioxide content of the waters of Douglas Lake was undertaken during the summer of 1912 at the suggestion of Professor Jacob Reighard. Owing to delays in the shipping of chemicals and apparatus the work was somewhat interfered with. The investigation of the oxygen content was much more complete than that of the carbon dioxide content.

Douglas Lake is in Cheboygan County, Michigan. It has an area approximately of twenty-two square miles, being shaped something like a fish with the median longitudinal axis running in a N.W.-S.E. direction. Of the various parts of the Lake the deepest portions, as shown by the soundings of the engineering students of the University of Michigan, are in the so-called South Fish-Tail Bay—on the shores of which the Biological Station is situated. The greater number of samples were taken from this Bay.

The samples of water were obtained by means of a clock-pump from the various levels. For the collection Magnesium citrate bottles with a capacity of 385 cc. were used. These could be pumped full of water and then tightly stoppered. Some difficulty was encountered in getting the pump airtight in order to avoid any change of the gaseous content while being taken. The pump and hose were always thoroughly flushed with water at the given level before the sample from that level was taken. It is quite probable that the receiving hose while lowered to a definite depth actually carried water up from a stratum of a foot thick, or even more on days when the boat was rocked by the wind. The temperatures at different depths were recorded by maximum and minimum thermometers.

The estimation of the oxygen content was made by an iodometric method—the same as used by Birge in similar investigations of the waters of Wisconsin Lakes. To each bottle of water 1¾ cc. of $MnCl_2$ solution was added by means of a pipette which reached the bottom of the bottle. An equal quantity of NaOH-KI solution was then added, resulting in the precipitation of $Mn\ (OH)_2$ which was shortly oxidized by the Oxygen dissolved in the water; the process being indicated by the change in the color of the precipitate from white to brown. After the precipitate had settled to the bottom, 3 cc. of concentrated HCl was introduced just above the precipitate, which, acting on the $Mn(OH)_4$ resulted in the formation of $MnCl_2$ and the liberation of clorine. This latter substance reacting with the KI gave free Iodine. The amount of Iodine set free being porportional to the quantity of oxygen dissolved in the water. The Iodine was determined by titration against a standard solution of sodium thiosulphate.

The following formula from Birge was used in the calculation of the numerical results:

(1) Oxygen in cc. per liter =

$$\frac{0.05825\ n \times b \times 1{,}000.}{v \times n^1} = \frac{55.825\ bn}{n^1 v}$$

In this formula b = the number of cc. of potassium dichromate solution used in standardizing the sodium thiosulphate, i.e. 25 cc.; n^1 = the number of cc. of thiosulphate used in standardization against the dichromate; n = the number of cc. of thiosulphate required for the sample of water.

By means of a table showing the number of cc. of oxygen required to saturate one liter of water at various temperatures, the percentage of saturation was calculated.

The strengths of the solutions used are shown as follows:

$MnCl_2$ — 200 grs. of the salt, free from iron, dissolved in water and diluted to 250 cc.

NaOH-KI — 180 grs. of NaOH and 75 grs. of KI dissolved in water and diluted to 500 cc.

HCl — Concentrated, chemically pure.

Sodium thiosulphate — approximately N/100.

Potassium dichromate — accurately N/100.

Starch indicator was used in the titration of the iodine.

The samples were in every case analysed within four hours after the collection. The experiments of Birge indicate that no loss of oxygen results in this time.

The results of the analyses for the depths 0, 3, 5, 10, 15 meters and the bottom are plotted so that the vertical spaces represent the cc. of oxygen per liter and the horizontal spaces indicate the time at which the observations were made. At the beginning of the observations, July 13, the oxygen content at the surface was a little over 7.2 cc. per liter while at three and five meters the quantity was about 6.8 cc. At ten meters 4.6 cc. per liter were found at 15 meters 3.3 cc. per liter, while at the bottom there was only 0.9 cc. per liter present. During the next three days, 13th to the 16th there was a decrease of about 0.3 cc. per liter at the surface and the 3, 5 and 10 meter levels. The quantity at 15 meters dropped 26 cc. per liter while only a trace was found at the bottom. From the 16th to the 18th there was an increase at the surface of about 0.45 cc; the oxygen at 3 and 5 meters decreased slightly, between 0.2 and 0.3 cc. so that on the 18th the water at these depths contained the same amount of oxygen, namely about 6.6 cc. per liter. At 10 meters 4.7 cc. were present while there was little change at the 15 meter level. From the 18th to the 22nd the surface water lost only a fraction of a cubic centimeter, while at 3 and 5 meters there was a decrease of some 0.8 cc. But little change took place at 10 meters. At 15 meters, however, a marked loss of oxygen was found. A trace of oxygen was found at the bottom on the 19th but none at all on the 22nd. During the two days—22nd to 24th—the surface content was lowered one cc.; that at 3 and 5 meters one-half cc., that at 10 meters a fraction of a cc. while at 15 an increase of 0.8 cc. was noted. A trace of oxygen was found at the bottom. During the period from the 24th to the 31st the surface content remained quite uniform; an increase in oxygen at the three meter level of 0.6 cc. occurred; a decrease of 0.6

cc. at 15 meters with no change at the 10 meter level resulted in the lower level having a slightly greater quantity of oxygen. The oxygen at 15 meters fell to 0.3 cc. On the 30th there was no change in the surface content but that of the 5 meter level had increased 0.8 cc. bringing it up to about 5.3 cc. per liter. However, on the 1st of August the 5 meter level showed again a little less than 4.5 cc. per liter; and the oxygen at 15 meters had become almost negligible and only traces of the gas could be found at the bottom after July 24th; most of the analyses showing no oxygen at all at the bottom.

The oxygen in Lake Douglas has a summer distribution similiar to that found by Birge in Lake Mendota. The lake is deep enough at least in North and South Fish-Tail Bays for the formation of a well marked thermocline (see Fig. 3). Since the water below the thermocline is not in circulation so as to come in contact with the air it has no source of oxygen during the summer months unless brought in perhaps by springs. The analyses indicate so little oxygen below the thermocline as to make improbable the carrying of any large amount of oxygen to the lower strata in this manner. It is probable then that the oxygen secured by the lower waters at the time of the vernal overturn and before the thermocline is well established constitutes its summer supply. There is a constant removal of the oxygen due to the living organisms; at the same time oxygen is furnished the water through plants, but also oxygen is removed by the decomposition of organic matter. The vast number of organisms which sink to the bottom is according to Birge the most effective agency in depleting the lower waters of oxygen. This depletion is shown to occur progressively as the summer passes by the analyses and affects the strata below 12 meters to the greatest extent since that depth marks the upper limit of the thermocline. Above the thermocline convection and wind currents tend to keep the water aereated to such an extent as to prevent anything like its complete depletion.

The excess of oxygen which is shown by the fact that on some days and at some levels the water was supersaturated is undoubtedly due in large part to the activity of algae and other chlorophyll bearing plants. Such an excess is shown in the table for July 23rd. The excess of oxygen produced in this manner can only accumulate in calm weather and as there was usually quite strong winds blowing over the Lake as often as every twenty-four hours there was little opportunity for a large excess accumulation. The tendency for the water above the thermocline become supersaturated decreased so that after the 3rd week in July only the surface water was supersaturated.

Observations were made on the water contained in shallow regions densely populated with weeds of various kinds and it was found that in these places the oxygen content was usually greater at a depth of 1 to 2 meters and that the oxygen was present in greater quantities than at the same level in the deeper water. The analyses for July 24th indicate these facts.

Analyses of water taken at 9 a. m. and at 4:30 p. m. on the same day showed a slightly increased amount of oxygen at depths 6 or 8 meters in the samples taken at 4:30 p. m. Sufficient data were not acquired on this point to give accurate quantitative results.

Briefly then the investigation shows that during the summer the surface oxygen content is between 6 and 7 cc. per liter; that at 5 meters is 5 to 5½ cc. per liter, at 10 meters 3 cc. and at 15 meters the oxygen supply which is early in the summer about 3 cc. per liter becomes depleted so that by the first week in August only traces are found; also that the bottom waters which have at the beginning of the summer less than a cc. of oxygen, become entirely depleted.

The data secured regarding the carbon dioxide content are not offered for publication at this time as they are incomplete. However, the results of the analyses seem to indicate that Lake Douglas is to be classed as a hard water lake with a carbon dioxide distribution similar to that found by Birge in Lake Mendota.

Date.	Depth, meters.	Temperature, degrees C.	Oxygen, cc. per liter.	Per cent Saturation.
July 13.......	0	22.2	7.245	120.1.
	3	22	6.93	114.5.
	5	20	6.72	110.1.
	10	17.7	4.67	70.9.
	15	12.5	3.27	44.4.
	18	10	.924	.1189.
15.......	0	22.3	7.156	121.09.
	3	22	6.9	113.2.
	5	19.7	6.861	108.6.
	10	17	4.526	67.9.
	15	13	3.1	42.5.
	18½	10	.843	1.08.
16.......	0	22	6.91	114.3.
	5	19.6	6.81	107.6.
	10	17.6	4.44	667.3.
	15	12.5	2.7	36.7.
	19	10	0	0.0.
18.......	0	20	7.341	118.63.
	5	19	6.6	103.1.
	10	17.7	4.662	70.8.
	15	12.2	2.84	38.2.
	19	9.77	.843	1.08.
19.......	5	19.2	6.419	100.8.
	10	17.7	4.62	76.1.
	15	12.1	2.6	35.09.
24.......	7	18.8	4.786	74.75.
	8½	18.8	4.966	77.24.
	8½	18.8	4.932	76.72.
	10	17.	4.42	
	15	10.6	1.9	24.7.
	18	10	trace.	
29.......	5	19.5	4.589	
	10	18.7	4.321	
30.......	0	20.3	5.77	92.3.
	3	20	5.62	89.1.
	5	19.7	5.34	84.5.
	10	17.	4.49	60.1.
	15	11.1	.6216	8.18.
	17	10	.4715	6.06.
	19	9.77	trace	
31.......	0	20	5.54	88.2.
	1	20	5.8207	92.6.
August 1.......	0	20.1	5.7	90.9.
	5	19.4	4.56.	71.7.
	10	18.8	4.26	60.6.
	15	10.5	.0026	.37.
	13	13.89	1.89	26.1.
	19	10	trace	0.0.
7.......	0	19.4	5.94	93.4.
	55	18	4.98	76.1.
	8	17.7	4.23	64.2.
	10	17.3	3.84	57.8.
	15	10	.0465	.59.
	18	10	0.0	0.0.
	Bottom.			
19.......	19	10	trace	0.0.
20.......	0	19.8	6.64	105.3.
	3	19.8	6.47	102.6.
	5	17.6	6.32	97.4.
	15	12.11		
	18½	10	0.0	0.0.
22.......	0	19.9	6.59	104.9.
	5	18.8	6.128	92.2.
	15	12.2	.4419	5.9.
	19½	9.77	0.0	0.0.

Date.	Depth, meters.	Temperature, degrees C.	Oxygen cc. per liter.	Per cent Saturation.
August 23.......	0	20	5.42	111.6.
	1	19.9	5.54	88.05.
	2	19.7	5.625	89.5.
	3	18.3	5.348	82.3.
	5	18.8	5.25	
	6	18.8	5.056	78.67.
	8	19.1	5.06	79.07.
	21	9.77	0.0	0.0.
24.......	0	19.4	5.53	87.12.
	0	19.4	5.418	85.89.
	28 in.	19.4	5.469	86.09.
	1	18.3	5.198	79.99.
	3	18.18	5.028	78.22.
	7	18.8	4.786	74.75.
	8½	18.8	4.966	77.24.
	8⅓	18.8	4.932	76.72.
	10	17.	4.42	
	15	10.6	1.9	24.7.
	18	10	trace	
30.......	0		5.77	
	3	5.62		
	5		5.34	
	10		4.49	
	15		.6216	
	17		.4715	
	19		trace.	
29.......	5		4.589	
	10		4.321	
	15		.3341	
31.......	0	20	5.54	88.2.
	1	20	5.8207	92.6.
1.......	0	20.1	5.7	90.9.
	5	19.4	4.56	71.7.
	10	18.8	4.26	60.6.
	15	10.5	1.0026	.37.
	13	13.89	1.89	26.1.
19.......	19	10	trace	0.0.
7.......	0	19.4	5.94	93.4.
	55	18	4.98	76.1.
	8	17.7	4.23	64.2.
	10	17.3	3.84	57.8.
	15	10	.0465	57
	18	10	0.0	0.0.

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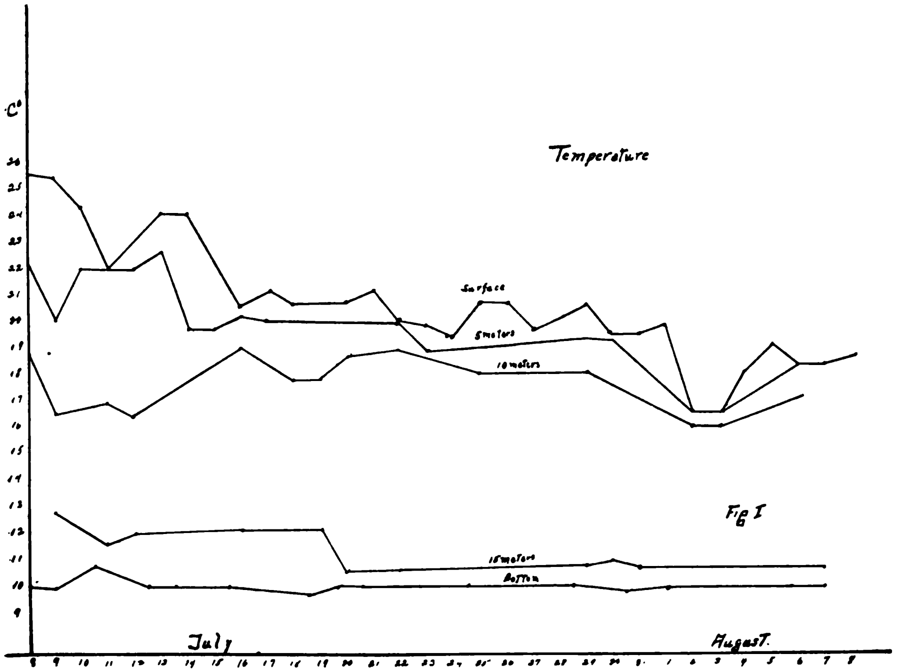
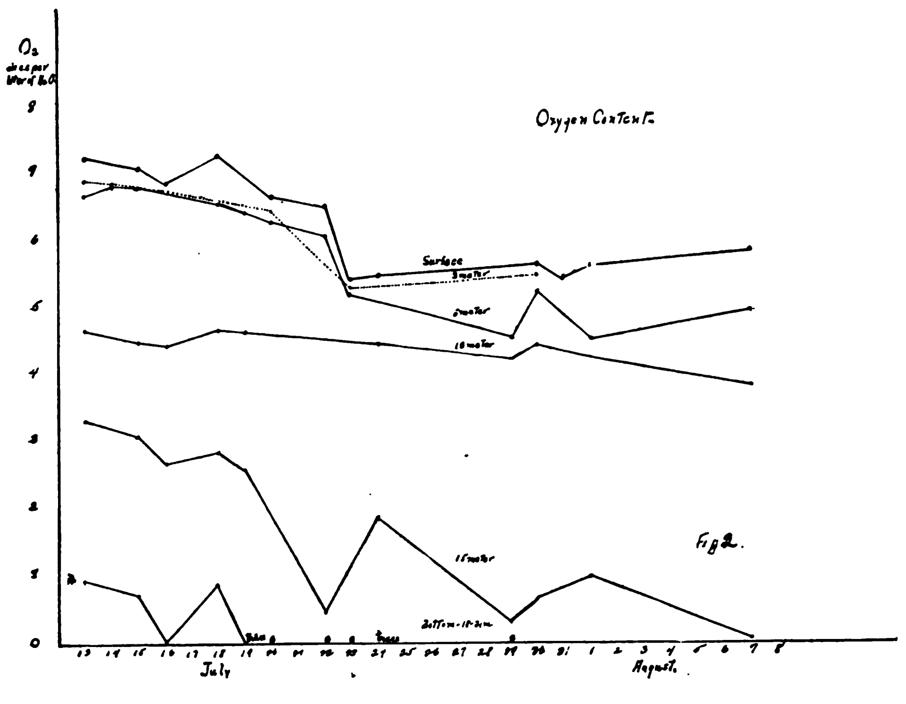
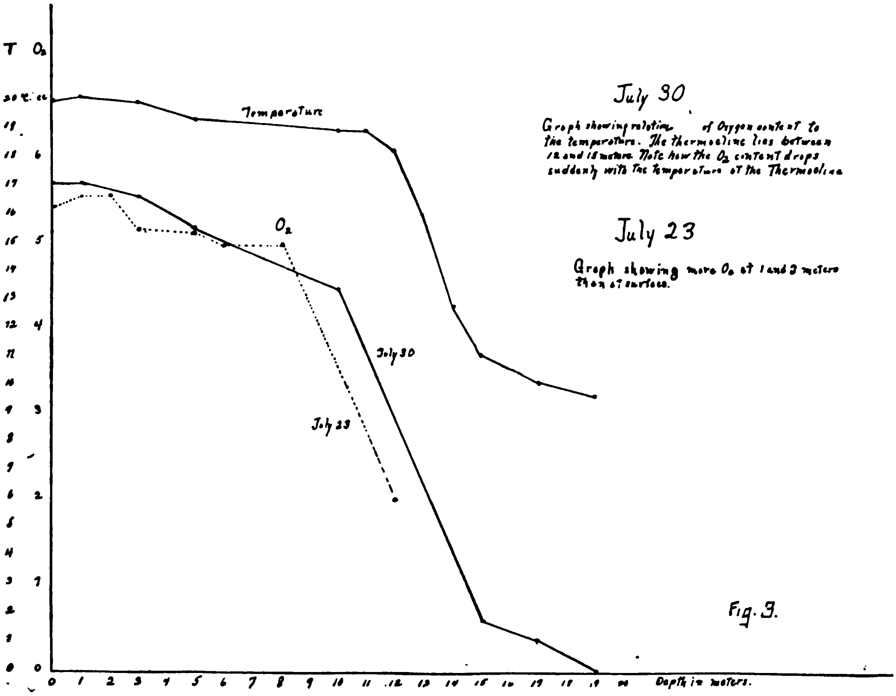

C°
Temperature
Surface
5 meters
10 meters
15 meters
Bottom
July
August
Fig I


O₂
Oxygen Content
Surface
5 meter
10 meter
15 meter
July
August
Fig 2.



T O_2
Temperature
O_2
July 30
July 23
July 30
Graph showing relation of Oxygen content to the temperature. The thermocline lies between 12 and 15 meters. Note how the O_2 content drops suddenly with the temperature at the Thermocline
July 23
Graph showing more O_2 at 1 and 2 meters than at surface.
Depth in meters.

Fig. 3.

SOME OBSERVATIONS ON INTESTINAL VILLI.

A PRELIMINARY REPORT BY OTIS M. COPE.

This research was undertaken as a result of the observation of movements of individual villi of the intestine when viewed under a low power binocular microscope. The rate of this movement was observed to be much more rapid than one would naturally expect in un-striped muscle. This initial observation having been made while working with Prof. W. P. Lombard, he suggested a further study of the movements to determine their nature and cause.

The method of attacking the problem was to anesthetize the animals, (dogs and rabbits), with Chloretone, which was given intra-peritoneally in hot olive oil solution, and which causes complete anesthesia in about thirty minutes, the anesthesia lasting as long as two weeks, providing the animal is properly nourished by artificial means. After anesthetizing the animal, it is placed on its back, an opening made into the abdominal cavity in the lower posterior portion of the abdomen, a loop of the intestine is brought up to the surface, a longitudinal slit about 2 cm. in length is made in the gut opposite to the attachment of the mesentery and the out-rolled mucosa examined with the binocular microscope, under a strong reflected light.

Repeated examinations of the villi in rabbits have so far failed to show any movements whatsoever, while in dogs, only a few experiments have been satisfactory, owing to the fact that the movements cease within a very few minutes after the gut has been exposed to the air, while abdominal respiratory movements alter the focal distances so much that a clear picture of the villi is impossible.

To obviate the latter difficulty, an apparatus was constructed to support the loop of intestine and prevent the respiratory movements from being communicated to it. The apparatus consists of a metal disc with a long handle for clamping to a stand. The disc has two flanges, one at each edge, to catch the tissues of the abdominal wall and hold them apart to allow the gut to be more easily handled and to allow the necessary amount of light to be thrown on the villi. The upper flange is fitted with several perforations to allow the gut to be caught up in several places by fine threads and tied to the apparatus itself. By this means, the respiratory movements are entirely done away with.

Up to the present time, but little has been accomplished in actually answering the questions suggested by the problem, but it is thought that by a further use of the instrument, more light may be thrown on the subject. A fuller discussion of the problem is reserved for a later paper.

Ann Arbor, Mich., April, 1913.

THE ANTITOXIC ACTION OF CHLORAL HYDRATE UPON COPPER SULPHATE FOR PISUM SATIVUM.

(Preliminary contribution.)

With One Figure.

BY RUFUS PERCIVAL HIBBARD.

The problem of balanced solutions is of fundamental importance to general physiology, for it is recognized that each cell, plant or animal, is bathed by a fluid which may be conceived of as being a physiologically balanced solution. Moreover, the physiologist must needs use the facts of antagonism in interpreting the role of given elements or nutrients. O. Loew, the pioneer in researches of this nature, goes so far as to postulate that calcium in the cell is important largely as an antagonist. Again, it is conceivable that the normal tissues produce substances whose function it is to inhibit or ameliorate the injurious products that are the results of metabolism. As a few of the many examples, one might mention the inhibition of a too excessive amount of carbon dioxide in the tissues and the counteraction of the so-called "fatigue substances" in the body.

The importance of antagonistic action in agriculture is evident when one considers that the cultivated plants are wholly dependent on the soil solution which bathes the root hairs, and this soil solution can be conceived of as a physiologically balanced solution for such plants as thrive in that particular soil. It might be remarked that the bulk of experiments in the application of fertilizers and general agricultural practice have failed to consider the possible effects of such treatments upon the soil solution, and vice versa.

Ringer was the first to observe antagonism between salts. He drew the conclusion that this phenomenon was based upon the fact that each salt when applied singly acted in the opposite way from that of its antagonist. Since his time, many have added to the sum total of our knowledge of balanced solutions. We know now of a large number of antagonistic actions and in addition are acquainted with certain theories to account for these conditions. The investigations of recent times have been led by Loeb, Lillie and Osterhout, the latter approaching the subject from the standpoint of the botanist, so few of whom have entered this interesting field.

As one reads the literature, he can not help but draw the conclusion that substances which act in an antagonistic manner may not after all be confined to a limited class of compounds. The great mass of experiments have been done with salts and only a few non-electrolytes have been tried—such, for example, as glycerine, urea and alcohol. It has been assumed, therefore, that salts alone show antagonism. We have only to refer to the work of Lillie[1] to see that outside this group of com-

[1]Lillie, R. S., Amer. Journ. Physiol., 1911, 21: 372-398.
" " " 1912, 30: 1- 17.

pounds are other substances of a different chemical nature showing antagonism. Lillie gives us a number of examples of antagonism between salts and organic compounds such as make up the common anaesthetics. Further, the antagonistic action of calcium on organic poisons has been shown for a number of living organisms by the work of Fuhner,[2] Ishizaka and Loewi,[3] Eisler and Portheim,[4] and Loening.[5]

For the literature on antagonisms between secretions, toxins and haemolysins, see T. B. Robertson[6].

The recent investigations of Schreiner[7] and his co-workers on the effects of nitrogeneous and other fertilizer elements on certain organic compounds isolated from soils suggests the possibility that the ameliorated conditions obtained fall in line with results observed under the general head of antagonism. The fact that a culture solution in which wheat seedlings have grown is harmful to a second crop of wheat, but not injurious to some other species of plants may also be another instance of antagonism.

It must be admitted that many cases of so-called antagonism are complicated by certain factors of nutrition, osmosis, ionization, surface tension, etc. So far, experiments in antagonism have dealt wholly or in part with substances used by the plant in the process of metabolism. This has lead to a just criticism, from such authorities as Loew and Aso[8] and it is further generally considered that the nutritive or stimulative effects may mask the toxic or antitoxic action. One would be justified in assuming that the better growth observed in some cases could be attributed to the nutritive effects of the substances which in balanced solutions according to Osterhout[9] enter the plant at a very much reduced rate and at what might be in some cases a nutritive ratio.

Loeb and Lillie have added to the explanation of this phase of the problem by using one solution of the known nutrient with another solution not normally used in nutrition. For example, Loeb[10] obtained antagonistic action with NaCl by the use of zinc salts, etc., while Lillie obtained his results by noting the effect of anaesthetics in various concentrations of nutrient salts.

In summarizing the previous work done on antagonism, one might point out that the solutions used by Loeb,[11] Osterhout[12] and Lillie were concentrated solutions of comparatively high osmotic pressure. How far these concentrated conditions effect ionization and the possible role of ionization, has not yet been determined. Without questioning the fact that calcium acts as an antagonist, many investigators, as has been said before, are using this element at a concentration which produces excellent growth of itself. In the work reported here, the author has used two known poisons and has been able to work at greater dilutions on account of their extreme toxicity. Neither of these substances is normally included in the plant metabolism.

During the summer of 1912, the writer conducted some experiments

[2]Fuhner, Arch. Expt. Path. u. Pharmakol 1907, 58:1.
[3]Ishizaka and Loewi, Centralb. f. Physiol. 1905, 19:593.
[4]Eisler and Portheim, Biochem. Zeitschr. 1909, 21:59.
[5]Loening, Munchen med. Wochenschr. 1910, Nos. 4 and 5.
[6]Ergeb. d. Physiol. 10, 1910, p. 216.
[7]Bull. of the Bur. of Soils, U. S. A.
[8]Bul. Col. Agr. Tokyo Imp. Univ. (1907), 7:395.
[9]Science N. S., Vol. 34, No. 867, p. 189.
[10]Amer. Jour. Physiol., 1902, 6:411-433.
[11]Amer. Jour. Physiol., 1902, 6:411-433.
[12]Osterhout, W. J. V., Bot. Gaz. 1906. 42:127-134 and Bot. Gaz. 1907, 44:259-272.

to learn what relation exists between two poisonous substances when one is a known narcotic. For these experiments, copper sulphate was used at concentrations varying from M3 x 10^{-4} to M2.5 x 10^{-6} together with the non-volatile anaesthetic chloral hydrate in concentrations varying from $\frac{M}{165.5}$ to $\frac{M}{16550}$. Garden peas of the variety of Little Gem were selected as indicators, and the increase in length of the roots afforded the criterion as to the effects produced by the toxic substances. For a criticism of this criterion, see Heald.[13] Five seedlings floating on paraffine discs were grown in each dilution so that the roots were the only portions of the plants exposed to the solutions. While the number of plants used appears small, the work has been repeated three times with concordant results. In the series, run in duplicate, from which the curve is plotted, copper sulphate M/51000 and chloral hydrate M/165.5 were each diluted by the addition of 50, 100, 150 cc., etc., of water to 450, 400, 350 cc., etc., respectively, of the original solutions. Then the copper sulphate was mixed with chloral hydrate to form another series by the addition of 50, 100, 150 cc., etc., of $CuSO^4$ to 450, 400, 350 cc., etc., respectively, of chloral hydrate.

Observations were made at the end of twenty-four and forty-eight hours. The average increase in the length of the roots in each dilution was chosen and the results plotted. The curve shows clearly the poor growth in the solutions where the single substance was used, except at the lowest dilutions, and a noticeably better growth where the two substances were combined. Antitoxic action of the combined solution is especially noticeable in the central part of the curve where the amounts of the different solutions are nearly equal. One further statement may be made, namely, that according to the accepted dissociation theory, we may look upon the compounds in these dilutions as completely dissociated, and it seems also safe to conclude that since there is an absence of reaction between copper sulphate and chloral hydrate at ordinary and even at high temperatures according to Werner,[14] there is no chemical reaction between the two compounds as they have been used.

The results of these experiments with pea seedlings show that we are dealing with a case of antagonism between a salt and an anaesthetic. Chloral hydrate thus exhibits an antitoxic action which though less marked may be comparable to the antitoxic influence of calcium over magnesium salts. It is interesting to note that the use of anaesthetics on plants gives results comparable to some extent to those obtained by Lillie with lower animals.

A number of theories have been brought forward to explain the mechanism of antagonistic salt action. No detailed account can be attempted here, but it might not be out of place to outline the avenues of attack. First, the effect may come about through reactions in the liquid itself. These may be due to chemical reaction or chemical affinity. A proper choice of materials, however, eliminates many of these cases and under this head we need consider only such effects as do not come about in that way.

The extent of ionization is perhaps the problem which is most important in this connection. If we look upon the molecule as compara-

[13] Heald F. D., Bot. Gaz. 1896, 22:125-153.
[14] Werner, E. A., Jour. Chem. Soc, 1904, 85:1376-1381.

tively inert and the ion the reverse, the importance of knowing the extent of ionization becomes obvious. But in this problem we deal not with the single salt, but with a combination, and the effect of this combination on restraining or bringing about ionization must be considered. Here also the concentration of each is fundamental. There is a great opportunity for a review of the work of antagonism in the light of ionization and in the light of the effect of combinations on this ionization.

Not to be omitted here is the relation of adsorption phenomena, and whether we should include this discussion here or under a later head, is a question. We know that adsorption phenomena are well marked between colloids and various other classes of compounds. Moreover, we know from the work of Höber R.[15] that the effect of a combination of substances is very great on the relative adsorption, one substance as it were crowding the other away and even crowding it away excessively. What role this plays in antitoxic action is as yet in the "suggestion" stage. Surely, however, its role is more important in such an experiment as the one just detailed, than in those where greater concentrations are employed. Again, in the problem of reactions in the solutions and the effects of combined influences we have to deal with molecular complexes, the significance of which we are only beginning to observe, by thermometer and by spectroscope. What relation one substance has in its inhibition role upon another must be carefully considered.

Secondly, the effect may come about through changes in the plasma membrane. It is obvious that these changes must ultimately modify the permeability of the limiting layer. In accounting for the phenomenon of antagonism, Loeb[16] has postulated the "tanning" theory and has shown in certain cases that antagonism depends upon a common cooperative action of both salts through which action the membrance becomes completely or comparatively impermeable to both salts. He further concludes that each salt in solution by itself is toxic in view of the fact that it diffuses rapidly and comes into direct contact with the protoplasm of the germ. The change in the membrane which results in a modification of its permeability is explained by him as a process of coagulation through the action of the electrolytes in the protein colloids. This finds substantiation in the field of pure physical chemistry for colloidals are coagulated by electrolytes if the electrolytes are strongly dissociated into ions and are present in sufficient quantity.

It is also a possibility that the antagonistic action comes about through the effects of the solutions on the lipoids. The various schools are divided as to the distribution of the lipoids in the surface layer. This brings about a lack of uniformity, in the theories presented, as to the role of lipoids. Necessarily, the application of this theory of Overton has been most elaborate in the study of narcotics and anaesthetics since the Overton theory deals primarily with the class of substances used in anaesthesia. The theories concerning the effect of a combination of solutions on the lipoids conceived this effect to be more than a mere solvent action and postulate either an increase in the colloidal dispersion or else a direct change of the relation of the constituent parts of the plasma membrane.

[15] Physik. Chemie der Zelle u. Gewebe. 3. Aufl, p 278.
[16] Biochem. Ztschr. Bd. 36. 275.

It has not yet been determined just what relation surface tension has to the mass of data on antagonism. Perhaps with our present knowledge this relation is immeasurable, but it is true that surface tension plays a fundamental role in osmosis if we are to accept the work of B. Moore.[17] Recently, surface tension phenomena have been used to explain the coagulation of colloids. Since it is also true that the surface tension changes with the electrical potential, the application of Lillie, of certain relations of electrical charge to permeability in which he assumed that the contact of an ion of a given charge changed the nature of the charge in the membrane and the assumption that the anaesthetics played their role in antagonism by restricting the effects of this change of potential, may be extended and the whole phenomenon may be viewed from the standpoint of the effect of this contact on surface tension. There are those also who view the plasma membrane as a direct reaction to the surface tension of the bathing fluid. Hence the importance of the interpretation of this class of phenomena in the light of the views on surface tension. But in view of our present knowledge of surface tension, we can not as yet formulate a definite hypothesis dealing with the relation of surface tension to antagonism.

Thirdly, the effect may come about through changes in the cell itself. Here we enter a comparatively new field. It is easier to conceive that the effects of antagonism are brought about by producing profound changes in metabolism, such as the formation of compounds with the proteins,[18] precipitation even of these bodies or by effects on oxidation,[19] enzymatic action[20] and the like, it is easier, I repeat, to conceive of such action than it is to eliminate other factors and prove the case. Finally we may be dealing with a combination of any of these general groups.

With this mass of theories and this outline of possible causes of antagonistic action, little can be concluded to apply to the case in point. I have not believed the action in the case of chloral hydrate and copper sulphate to come to any great extent under the head of reactions within the solution. It is true that in dilute solutions certain reactions occur which are not apparent in concentrated solution. Moreover, I have made no attempt to conclude anything about the effect on different ions, although from previous work in this line and a knowledge of the reactions of chloral and chloral hydrate such conclusions might be permitted. It is now believed that the dissociation of copper sulphate does not include the formation of complex hydroxides, since recent work on copper sulphate and other common copper compounds in a great variety of solutions have failed to bring to light these mythical compounds. The formation of complex "hydrates" in water by copper and the lessening of such effects by such substances as chloral hydrate has not as yet assumed tangible form.

Nor have I seen fit to interpret my results as refuting or confirming the Overton theory, although Lillie draws conclusions from his experiments to substantiate this theory, and Loeb and Osterhout use their experiments in the opposite direction. We must remember that

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[17] Phil. Mag. 1894, (5) 38:279.
[18] Moore and Roaf. Proc. Roy. Soc. London, 1904, B. 73:382.
[19] Loeb. J., Amer. Jour. Phys. 1911, 28, 213.
[20] B. Moore in Recent Advances in Physiology and Biochemistry, 1906, by L. Hill, London, Publisher, E. Arnold.

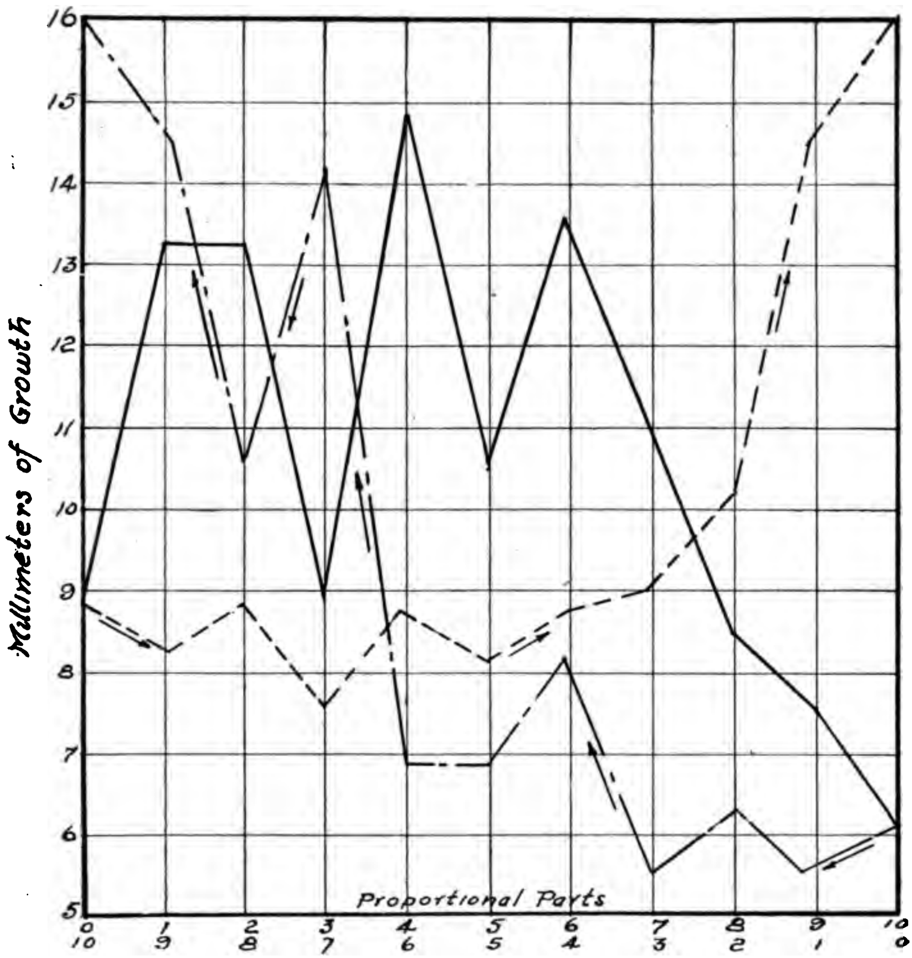
the Overton theory, while giving the most extensive study of permeability yet deduced, was developed before the general application of physical chemistry. If, therefore, we hold to the belief that the plasma membrane is colloidal or part colloidal in its nature, we are not permitted to transfer facts of mere solubility in the realm of pure solutions, into this domain of colloidal chemistry. In the application of this ingenious theory, chemical facts dealing with another class of compounds are carried over to too great an extent to make this theory a safe one on which to build.

As to the "tanning" theory of Loeb, one must be cautious. This is perhaps the most ingenious of all theories in permeability, but one which so far is not of universal application. Until the antitoxic action between a wide range of compounds can be given for colloids apart from the cell, we shall need to suspect other factors at work besides the mere coagulation of the cellular limiting membrane, or at least look upon such coagulation only as a result of some other process.

Explanations based on the third class are as yet too general to enable us to advance far. For the special case under consideration, the hypothesis about to be advanced may properly fall in part under this head. In the case of the antitoxic action of chloral hydrate and copper sulphate, the writer would like to call attention to the catalytic power of small amounts of copper. It is a well known fact through the work of Ostwald, Bigelow and others,[21] that a mere trace of Cu ions causes a rapid decomposition of $NaHSO_3$ and that substances such as glycerine, mannite and a number of others inhibit strongly this catalytic action of copper. Experiments performed with a dilute solution of copper and a number of organic compounds which will be reported more fully later lead to the belief that chloral hydrate may affect the action of copper in some anti-catalytic way. Be this a mere "poisoning" in the solution, such as carbon monoxide or KCN are known to exert upon catalyzers or not, the inhibition exhibited by the chloral hydrate must stand in some relation to the plant, either to the plasma membrane or to the cell. Experiments are in course of preparation in the attempt to answer some of these puzzling questions thus brought to light. It has been thought worth while to focus attention on this feasible but neglected possibility.

In summarizing, the author has tried to give more than the mere record of an experiment. He has reviewed very briefly the classic experiments on antagonism and has arranged these as it were into three groups, and has attempted to show that the experimenrs he performed dealt with different conditions from any brought forward so far. The relation of this problem to general physiology and to agriculture was mentioned. One typical curve from the experiments was chosen for this preliminary paper. Before developing a theory for the explanation of the results obtained, he has reviewed briefly some of the possible causes for antagonistic action. It is conceived that the results may come about from effects within the solution itself, in the plasma membrane, or within the cell, or there may be combinations of these effects. Since the theories suggested were not entirely positive, another theory was advanced, namely, that in the particular case studied the action of

[21] Zeitschr. f. Physik. Chem. Bd. 26, 1898, p. 493.



KEY

—·—·— = $CCl_3CH(OH)_2$

- - - - - = $CuSO_4$

———— = $CCl_3CH(OH)_2$ and $CuSO_4$

chloral hydrate in antagonizing copper sulphate might come about through the anticatalytic action of the organic substance. How far this explanation can be applied to other cases of antagonism is not determined, but it may be applicable in some analogous way.

Antagonism as it now stands is a phenomenon of wide scope one which is judged merely from the effects produced by combinations of chemicals. Until refinement of definition based on physiological differences in the reactions, is possible, it is at least permissible to class the antitoxic action obtained above through the means of chloral hydrate, (with the reported observations). If the results obtained are strictly comparable, a considerable increase in the scope of antagonistic action is thus given. In the experiments reported above very dilute solutions of copper sulphate and chloral hydrate were used and neither of these are known to be of nutritive value in any concentration. When we find antitoxic action in such dilutions and between such bodies, we necessarily widen the field of inquiry and eliminate many irrelevant factors.

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IMPROVED METHODS FOR THE QUANTITATIVE DETERMINATION OF DILUTE SOLUTIONS OF ELECTROLYTES.

(Preliminary contribution).

BY RUFUS PERCIVAL HIBBARD.

The use of a Wheatstone slide wire bridge or Kohlrausch's improvement of the same in botanical investigations is relatively new. To those of you who may not be familiar with its uses in plant physiological studies, let me state that among the many, it affords perhaps the most accurate method for determining the concentration of solutions. The concentration of a dilute solution is an index of the number of ions in that solution, and in the same way the electrical resistance is dependent on the number of ions. The greater the number of ions, the less the resistance to the passage of an electric current, and the less the number of ions the greater the resistance to the passage of an electric current. So by calculating the specific resistance and inserting the values in certain formulae, the concentration of the solution can be determined.

Recent work has shown that for purposes of greater accuracy and speed, it has been necessary now to make some modifications in the present form of the apparatus. With the changes suggested in the following pages, one can obtain a high degree of precision with greater rapidity and with much less strain on the nerves. The correct bridge setting is determined by the aid of the eye instead of the ear, which is a feature of some advantage. It seems probable that electrolytic conductivity methods will be of considerable value towards a better understanding of many of the fundamental problems in the life of plants and animals. In this connection I might call your attention to the work of Höber on blood reactions, Bugarsky and Tangl on serum, and the work of many zoologists and pathologists. Of the American investigators who have used the method recently, perhaps the work of W. J. V. Osterhout[1] has attracted the most attention. True & Bartlett[2] have also made use of the Wheatstone Bridge in their investigations on "Concentration Relations of Dilute Solutions of Calcium and Magnesium Nitrates to Pea Roots." Bayliss[3] has published an extensive series of observations on the hydrolysis of various proteids by the action of trypsin. The method used was that of measuring the increase in electrical conductivity due to the reaction of the enzyme.

No further enumeration of the literature is necessary to show one the evident value of conductivity methods. A study of the articles mentioned above will convince one also of the necessity of eliminating errors, many of which are capable of correction. The work was begun in the summer of 1912, when I was making a study of "Adsorption" and its relation to biology. I first used the ordinary slide wire or meter

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[1] "The PERMEABILITY of PROTOPLASM to IONS and the THEORY of ANTAGONISM," Science N. S. Vol. XXXV NO. 890, p. 112 (1912).
[2] U. S. Dept. of Agri. Bur. Plant Ind., Bul. No. 231 (1912).
[3] Arch. des Sciences Biologique: Vol. XI Suppl. p. 261, St. Petersburg, (1904).

bridge, and soon discarded this for the electrical bridge perfected by the Bureau of Soils. With neither of these could I obtain any good results, and data found at different times, using the same materials, were not comparable. This was due to several factors the mention of which is at present unnecessary. The work has been interrupted more or less for lack of time and the usual delays in getting apparatus. As a result of the work so far, we feel safe in saying that the present method attains at least ten times the precision obtained by the ordinary Kohlrausch method. Before the completion of the work, there came to my notice in the February number of the Journal of the American Chemical Society, an article by Washburn and Bell on "An Improved Apparatus for Measuring the Conductivity of Electrolytes." The proposed method does not differ much from that used by these authors, and we have attained at least the same degree of precision. We used the Alternating Current Galvanometer, while Washburn and Bell still use the telephone which they have much improved, however. A description of the apparatus I have used follows, the changes made were based on the following consideration.

(1) The ordinary resistances are not free from inductance or capacity. Since most of the solutions to be studied were dilute and for that reason high resistances were necessary, errors due to inductance and capacity are quite appreciable. The special resistances for dilute solutions are those perfected by Dr. Curtiss of the Bureau of Standards of Washington, D. C. Based upon a new method of winding, it has been found that these resistances are quite pure as to capacity and inductance and have no temperature coefficient.

(2) The induction coil is not a suitable source for alternating current. The E. M. F. in one direction is always greater than that in the other direction. When used with a telephone, the induction coil is not free from overtones. Such features are a source of error. The induction coil was therefore abandoned and the current taken from a 110 volt 60-cycle rotary converter. The alternating current galvanometer was substituted for the telephone. The "extended" bridge wire though not used in the present study will be for all later work.

THE COMPLETE APPARATUS.

The alternating current was derived from a 60-cycle rotary converter situated in a room some distance from the room in which the conductivity measurements were made. The current was led to a switchboard in the conductivity room. It was then reduced to 12 volts by an ordinary transformer.

The galvanometer used was one put out by the Leeds and Northrop Company and is of the dynamometer type, a modification of the one perfected by the late Professor Rowland of Johns Hopkins. While it was suggested early in its inception as available in such work, it has usually been held that the telephone is good enough. When the galvanometer is used with the bridge to measure resistances of electrolyte, the exciting current is passed through the stationary coil in series with the bridge, while the swinging coil is connected across the bridge, identical to the connections with the telephone in the Kohrausch method. The resistance of the fixed coil is about 38 ohms and the maximum allowable current to be used is one-fifth of ampere for ten second periods. An ordinary resistance box can be introduced between the transformer and the fixed coil of the galvanometer, so that a total resistance of 60 ohms can be had, thus reducing the exciting current from the 12 volt transformer to one-fifth of an ampere. The resistance of the swinging coil is 10 ohms and the maximum allowable current to be used is 1/10 of an ampere for ten second periods. By introducing a transformer of variable voltage from 0 to 9 volts, stepping up by increments of ½ volts, a maximum sensibility can be obtained providing the proper conductivity cells or cups are used. The switch on this transformer can be used to make and break the current for the time allowed.

The bridge employed in these experiments is also a product of the Leeds and Northrop Company. It is the roller type supplied with a rheostat coil in the base. For very accurate work requiring at least and precision of .05 per cent, it is necessary to use the "extended" wire attachment. The smallest scale division on the bridge is 3 mm. wide, and in all but the dilute solution, the movement of the scale, in some cases scarcely the thickness of a line, caused a deflection in the galvanometer. For convenience, each scale division is divided into tenths, such divisions being easy to estimate with the eye. All measurements were made as near the middle of the bridge as possible and for this reason, a variable resistance was put in series with the known resistance so that a maximum sensibility could be reached. The Otto Wolf high grade standard manganin resistances were used in the preliminary experiments. The purer resistances as perfected by Dr. Curtiss ("Resistant Coils for Alternating Current Work, Bul. No. 3 Vol. 8 Reprint 177, Bureau of Standards) to whose work we have already referred will be used in the final test.

For the purpose of showing the degree of precision that has been attained, I mention below a few preliminary experiments. The cells used were the ordinary Kohlrausch type and will be referred to as cell No. 1 and No. 2. With the aid of a cathetometer, the electrodes were measured. These were platinized according to the usual method, the cell constants determined and from this data the specific conductance of the various solutions calculated. During the measurements, the

TABLES.

SERIES I CELL NUMBER 1.

Dilution of K Cl.	Resistance in ohms.	Dead point.
$\frac{n}{10}$	11.27	+
$\frac{n}{100}$	102.83	+
$\frac{n}{1000}$	934.23	+
$\frac{n}{10000}$	6547.34	.5 scale division
Conductivity water	24,872.00	9 scale divisions

SERIES II CELL NUMBER 2.

Dilution of K Cl.	Resistance in ohms.	Dead point.
n/10	50.00	+
n/100	389.17	+
n/1000	3673.02	+
n/10000	23,196.50	.1 scale division
Conductivity water	41,110.00	8.5 scale divisions

cells were placed in a water bath at a constant temperature of 18° C. The "dead point" means that no movement of the galvanometer scale took place at one point, and that movement appeared if the contact was changed one-tenth of a scale didivion on either side of the "dead point." The test solutions used were solutions of K C L in the following dilution: N/10, N/100, N/1000, N/10000. In addition conductivity water having a specific conductance of 1.9 x 10-6 ohms was also tested.

DISCUSSION.

In this preliminary paper I have suggested some changes in the usual form of the apparatus commonly employed for determining the conductivity of electrolytes. These changes are in some respects similar to those made by Washburn & Miller whose paper came out before I had completed my work. In one respect I have introduced a more radical change in the apparatus since I make use of an alternating current galvanometer instead of the ordinary telephone. In regard to the use of the galvanometer this must be said: The zero indication (no deflection) will be largely dependent on the phase difference between the two circuits. Now when the currents in both systems (swinging and fixed coils) are in quadrature no deflection will be produced in the galvanometer although there is considerable current present. A condition of this sort would lead to false readings on the bridge. In our work so far this condition has not arisen since we have always obtained a deflection.

A glance at the table will show that a high degree of precision has been obtained and that only in the more dilute solutions does the bridge setting extend over more than 9 scale divisions. From a study of the paper published by the authors noted above we are assured that these results could be improved should we use the "extended" bridge wire, electrolytic cells with electrodes closer than 10 mm., and some form of resistances that are free from capacity and inductance. In regard to this latter item we expect to use in all our future work the new Curtiss Resistance Coils, which we are told are practically free from inductance and capacity and possess no temperature coefficient. The changes suggested in this paper give an easier and quicker method and one which at least attains a high degree of precision.

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SOME NOTES ON THE BLACK KNOT OF PLUMS AND CHERRIES.

BY J. A. MCCLINTOCK.

Investigations were begun on the life history of *Plowrightia morbosa* in the fall of 1911. The first step was to determine at what time the ascospores appeared. These observations have shown that the time of year when ascospores develop varies somewhat. For example, in 1911, well developed spores were found November 16; while in 1912, knots from the same tree failed to develop these spores until early in December, or about fifteen days later than in 1911.

During the season of 1911 and 1912 constant attempts were made to germinate ascospores in drop-cultures, using a great variety of media. Late in April some of the spores in one culture, with tap-water as a medium, did send out short germ tubes, but never produced mycelium. With this exception all the attempts were unsuccessful.

To avoid the constant bacterial contamination which occurred when perithecia were mashed up and put directly into drop culture, attempts were made this winter to get the ascospores free from contamination at the start. After several unsuccessful attempts a practical method was devised as follows: A glass ring was sealed to a slide; then a small block of pith was cemented to the slide in the center of the ring and moistened with tap water. On top of this block was placed a small mass of perithecia directly from a knot; then a sterile cover glass was sealed down over the top of the ring. The moisture from the pith block soon passed up as vapor and condensed on the dry, sterile cover glass in small drops. Such a culture was then set away in a warm place over night, and the next morning when examined under a microscope the drops of water on the cover glass were found to be abundantly stocked with ascospores, thus showing that under warm, moist conditions the asci are able to shoot their spores.

By varying the distance from the perithecia to the cover glass it was found that some spores were shot more than one centimeter directly upward from the asci; but a far greater number were found on the cover glass when it was one-half centimeter or less from the surface of the perithecia.

Spores collected in this way germinated within forty-eight hours; the germ tubes being pushed out either from the tip of the larger cell or from the side of this cell near the septum. In no case were germ tubes pushed out from the smaller cell of the spore.

On failure in 1911 to get cultures by germinating ascospores, attempts were made to get cultures from the diseased wood by the following method: Small blocks of diseased wood were cut from plum twigs, just below the point where the knots had formed. These blocks were disinfected externally in 95% alcohol and $HgCl_2$. Then the bark was removed with sterile tools and some of the blocks placed in tubes of liquid gelatin, others in tubes of liquid agar, both of which were allowed to solidify so that a portion of each block was above the surface. In about five days white mycelium began to appear on the surface of the media. A few days later a portion of this mycelium was transferred to sterile bean pods, where it grew quite rapidly and in less than one week developed black pustules over the surface of the pods. Some of these pustules were mashed in water and examined under a microscope and found to be full of elliptical, hyaline, one-celled spores. These black pustules and spores resembled the pycnospores described by Humphrey in 1891 as developing from ascospores growing on culture media. These spores germinate readily in water or other media, and on agar they produce colonies of white mycelium in a few days.

Hundreds of inoculations have been made in plum and cherry trees with these pycnospores and also with the white mycelium growing on bean pods, but in no case have the characteristic symptoms of black knot resulted.

To determine whether mycelium of *Plowrightia morbosa* would pass down from a diseased twig into healthy wood, several scions of diseased wood bearing knots were whip grafted onto healthy plum trees May 10, 1912. In no case did the mycelium pass down from the diseased scion and infect the healthy stock; but many new knots did develop on other limbs of these trees. As these trees were not near diseased ones and it was too early in the season for conidia to be present the infections must have resulted from the ascospores shot out from the knots on the diseased scions used for grafting.

In the vicinity of Lansing new knots appeared about the first of May and by July abundant conidia were being produced. Attempts to germinate the conidia in drop cultures were unsuccessful.

During the month of July, 1912, two hundred and fifty inoculations were made with conidia in some young plum trees. Up to the present time these show no signs of infection; but it is possible that the disease may develop during the spring.

To determine the accuracy of the statement that diseased twigs thrown on the ground serve as centers of infection, over one hundred diseased twigs were collected here and there throughout an orchard of about six hundred plum trees on November 3, 1912. The next day samples were taken to the laboratory, sectioned and examined with a microscope to determine whether asci and spores had developed in the perithecia. In no case was either found.

The twigs were then tied in a bundle and placed on the ground in an exposed position, the same as if they had been cut from the trees and dropped on the ground in the orchard.

December 25, after lying on the ground for almost two months, these twigs were again taken to the laboratory, sectioned and examined. Some few of the perithecia were still free from spores; but most of them were full of asci containing spores that were well developed, thus showing that the fungus continues to grow and spores are produced after the twigs have been cut from the trees.

This bundle of twigs was then placed on the ground and left until March 12, 1913, when some of the twigs were taken to the laboratory, where masses of perithecia were placed on pith blocks in rings, as previously described, to see if they would shoot their spores. The next morning many spores were found in the drops of water condensed on the cover glass; demonstrating that after being removed from the trees and left lying on the ground for five months such diseased twigs are a possible source of infection. Therefore it should be recommended that diseased twigs cut from the trees be immediately destroyed.

Michigan Agricultural College.

THE PINE HILLS AT LOWELL, MICHIGAN.

BY BERT E. QUICK.

The southern portion of Kent County lies near the southern border of the North-eastern Conifer Province, typified on dry ground by forests dominated by the white pine, Pinus Strobus. The pine here, today, is not abundant, and such isolated areas as now occur in this region should be studied and described before they have all vanished.

The town of Lowell is located on Grand River, about a mile from where it enters Kent County on the east, and at a point where a tributary, the Flat River, joins the Grand from the north. The hills which border Flat River are part of one of the largest moraines left by the Saginaw lobe of the ice-sheet in its retreat at the end of the glacial period. A few of these hills about a mile north of the town are always referred to locally as "the Pine-hills."

Looking at these hills from a distance, one would scarcely recognize them by this name. The hills seem wooded almost exclusively with deciduous trees, and only in the winter do the few pines stand out conspicuously. They lie close to the river, and suffer considerably from cutting by the currents, so the sides rise somewhat precipitously. The soil is dry and sandy, showing as yellow scars where a portion of the hillside has fallen into the river.

Proceeding northward from the town, the first of these hills shows but little tree growth. The pines are scattered, a few small ones here and there occur, but the majority of the smaller growth is deciduous. The large pines still left are all dead, apparently because of the caving of the soil from about their roots. The arbor-vitae is conspicuous here, and small junipers border the caved places, and are perched on the more solid portions of soil in the cuts themselves. The following list embraces the most common plants here:

Pinus Strobus
Thuja occidentalis
Juniperus virginiana
Equisetun hiemale, var. robustum
Salix sp.
Quercus rubra
Anemone cylindrica
Pyrola asarifolia
Chimaphila umbellata
Rhus toxicodendron
Solidago caesia, var. axillaris
Solidago canadensis
Antennaria plantaginifolia
Rudbeckia hirta
Achillaea millefolium
Hieracium sp.

The second hill has its riverward face rather sharply divided into two parts. The southern half is covered with oak and hickory, while the northern half has almost no vegetation except pines of moderate size. The smaller pines were less than a foot high, the larger ones up to thirty feet. Even the smallest are not young; the smallest individual found showed an age of twenty-five years. Other plants in less exposed situations showed a growth of five feet for only thirty years.

On the third hill the pines are reduced to scattered individuals in a dense growth of deciduous trees. This hill is less steep and there is no caving of the hillsides. The deciduous trees are well-established and have accumulated a noticeable amount of humus. At the edge of the river there is a marshy strip about ten feet wide. The differences in soil and moisture conditions are also seen in the flora. The following plants occur here:

Pinus strobus	Quercus alba	Vitis sp.
Juniperus virginiana	Quercus rubra	Cornus stolonifera
Smilax hispida	Quercus velutina	Chimaphila umbellata
Carya ovata	Anemone cylindrica	Prunella vulgaris
Corylus americana	Hamamelis virginiana	Gerardia grandifolia
Ostrya virginiana	Rosa sp.	Rudbeckia hirta
Fagus grandifolia	Rhus glabra	Helianthus sp.

Besides the above, Alnus incana occurs with Cornus along the marshy shore.

The fourth and fifth hills have no pines left, their former presence being attested only by the large stumps which remain from the lumbering of the past. A sharp ravine separates these hills to quite a distance from the river. The ground here is wet, almost swampy, and hence springs the small brook which has cut the ravine. The ordinary oak and hickory of the riverward face of the hills is here varied by the admixture of a little burr-oak and white ash and quite a lot of red maple. In and bordering this wetter ground are three plants of special significance: Epigaea repens, Gaultheria procumbens, and Vaccinium canadense. These three plants, especially Epigaea, can always be taken as signs of the pine association in this region, even when the pines have left no signs of themselves. Gaultheria and Vaccinium are too easily bird-distributed to be safe criteria of themselves, but when associated with Epigaea they may be always so regarded.

From the preceding it is seen that pines are at present quite scarce on these hills, persisting on but a few of them, and then only on the sides toward the river. They have been left here on the more inaccessible places by the lumbermen, and have persisted because the deciduous trees can not use the sterile and rather unstable soil where they are perched. The deciduous trees do not seem as well able to stand the caving of the soil as do the younger pines, nor do they establish themselves as well on the denuded areas. The pines are not reproducing themselves to any extent; no cones were present on the trees, and only one fallen cone was found. These pines may fruit only at long intervals, most of them are too young to fruit. With a fair seed-production the pines might persist here for a long time, but seed-production has been nearly entirely stopped, probably because of the death of the older trees where the soil has caved from about their roots.

University of Michigan, April, 1913.

SOME INTERESTING PLANTS FROM THE VICINITY OF DOUGLAS LAKE.

BY HENRY ALLEN GLEASON.

During the first two years of botanical work at the Biological Station of the University of Michigan, located at Douglas Lake in Cheboygan County, 294 species of flowering plants and ferns were listed. During the third season, Dr. Frank C. Gates, in the employ of the State Biological Survey, conducted an ecological survey of the Douglas Lake region, and increased the list to 468 species. This number includes not only those seen personally by Dr. Gates, but also others collected by members of the Station during the same year or previously. During 1912, the fourth season of the Biological Station, a more thorough study of the flora was made by Miss Maud Robertson, who collected specimens of approximately 560 species of flowering plants and ferns, of which 166 species had not previously been reported from the vicinity of the Station. The continued thoroughness and industry with which Miss Robertson prosecuted this work is worthy of special mention.

About 70 species reported in Dr. Gates' list were not found by Miss Robertson, so that the reported flora of the Biological Station includes at the present time 634 species. The official flora, however, includes only those species which are represented by specimens in the Station herbarium, approximately 560 in number. The term approximately is used because the study of the grasses and sedges is not yet completed, and because of a few doubtful species mentioned below.

Among these 560 species are several which are of sufficient interest to deserve mention here. These will be grouped in four classes.

A. Species whose occurrence at Douglas Lake marks a conspicuous addition to their known distribution, as reported in Beal's Michigan Flora.

1. *Botrychium simplex* E. Hitchcock. The only station hitherto reported from the Lower Peninsula is at Oscoda.

2. *Viola Rafinesquii* Greene. This violet is usually considered essentially southern in its distribution.' It is reported by Beal from Croswell and Detroit, in the southeastern part of the state, and by Gates from the extreme southwestern portion.

3. *Fraxinus pennsylvanica* Marsh. Although reported from Black Lake in Beal's Michigan Flora, the red ash is rightly regarded as characteristic of the southern part of the Lower Peninsula. Authentic fruiting specimens were collected by Miss Robertson from a tree at the extreme north end of Burt Lake.

4. *Scrophularia leporella* Bicknell. The plant grows thriftily in the wet, frequently burned woods along Maple river, near its source in Douglas Lake, and reaches a height of eight feet.

5. *Hieracium paniculatum* L. The species is credited by Beal to the central and southern portions of the Lower Peninsula. It is fairly

common at Douglas Lake in the dry sands of the aspen association, where it grows in company with *Hieracium venosum.*

B. Species of considerable rarity in the State.

1. *Streptopus longipes* Fernald. The species was recently described from Marquette County, in the Upper Peninsula, but is common at Douglas Lake in the deep shade of the hardwood forests. Here it grows in company with *Streptopus roseus*, but the two are at once distinguished by the three-angled berries of *S. longipes,* as was indicated by Dr. Gates.

2. *Arceuthobium pusillum* Peck. Although the plant has frequently been reported from the State, its diminutive size makes it very inconspicuous, and its rediscovery is always a matter of interest. At Douglas Lake it has been observed only on the short-leaved bog form of *Picea mariana.* The specimens collected never exceed 7 mm. in height.

3. *Ranunculus Flammula* L., var. *reptans* (L.) Mey. Rare, in wet ground near the shore of Douglas Lake.

4. *Chrysosplenium americanum* Schwein. A very dwarf form, with a tendency to minute pubescence, grows in wet sand at the north end of Burt Lake.

5. *Ribes hudsonianum* Richards. The collection by Dr. Gates, referred to this species, has not been examined, but specimens collected by Miss Robertson in the deep shade of wet cedar bogs have been verified by comparison with authentic material in the herbarium of the New York Botanical Garden. So far as known, this is the second station for the species in the eastern States. The ripe red berries are minutely black glandular and very fetid, and both of these characters disappear in pressing.

C. Species not listed in Beal's Michigan Flora, and not collected by Dr. Gates. They are therefore apparently new to the state.

1. *Habenaria macrophylla* Goldie. In damp thickets on the north shore of Douglas Lake. It is distinguished at once from the commoner *Habenaria orbiculata* by the spur, which is nearly twice as long. The species is credited to Michigan in Gray's New Manual.

2. *Rumex elongatus* Guss. An introduced species, growing along logging roads in the vicinity of Douglas Lake, which has been confused with *Rumex crispus.*

3. *Sisymbrium officinale* (L.) Scop. The typical form, with pubescent pods.

4. *Rubus idaeus* L. In the specimens collected, the sepals are softly and closely velvety, entirely lacking the hispid pubescence or prickles of the commoner variety *aculeatissimus.*

5. *Oenothera muricata* L. The species is at once distinguished from *Oenothera biennis* by the red hairs with conspicuously enlarged bases. It is common in the aspen association, especially near the shore of the lake.

6. *Circaea intermedia* Ehrh. In deep moist woods, such as the sides of the "gorge."

7. *Teucrium occidentale* Gray, var. *boreale* (Bicknell) Fernald. In gravelly soil under thickets near the northwest end of Burt Lake. The general character of the pubescence is strongly suggestive of *T. canadense*, but the two are distinguished by the shape of the calyx teeth.

8. *Saturcja Acinos* (L.) Scheele. Introduced or escaped near dwellings.

9. *Aster macrophyllus* L., var. *sejunctus* Burgess. With the species, in rather dry, shaded places.

10. *Aster lateriflorus* (L.) Britton, var. *hirsuticaulis* (Lindl.) Porter.

11. *Hieracium aurantiacum* L. Introduced and growing along roadsides about four miles west of Levering, in Emmet County.

D. Plants of doubtful identity.

1. *Ranunculus* sp. With the general habit of *Ranunculus abortivus*, but the achenes with an elongated beak.

2. *Apios ? tuberosa* Moench. The solitary tuber, 3 cm. in diameter, suggests *Apios Priceana*, but the flowers necessary for complete identification were not collected. The typical form with moniliform elongated tubers grows with it on the sandy shores of both Burt and Douglas Lakes.

3. *Aster ? laevis* L. Common in the dry sands of the aspen association, and differing from the typical form of southern Michigan in the narrowly attenuate involucral scales.

4. *Senecio* sp. A form with bright-green foliage, leafy stems, large heads, and floccose pubescence chiefly confined to the bases of the deeply lobed leaves grows in damp woods at Grapevine Point, on the shore of Douglas Lake. It has hitherto been called *S. Balsamitae*, but is amply different from the typical form of the latter species as it grows in the aspen association.

CONTRIBUTIONS TO THE BOTANY OF MICHIGAN.

NO. 9.

THE FLORA OF PARKEDALE FARM, WITH SPECIAL REFERENCE TO STONY CREEK VALLEY.

BY OLIVER A. FARWELL, CURATOR OF HERBARIUM FOR PARKE, DAVIS & CO.

Stony Creek is a tributary of the Clinton River and derives its name from the large numbers of boulders and stones which make up the bed of the river; it takes its rise in the northeastern corner of Oakland County and flows southeast into Macomb County, then south, southwest and west into Oakland County again, thence south into the Clinton River about a mile east of Rochester and not far from the east central boundary of the county.

Oakland County is in the southeastern section of Michigan, being the 2nd county in the 3rd tier. It is thirty miles square and lies approximately between 42° 26′ and 42° 52′ north latitude and 83° 5′ and 83° 42′ west longitude. The surface of the county is very diversified but of moderate relief, being from 100 to 600 feet above the surface of the Michigan-Huron basin; it abounds in small lakes, streams, marshes and sand hills. The county lies entirely within Dr. Merriam's Alleghanian life area, but close to its southern boundary. The flora is characteristically transitional, the southern and northern meeting and well represented.

The topography is rolling, the highest points on either side of the stream are about ½ a mile apart and reach an elevation of 820 feet or 120 above Stony Creek river. The section of the valley collected over lies between the first ranges of hills on either side and is about ⅓ of a mile in length in a north and south direction, by ¼ of a mile wide. The first range of hills on the east side is rather steep and varies from 20 feet to 80 above the river, and, like those on the west, are either under pasturage or cultivation; the range on the west side, for the most part, is a gradually rising slope. This section of the valley is on the northeast corner of Parkedale Farm, the stock-farm of Parke, Davis & Company of Detroit.

The hills are composed of gravel and sand. The low lands between the ranges and the river are mostly of a rich black muck and those parts of the soil saturated by the overflow from the numerous cold springs become mud holes which it is well to avoid; the water from these mud holes finally reaches the river by seepage, as there is no direct channel running into it. The flood plain of the river up to where the slopes begin is a flat stretch of land varying in width from 2 to 50 rods. It is sparsely covered with trees, is free from undershrubs, and constitutes a "park"-like growth with a good grass floor; this "park" covers the greater part of the flood plain and at the south end is merged into the woods of the low lands on the east side; it consists of Quercus macrocarpa and Ulmus Americana; associated with these are Pyrus Malus, Prunus serotina, Tilia Americana and Juniperus Virginiana. To the north of the "park" is a Crataegus-Viburnum-Cornus thicket and a reed swamp. To the south there is an Elm-Aspen-Crataegus-Carpinus thicket. At various places along the western edge of the plain are cold springs which keep the ground well saturated and this condition, probably, is the reason why there is no shrubby growth in the "park."

On the east side of the river, the southern part is nearly taken up by a low spur of the range running east and west. This is flat-topped, about 35 feet above the river, and supports a sparse growth of juniper. To the north is a lower spur which is well covered with oaks, maples, beech and ironwood, with a dense undergrowth of blackberries, witch-hazel, crataegi, etc. Between these is a shallow ravine with a small stream partly natural, partly artificial, to carry away the drainage water. This narrow ravine is filled up with a dense growth of Impatiens biflora to the exclusion almost of everything else; on either side of it is a profuse growth of Panicularia nervata. On the hillside on the south was found the only ericaceous plant in the valley, the Monotropa uniflora. To the north of this is the tamarack swamp now cleared or trees and well drained. It stretches clear across the valley from the river to the range, a distance of about 1/6 of a mile by half as wide. The northeast quarter of the field is crossed by a marl bed which extends some quarter of a mile up the valley beyond our limits. The southern half of this marl bed is on a gently rising slope, and in general outline very much resembles that of a shoe. This part lies over a number of cold springs and at one time was so saturated with water from this source that, by jumping up and down upon the surface, short but distinct waves could be made to appear on the surface. This section, which is about 220 yards long on its longest axis and half as wide on its widest, is now thoroughly tiled and has a hard and dry surface. The northern half is much steeper and lies across the nearly vertical base of the range which here reaches a height of about 80 feet above the stream; it was always dry and is covered by a dense growth of Potentilla fruticosa. Since the tiling was put in and the bog has become dry, the Potentilla has been spreading and has nearly surrounded the latter part; probably some day it will over-run it.

Between the river and the marl bed, the flood plain is mostly a level stretch, but not so wide as on the west side. Not being saturated by the overflow from cold springs, it is covered with a dense growth of shrubs and small trees, among which the following may be mentioned: Corylus Americana, Cornus Amomum, Populus tremuloides, Salix lucida, Quercus macrocarpa, Fraxinus viridis, F. nigra, Larix Americana, etc.

The ranges have been, for the most part, cleared of their forest growth and are now used as pasturage or have been brought under cultivation. Those parts that are used as pasturage show a typical upland flora, such as Anemone cylindrica, Arenaria Michauxii, Houstonia longifolia, Arabis laevigata, Carex alopecoidea and Solidago nemoralis.

The invasion of this field by man and animal, i. e., the extensive draining and pasturing, is producing a change in the character of the flora, some plants like Potentilla fruticosa, Salix candida and Betula pumila are spreading, others like Pyrola, which was once frequent in the tamarack swamp, is no longer seen, while the flowering season of some has been retarded, and other plants have been dwarfed. The floral conditions here are of such interest that it seems desirable to place on record as complete a list as possible of the flora before it has become radically changed or partially exterminated. The list is by no means complete as collecting was begun late in May and during August I was away on my annual vacation.

The valley may be divided into two natural areas, The Wooded Area and The Cleared Area.

The Wooded Area may be sub-divided into the Upland Series, The Lowland Series and The Bottomland or Flood Plain Series.

The Cleared Area may be sub-divided into the Edaphic Series and the Aquatic Series.

The Edaphic Series may be again sub-divided into the Upland Pastures, The Tamarack Swamp, The Mud or Reed Swamp and the Marl Bed.

THE UPLAND SERIES.

The range of hills has been, for the most part, cleared of its forest growth, so that the series is but poorly represented.

June 9th, 1912.
Carex Pennsylvanica.
Waldsteinia fragarioides.

June 23rd.
Carpinus Caroliniana.
Also on lowland and plain.
Ostrya Virginiana.
Rhus Canadensis.

June 30th.
Amelanchier florida.
Amelanchier sanguinea.

July 28th.
Equisetum arvense.
Also on the plain.
Festuca nutans.
Monotropa uniflora.

October 27th.
Populus grandidentata.
Corylus Americana.
Also on the plain.
Quercus alba.
Also on the lowlands.
Quercus ellipsoidalis.
Quercus velutina.
Euosmus Sassafras.
Crataegus opulans.
Rhus glabra.
Rhus hirta, Var. typhina.
Tilia Americana.
Also on the plain.

THE LOWLAND SERIES.

The lowlands are the lower knolls and the intervening valleys. The soil here is mostly gravel and sand, but is overlaid with vegetable mould and holds more or less moisture through the season so that there is a thin forest growth with abundant shrubs and undershrubs. It gradually merges into the flood plain.

May 19th, 1912.

Arisaema triphyllum.
Juncoides campestre, Var. multiflorum.
Juncoides saltuense.
Vagnera stellata.
Trillium grandiflorum.
Salix discolor.
Salix rostrata.
Salix sericea.
The last two species also on the plain.
Fagus grandifolia, Var. Caroliniana.
Claytonia Virginica.
Cerastium vulgatum.
Also on the upland pasture.
Anemone quinquefolia.
Ranunculus abortivus.
Ranunculus septentrionalis.
Podophyllum peltatum.
Also on the plain.
Bursa Bursa-pastoris.
Also on the upland pasture.
Cardamine bulbosa.
Tiarella cordifolia.
Prunus Virginiana.
Zanthoxylum Americanum.
Also on the plain.
Viola papilionacea.
Viola scabriuscula.
Viola sororia.
Phlox divaricata.
Veronica arvensis.
Also on the upland pasture.

June 2nd.

Adopogon Virginicum.
Senecio aureus.

June 9th.

Carex leptalea.
Asparagus officinalis.
Also on the tamarack swamp and on the plain.
Fragaria Americana.
Cornus stolonifera.
This is found also in the tamarack swamp and on the plain.

June 11th.

Carex cephalophora.
Carex granularis.

This is rather plentiful and is found in the tamarack swamp also.
Carex laxiflora, var. blanda.
Carex laxiflora, var. varians.
Carex pubescens.
Carex rosea.
Rubus occidentalis.
Found in the tamarack swamp also, as is the next.
Geranium maculatum.
Taenidia integerrima.
Galium Aparine.

June 23rd.
Botrychium Virginianum.
Allium Canadense.
Heuchera hirsuticaulis.

June 30th.
Carex cristata.
Carex mirabilis.

July 4th.
Filix spinulosa.

July 14th.
Dioscorea villosa.
Rubus Andrewsianus.
Acalypha Virginica.
Circaea Canadensis.
Uraspermum Claytoni.
Found also on the plain.
Uraspermum aristatum.
Nummularia ciliatum.
Sambucus Canadensis.
Found also on the plain and in the tamarack swamp.

July 28th.
Urticastrum divaricatum.
Boehmeria cylindrica.
Also on the plain.
Agrimonia gryposepala.
Also on the plain and in the tamarack swamp.
Euonymus obovatus.
Also on the plain.
Deringa Canadensis.
Fraxinus Americana.
Fraxinus nigra.
Also on the plain.
Apocynum cannabinum, Var. glaberrimum.
Lappula Virginiana.
Verbena urticaefolia.

August 4th.
Phegopteris hexagonoptera.
Athyrium Filix-femina.
Athyrium Filix-femina, Var. angustum.
Adiantum pedatum.
Oakesia sessilifolia.
Vagnera racemosa.

Smilax hispida.
Rubus hispidus.
Rosa Carolina.
Glycine Apios.
Lycopus uniflorus.
Also found in the tamarack swamp.
Galium triflorum.
Mitchella repens.

September 2nd.
Acer nigrum.
Aster laevis, Var. amplifolius.

October 27th.
Smilax rotundifolia, Var. quadrangularis.
Hamamelis Virginiana.
Rhus radicans.
Acer rubrum.
Scrophularia leporella.
Solidago serotina, Var. gigantea.

THE RIVER SERIES OR FLOOD PLAIN.

The flood plain is a nearly level flat through the center of which the river winds its crooked way. It is about 60 rods wide at its widest part. On both sides of the river, at the upper end of the valley, the plain is covered with a large "park-like" growth of oak and elm, but the greater part of the east side is covered with a dense thicket of hazel, willows and other shrubs. The surface is too or three feet above the water level and is often flooded by spring freshets. The soil is a rich muck mixed with sand washings from the ranges, and in places is converted into mud swamps by the overflow from cold springs. It is covered with a good grass-sod.

May 19th, 1912.
Populus balsamifera.
Quercus macrocarpa.
Ulmus Americana.
Cardamine pratensis.
Fragaria Virginiana.
Vitis vulpina.

June 2nd.
Ranunculus recurvatus.

June 9th.
Populus deltoidea.
Ranunculus hispidus.
Vicia Americana.
Lonicera Tartarica, Var. alba.
Viburnum pubescens.

June 11th.
Carex stipata.
Iris versicolor.
Iris versicolor, Var. Virginica.
Ranunculus sceleratus.

June 23rd.
Opulaster opulifolius.
June 30th.
Carex vulpinoidea.
Rumex crispus.
Thalictrum dasycarpum.
Barbarea Barbarea.
Barbarea Barbarea, Var. longisiliquosa.
Geum Canadense.
Geum strictum.
The last two also in the tamarack swamp.
Geum Virginianum.
Lobelia leptostachys, Var. hirtella.
Erigeron annuus.
Erigeron Philadelphicus.
The last two also in the tamarack swamp.
Achillea occidentalis.
July 4th.
Oxalis corniculata (O. cymosa).
Leonurus Cardiaca.
July 14th.
Ascelepias Syriaca.
Prunella vulgaris.
July 28th.
Anemone Virginiana.
Clematis Virginiana.
Spiraea alba.
Agrimonia pubescens.
Trifolium hybridum.
Trifolium pratense.
Trifolium repens.
Oenothera muricata.
Verbena hastata.
Stachys tenuifolia, Var. aspera.
Monarda mollis.
Mentha Canadensis.
Galium asprellum.
Heliopsis scabra.
Cirsium lanceolatum.
August 4th.
Setaria glauca.
Poa annua.
Trichophyllum palustris.
Scirpus atrovirens.
Scirpus atrovirens, Var. pycnocephalus.
Juncus Dudleyi.
Salix cordata, Var. augustata.
Salix longifolia.
Rumex obtusifolius.
Polygonum Persicaria.
Saponaria officinalis.
Ranunculus Pennsylvanicus.

Pyrus Malus.
Melilotus alba.
Lathyrus myrtifolius.
Hypericum corymbosum.
Daucus Carota.
Scutellaria lateriflora.
Monarda fistulosa.
Lycopus Americana.
Also in the tamarack swamp.
Solanum nigrum.
Plantago lanceolata, Var. irrigua.
Plantago major.
Plantago Rugelii.
Lobelia syphilitica.
Gnaphalium polycephalum.
The last two also in the tamarack swamp.

September 2nd.
Prunella vulgaris, Var. albiflora.
Lycopus rubellus.
Helianthus giganteus.
Also in the tamarack swamp.
Helenium autumnale.
Also in the marl bed.

October 27th.
Juniperus Virginiana.
Smilax herbacea. Var. pulverulenta.
Smilax rotundifolia.
Salix amygdaloides.
Salix lucida.
Populus tremuloides.
Prunus Americana.
Prunus serotina.
Crataegus attenuata.
Crataegus punctata.
Crataegus structilis.
Cornus Amomum.
Fraxinus lanceolata.
Aster cardifolius.
Aster Novae-Angliae.
Aster paniculatus.

THE UPLAND PASTURE.

Here we have a rolling surface, the native forest flora of which has long since disappeared. The soil is sand and gravel, very porous and consequently very dry. It has long been under cultivation and pasturage. Various grasses constitute the chief herbage and these form a thin or broken sod. The flora is now campestrial.

May 19th, 1912.

JUNIPERUS COMMUNIS, VAR. DEPRESSA.

This low spreading and decumbent shrub is also found in the tamarack swamp and on the plain; in the latter situation it is being rapidly stamped out of existence by the stock which is pastured in the valley.

Arenaria serpyllifolia.
Antennaria mesochora.
Taraxacum Taraxacum.

June 2nd.
Senecio Sp.

June 9th.
Arenaria stricta.
Ranunculus fascicularis.
Arabis laevigatus.
Houstonia longifolia.

June 11th.
Sisyrinchium albidum.
Stellaria media.
Potentilla argentea.
Oxalis stricta.
Lithospermum arvense.
Lithospermum canescens.
Pentstemon hirsutus.

June 30th.
Danthonia spicata.
Helianthemum majus.
Cynoglossum officinale.
Plantago lanceolata.
Campanula intercedens.

July 11th.
Silene dichotoma.

This is new to the state, at least it is not included in Beal's Michigan Flora. Another species of Silene, not included in the work just mentioned, and collected by me at Detroit, is S. Gallica. It was observed at Galesburg also, but not collected at that station.

July 14th.
Bromus secalinus.
Erigeron ramosus.

July 28th.
Polygonum tenue.
Anemone cylindrica.
Verbascum Thapsus.
Solidago juncea, Var. scabrella.
Lactuca hirsuta.

This species is common on the dry uplands and is also found but much less frequently in the lowland and on the flood plain.

August 4th.
Eragrostis multiflora.
Carex alopecoidea.

September 2nd.
Solidago nemoralis.
Aster azureus.
Aster laevis.
Aster lateriflorus.
Aster lateriflorus, Var. glomerellus.
Aster sagittaefolius.

October 27th.
  Lechea villosa.
  Triosteum aurantiacum.

THE TAMARACK SWAMP.

This section lies between the lowland on the south and the marl bog on the north and a few years ago was a typical tamarack swamp. The trees have been cut off, the land has been thoroughly tiled, like the rest of the wet sections of the valley, and is now a dry field. It is a nearly level stretch, slightly rising toward the east end where it merges into the lowland. The vegetation is still characteristically that of the tamarack swamp.

May 19th, 1912.
  Savastana odorata.
  Salix candida.
    Also in the marl bog.
  Betula pumila.
  Ribes Americanum.
  Ribes Cynosbati.
  Ribes Cynosbati, Var. glabrata.
  Rubes oxyacanthoides.
  Rhamnus alnifolius.
  Viola rostrata.
  Sambucus pubens.
June 2nd.
  Eriophorum viridi-carinatum.
  Cypripedium bulbosum, Var. flavessens.
  Aquilegia Canadensis.
June 9th.
  Carex flava.
    Also in the marl section.
  Carex stellulata.
    Also in the marl section.
  Galium Claytoni.
June 11th.
  Carex hystericina.
  Saxifraga Pennsylvanica.
  Geum rivale.
  Zizia aurea.
  Lonicera glaucescens, Var. dasygyna.
June 23rd.
  Rhus Vernix.
  Viola conspersa.
  Cornus foemina.
  Solanum Dulcamara.
  Galium boreale.
June 30th.
  Cypripedium reginae.
July 4th.
  Sphenopholis pallens.
  Potentilla Monspeliensis.
  Rubus triflorus.
    Also in the marl bog.

July 14th.
Agrostis stolonifera (A. vulgaris).
Bromus ciliatus.
Bromus purgans.
Asclepias incarnata.
Koellia Virginiana.
Campanula aparinoides.
Rudbeckia hirta.

July 28th.
Larix laricina.

A few scattering trees are still standing in the original swamp and on the flood plain near the river banks. Young trees are beginning to spring up in the potentilla moor.

Chenopodium hybridum.
Cicuta maculata.
Veronica Virginica.
Lonicera glaucescens.
Liatris spicata.
Also through the marl section.
Aster junceus.
Rudbeckia hirta, Var. pulcherrima.
Also in the marl bed.

August 4th.
Filix Thelypteris.
Also in the reed swamp.
Alisma Plantago-aquatica, Var. trivialis.
With the last.
Cornus alternifolia.

September 2nd.
Rumex Britannica.
Epilobium coloratum.
Conioselinum Chinense.
Gentiana crinita.
Also through the marl section.
Chelone glabra.
Eupatorium maculatum.
Eupatorium perfoliatum.
Solidago altissima.
Solidago aspera.
Solidago aspera, Var. axillaris.
Solidago Ohioensis.
Solidago Ridellii.
Solidago uliginosa.
Aster paniculatus, Var. bellidifolius.
Aster puniceus.
Erechtites hieracifolia.
Prenanthes alba.

October 6th.
Aster Novae-Belgii.
Aster paniculatus, Var. simplex.

October 27th.
- Salix fragilis.
- Salix petiolaris.
- Solidago patula.

THE MARL BED.

A rather extensive marl bed crosses the base of the range in the northeast quarter of this section of the valley and extends up the valley for a quarter of a mile or so beyond our limits, where it spreads out and forms a broad low-lying swamp. There are two distinct sections, differing quite noticeably in their flora. First, the marl bog or that part which was fed with cold springs; Second, the part which always has been dry and which is characterized by a dense growth of Potentilla fruticosa.

THE MARL BOG.

May 19th, 1912.
- Polygala paucifolia.
- Viola vagula.

June 2nd.
- Carex conoidea.
- Triglochin maritima.
- Valeriana edulis.
- Valeriana uliginosa.

June 9th.
- Carex tetanica.
- Hypoxis hirsuta.
- Geum vernum.
- Senecio Balsamitae.

June 11th.
- Selaginella apus.
- Carex diandra, Var. ramosa.
- Sarracenia purpurea.

June 23rd.
- Carex granularis, Var. Haleana.
- Pogonia ophioglossoides.
- Limodorum tuberosum.
- Lathyrus palustris.

July 4th.
- Lilium umbellatum.

July 14th.
- Panicum implicatum.
- Tofielda glutinosa.
- Nummularia quadriflorum.

July 28th.
- Zygadenus chloranthus.
- Lobelia Kalmii.

August 4th.
- Aletris farinosa.
- Parnassus Caroliniana.
- Aster lateriflorus, Var. horizontalis.
- Aster lateriflorus, Var. pendulus.

POTENTILLA MOOR.

June 23rd.
- Salix serissima.
- Potentilla fruticosa.
- Convolvulus Americanus.

July 14th.
- Trichophyllum rostellatum.
- Scirpus Americanus.
- Triodon capillacea.
- Aster concinnus (?).

July 28th.
- Equisetum variegatum, Var. Jesupi.
- Agropyron repens.
- Scirpus occidentalis.
- Triodon glomerata.
- Silene noctiflora.
- Meibomia Canadensis.

August 4th.
- Scirpus validus.
- Euphorbia maculata.
- Aster laevis, Var. laevigatus.

THE MUD OR REED SWAMPS.

In many places on the flood plain and lowland, the overflow from springs, finding no outlet to the river, accumulates and converts the rich muck soil into reed or mud swamps. A characteristic flora appears in these places.

MUD AND REED SWAMPS.

May 19th.
- Spathyema foetidus.
- Caltha palustris.
- Viola cucullata.

June 11th.
- Equisetum fluviatile, Var. limosum.

June 30th.
- Panicularia nervata.
- Radicula Nasturtium-Aquaticum.
- Galium tinctorium.

July 4th.
- Sparganium eurycarpum.
- Panicularia grandis.
- Acorus Calamus.

July 28th.
- Impatiens biflora.
- Heracleum lanatum.

August 4th.
- Osmunda cinnamomea.
- Onoclea sensibilis.
- Sagittaria latifolia.
- Sagittaria latifolia, Var. hastata.

Cinna arundinacea.
Arundo Phragmites.
Panicularia septentrionalis.
Juncus brachycephalus.
Juncus nodosus.
Penthorum sedoides.
Mimulus ringens.
Rudbeckia laciniata.

September 2nd.
Mentha piperita.

THE AQUATIC SERIES.

The current of the stream is so strong that there is little vegetation represented, but one plant was observed, the Elodea Canadensis. In a stagnant pool, not connected with the river, another plant, the Spirodela polyrhiza, was also found.

The following catalogue constitutes as complete a list of the plants of Parkedale Farm as I have been able to gather. The farm consists of about 330 acres of very rolling upland pasture with here and there a small swamp area and some flood plain region.

Division I. Cryptogamae. Spore-bearing or Flowerless plants.

Order I. Filicales.

Family 1. Ophioglossaceae.

1. Botrychium Virginianum (Lin.) Swz. Grape-Fern.
Rich Woods. Scarce.

Family 2. Osmundaceae.

2. Osmunda cinnamomea Lin. Cinnamon Fern.
Swamps. Scarce.

Family 3. Polypodiaceae.

3. Onoclea sensibilis. Lin. Sensitive Fern.
Swamps. Scarce.

4. Filix spinulosa (O. F. Müller). Shield Fern.
Polypodium spinulosum, O. F. Müller. Flora Fridrichsdalina 136, 1767.
In rich woods. Frequent.

5. Filix Thelypteris (Lin.) Farwell. Marsh Fern.
Swampy grounds. Common.

6. Athyrium Filix-femina (Lin.) Roth. Female Fern.
Rich woods. Common.

7. Athyrium Filix-femina (Lin.) Roth., Var. angustum (Willd.) Farwell.
Borders of woods. Scarce.

8. Adiantum pedatum, Lin. Maiden-hair Fern.
Rich woods. Scarce.

9. Pteris aquilina, Lin. Common brake.
Borders of woods. Frequent.

10. Phegopteris hexagonoptera (Mx.) Fee. Beech Fern.
Rich woods. Frequent.

Order II. Equisetales.

Family 4. Equisetaceae.

11. Equisetum arvense Lin. Horsetail.
Sandy grounds. Common.
12. Equisetum fluviatile, Lin., Horsetail.
Dry sandy places. Frequent.
13. Equisetum fluviatile, Lin., Var. limosum. (Lin.) Gilbert. Horsetail.
In shallow water. Frequent.
14. Equisetum robustum, A. Br. Scouring Rush.
Sand Banks. Common.
15. Equisetum variegatum, Schleich, Var., Jesupi, A. A. Eaton. Horsetail.
In marl beds. Frequent.

Order III. Lycopodiales.

Family 5. Selaginellaceae.

16. Selaginella apus (Lin.) Spring. Swamp Club Moss.
In marl bogs. Common.

No. 1 and No. 16 are reputed to be good remedies in the treatment of snake bites. Nos. 2 to 7, inclusive, and Nos. 9 and 10 are reputed worm remedies. No. 8 is used in the treatment of consumption, bronchitis and other pulmonary troubles. The Equisetums are used as diuretics in the treatment of dropsy, kidney troubles, etc. No. 8 and No. 11 are commercial drugs.

Division II. Phanerogamae.

Subdivision I. Polycotyledones.

Order IV. Coniferales.

Family 6. Pinaceae.

17. Pinus Austriaca, Link. Austrian Pine.
Cultivated as a shade tree.
18. Larix laricina (Du Roi) Koch. Tamarack.
Swamps. Now scarce.
19. Picea Abies (Lin.) Karst. Norway spruce.
A shade tree.
20. Juniperus communis, Lin., Var. depressa Ph. Common Juniper.
Barren Hills. Frequent.
21. Juniperus Virginiana, Lin. Red Cedar.
With the last. Common.

No. 17 yields Austrian turpentine and No. 19 Strassbourg turpentine.

No. 18 yields a bark that is used in treatment of bronchitis, diarrhoea and dysentery. It is a commercial drug.

No. 20. Juniper berries are used as a diuretic in the treatment of dropsical complaints. Gin is also distilled from them.

No. 21. The twigs, like Savin, are used against abortion and in menorrhagia. The wood casing for graphite pencils is made from the wood of this species.

Subdivision II. Monocotyledones.

Order V. Pandanales.

Family 7. Sparganiaceae.

22. Sparganium eurycarpum, Engelman. Bur-reed.
Muddy places. Scarce.

Order VI. Najadales.

Family 8. Juncaginaceae.

23. Triglochin maritima, Lin. Arrow-grass.
Marl bogs. Frequent.

Family 9. Alismaceae.

24. Alisma Plantago-aquatica, Lin., Var. trivialis (Ph.) Farwell. Water Plantain.
Muddy places. Scarce.
25. Sagittaria latifolia, Willd. Arrow-head.
Muddy places. Scarce.
26. Sagittaria latifolia, Willd., forma hastata (Ph.) Robinson. Arrow-head.
Muddy places. Scarce.

Family 10. Hydrocharitaceae.

27. Elodea Canadensis, Mx. Water Weed.
Slow flowing water. Rare.

Order VII. Graminales.

Family II. Graminaceae. The Grasses.

28. Andropogon furcatus, Muhl. Beard Grass.
Sandy Hills. Common.
29. Sorgastrum nutans (Lin.) Nash. Indian Grass.
Sandy waste places. Scarce.
30. Panicum implicatum, Scribn. Panic Grass.
Marl bogs. Common.
31. Setaria glauca (Lin.) Beauv. Foxtail Grass.
Waste places. Common.
32. Setaria Italica (Lin.) Beauv. Hungarian Millet.
Waste places. Common.
33. Cenchrus Carolinianus, Walt. Bur Grass.
Waste places. Common.
34. Savastana odorota (Lin.) Scribn. Vanilla Grass.
Swamps. Scarce.
35. Phleum pratense, Lin. Timothy.
Fields and pastures. Common.
36. Cinna arundinacea, Lin. Reed Grass.
Rich woods. Common.
37. Agrostis stolonifera, Lin. Red Top.
A vulgaris Withering.
Pastures and swamps. Common.
38. Calamagrostis Canadensis (Mx.) Beauv. Blue joint grass.
Swamps. Rare.
39. Danthonia spicata (Lin.) Beauv. Oat Grass.
Sandy Hills. Rare.
40. Arundo Phragmites, Lin. Reed Grass.
Mud swamps. Occasional.
41. Eragrostis multiflora (Forsk.) Aschers. Stink Grass.
Waste places. Scarce.
42. Shenopholis pallens (Spreng.) Scribn.
Swamps. Common.
43. Poa annua, Lin. Spear Grass.
Low grounds. Common.
44. Poa compressa, Lin. Wire Grass.
Pastures. Frequent.
45. Poa pratensis, Lin. Kentucky Blue Grass.
Pastures. Common.

46. Panicularia grandis (Wats.) Manna Grass.
Glyceria grandis S. Wats. in A. Gray, Man. Ed. 6, 667, 1890.
Swamps. Frequent.
47. Panicularia septentrionalis (Hitchc.). Manna Grass.
Glyceria septentrionalis, Hitchc.: Gray's New Manuel of Botany, 7th Edition, 159, f. 171, 1908.
Swamps. Common.
48. Panicularia nervata (Willd.) O. K. Manna Grass.
Swamps. Common.
49. Festuca nutans, Willd. Fescue Grass.
Woods. Common.
50. Bromus ciliatus, Lin. Brome Grass.
Swamps. Common.
51. Bromus purgans, Lin. Brome Grass.
Swamps. Common.
52. Bromus secalinus Lin. Chess.
Waste places and barren soil. Common.
53. Bromus tectorum, Lin. Brome Grass.
Waste places. There are two forms of this growing side by side, one bright green and the other purplish, which afford a very striking contrast.
54. Agropyron repens (Lin.) Beauv. Quack Grass.
Marl bed. Rare.
55. Agropyron repens (Lin.) Beauv., Var. pilosum, Scribn.
Pastures. Common.
Agropyron repens and its varieties are very troublesome weeds if allowed to gain a foot-hold in agricultural lands. The rhizomes are official under the name *Triticum,* which is used in medicine as a diuretic, demulcent, and emollient in the treatment of cystitis and other bladder troubles. Other names for this species are Dog Grass and Couch Grass.

Family 12. Cyperaceae. Sedges.

56. Cyperus filiculmis, Vahl., Var. macilentus, Fernald. Galingale.
Waste grounds. Frequent.
57. Trichophyllum palustris (Lin.) Spike Rush.
Scirpus palustris, Lin. Sp. Pl. 47, 1753. Ehrhart's Trichophyllum is the oldest name for the genus.
Borders of streams, etc. Common.
58. Trichophyllum rostellatum (Torr.) Spike Rush.
Eleocharis rostellata Torr. Fl. N. Y. II, 347, 1843.
Marl bed. Common.
59. Scirpus Americanus, Pers. Bull Rush.
Marl bed. Common.
60. Scirpus atrovirens, Muhl. Bull Rush.
Low wet grounds. Frequent.
61. Scirpus atrovirens, Muhl., Var. pycnocephalus, Fernald.
Low wet grounds. Scarce.
62. Scirpus validus, Vahl. Bull Rush.
Marl bed. Frequent.
63. Scirpus occidentalis (Wats.) Chase. Bull Rush.
Marl bed. Scarce.

64. Eriophorum viridi-carinatum (Engelm.) Fernald. Cotton Grass.
Swamps. Frequent.
65. Triodon capillacea (Torr.) Beaked Rush.
Rhynchospora capillacea Torr. Fl. U. S. I. 55, 1824.
Richard's name, Triodon, is the earliest for the genus.
Marl bed. Frequent.
66. Triodon glomerata (Lin.) Beaked Rush.
Schoenus glomeratus, Lin. Sp. Pl. 44, 1753.
Marl bed. Frequent.
67. Carex alopecoidea, Tuckerm. Sedge.
Open woods. Rare.
68. Carex cephalophora, Muhl. Sedge.
Open woods. Common.
69. Carex conoidea, Schk. Sedge.
Marl bed. Rare.
70. Carex cristata, Schw. Sedge.
Swales. Frequent.
71. Carex diandra, Schrank, Var. ramosa, (Boott.) Fernald. Sedge.
Marl bog. Common.
72. Carex eburnea, Boott. Sedge.
This plant is not found on Parkedale Farm, but there is a locality on a hillside in Stony Creek Valley just north of it where a few plants are found in rich mould, under evergreens.
73. Carex flava, Lin. Sedge.
Marl bed and swamps. Common.
74. Carex granularis, Muhl. Sedge.
Open woods and swamps. Common.
75. Carex granularis, Muhl., Var. Haleana (Olney) Porter.
Marl bed. Frequent.
76. Carex hystericina, Muhl. Sedge.
Swamps. Frequent.
77. Carex laxiflora, Lam., Var. blanda (Dew.) Boott. Sedge.
Open woods. Frequent.
78. Carex laxiflora, Lam., Var. varians, Bailey. Sedge.
Open woods. Rare.
79. Carex leptalea, Wahl. Sedge.
Open woods. Frequent.
80. Carex mirabilis, Dew. Sedge.
Swales. Frequent.
81. Carex Muhlenbergii, Schk. Sedge.
Upland pastures. Frequent.
82. Carex Pennsylvanica, Lam. Sedge.
Dry woods. Rare.
83. Carex pubescens, Muhl. Sedge.
Open woods. Frequent.
84. Carex rosea, Schk. Sedge.
Open woods. Common.
85. Carex siccata, Dew. Sedge.
Barren soil. Frequent.
86. Carex stellulata, Good. Sedge.
Marl bed and swamps. Common.

87. Carex stipata, Muhl. Sedge.
Banks of streams, etc. Common.

88. Carex tetanica, Schk. Sedge.
Marl bed. Common.

89. Carex vulpinoidea, Mx. Sedge.
Banks of streams, etc. Common.

Order VIII. Arales.

Family 13. Araceae.

90. Arisaema triphyllum (Lin.) Torr. Indian Turnip.
Rich woods. Frequent.
This plant has a turnip-shaped, starchy corm with an intensely acrid juice. The corm is a commercial article and is used in medicine as an expectorant and diaphoretic, in the treatment of croup, whooping cough, asthma, bronchitis, etc.

91. Spathyema foetida (Lin.) Raf. Skunk Cabbage.
Boggy swamps. Frequent.
The heavy, thick root-stock is an article of commerce and is a stimulant, antispasmodic, and narcotic. In treatment of pulmonary troubles like the preceding; also in hysteria and in convulsive affections. All parts of the plant, when bruised emit the odor of a skunk. Whence the common name.

92. Acorus Calamus, Lin. Sweet Flag.
Borders of streams, etc. Frequent.
The rhizome peeled or unpeeled, is an article of commerce and is used as a carminative and tonic in flatulent colic and dyspepsia; also externally in indolent ulcers. The unpeeled rhizome is official under the name of *Calamus*.

Family 14. Lemnaceae.

93. Spirodela polyrhiza, (Lin). Schleid. Duckweed.
Floating on stagnant water. Frequent.

Order IX. Liliales,

Family 15. Juncaceae.

94. Juncus brachycephalus (Engelm.) Buch. Bog Rush.
Boggy grounds. Frequent.

95. Juncus Dudleyi, Wieg. Bog Rush.
Moist sand. Frequent.

96. Juncus nodosus, Lin. Bog Rush.
Reed swamps. Frequent.

97. Juncoides campestre (Lin.) Coville, Var. multiflorum (Ehrh.)
Juncus multiflorus Ehrh. Calam. Exsicc. 1791.
Open woods. Wood Rush. Common.

98. Juncoides saltuense (Fernald.) Heller. Wood Rush.
Open woods. Rare.

Family 16. Liliaceae.

99. Tofieldia glutinosa (Mx.) Pers. False Asphodel.
Marl bed. Rare.

100. Zygadenus chloranthus, Richards.
Marl bogs. Common.

101. Oakesia sessilifolia (Lin.) Wats. Bellwort.
Open woods. Frequent.

102. Allium Canadense, Kalm. Wild Garlic.
Open woods. Common.

103. Allium rubrum, Osterhout (?).
In dry grassy pastures there is a species of allium of the A. Canadense group, which is strikingly different in appearance, from that species. It is very glaucous, which is not the case in the ordinary form, and has shorter and broader perianth segments.

104. Lilium Canadense, Lin., Var. rubrum, Waugh. The common wild red lily.
From two to six feet in height; the perianth segments deep orange red, with brown spots, from rotate to strongly revolute forming a complete circle with the apices again pointing upward in the normal direction. Whole plant about twice as large as the common yellow flowered species of the Atlantic sea-board. Perhaps a distinct species.
Swamps. Common.

105. Lilium umbellatum, Pursh. Red Lily.
Marl bog. Rare.

106. Asparagus officinalis, Lin. Asparagus.
The young shoots or "turions" of the cultivated plant is a well known culinary product. The rhizomes and roots, also the seeds, are used in medicine as diuretics.
Open woods, etc. Frequent.

107. Vagnera racemosa (Lin.) Morong. Solomon's Seal.
The rhizome of this is a commercial article and is used in medicine as a tonic and astringent in treatment of leucorrhoea and menorrhagia; in intestinal irritation, piles and erysipelas; and in skin eruptions from poison oak.
Open woods. Common.

108. Vagnera stellata (Lin.) Morong. Solomon's Seal.
Open woods. Common.

109. Polygonatum biflorum (Walt.) Ell. Solomon's Seal.
Open woods. Frequent.

110. Trillium grandiflorum (Mx.) Salisb. Birthroot, Beth Root.
Open woods. Frequent.
The corms of the trilliums are a commercial article under the name of Beth Root. In medicine they are used as astringents and tonics in treatment of haemoptysis and bronchorrhoea.

111. Aletris farinosa, Lin. Star Grass. Unicorn Root.
Marl bog. Frequent.
The root of this species is a commercial article under the names of Star Grass or Unicorn Root. It is a tonic, diuretic and vermifuge. Used in treatment of diseases of the reproductive organs especially of the uterus.

112. Smilax herbacea, Lin., Var. pulverulenta (Mx.) A. Gr. Carrion Flower. Jacob's Ladder.
Banks of streams. Rare.
A popular domestic remedy in the treatment of scrofulous diseases and as a general blood purifier.

113. Smilax hispida, Muhl. Green Brier.
Thickets. Frequent.

114. Smilax rotundifolia, Lin. Horse Brier.
Thickets. Rare.

115. Smilax, rotundifolia, Lin., Var. quadrangularis (Muhl.)
Wood. Thickets. Rare.

Family 17. Narcissaceae.

116. Hypoxis hirsuta (Lin.) Coville. Yellow Star Grass.
Marl bed. Common.

Family 18. Dioscoriaceae.

117. Dioscorea villosa, Lin. Wild Yam.
Thickets. Rare.

The rhizome is a commercial article. Used in medicine as an expectorant, diaphoretic and antispasmodic. Useful in bilious colic, cramps of the stomach, uterine diseases, etc.

Family 19. Iridaceae.

118. Iris versicolor, Lin. Blue Flag.
Low wet grounds. Frequent.

119. Iris versicolor, Lin., Var. Virginica (Lin.) Baker. Blue Flag.
Low, wet grounds. Frequent.

There are two very pronounced forms of the Blue Flag both as to color and shape of the sepals.

In the type the sepals are spatulate, the blade being rotund and abruptly rounded into the claw, light blue, variegated with white, yellow and green. In the variety the sepals are oblong-obovate, dark purple, variegated as in the type, but not so pronouncedly so.

The rhizomes are a commercial product under the name Blue Flag, and were official under the name of *Iris*. They are used as a cathartic, cholagogue and alterative. In treatment of disorders of the liver.

120. Sisyrinchium albidum, Raf. Blue-eyed Grass.
Barren Soil. Rare.

Order X. Orchidales.

Family 20. Orchidaceae.

121. Cypripedium bulbosum, Mill., Var. parviflorum (Salisb.)
C. parviflorum, Salisb. Trans. Lin. Soc. I:77 pl. 2. Fig. 2. 1791.
Ladies Slipper.

Lip medium sized, yellow, vertically compressed. Rich woods. Rare.

122. Cypripedium bulbosum, Mill., Var. flavescens (D. C.) Ladies Slipper.
C. flavescens D. C. Redoute, Lil. I: pl. 20, 1802.
Smaller, lip laterally compressed.
Tamarack swamps. Rare.

123. Cypripedium reginae, Walt. Ladies Slipper.
Tamarack swamps. Frequent.

The root system of species of Cypripedium is a commercial article under the name of Ladies Slipper, and a pharmacopoeial drug, under the title of *Cypripedium*. Used as a tonic and antispasmodic in nervous excitability, hysteria, nervous headache, etc.

124. Pogonia ophioglossoides (Lin.) Ker. Snake Mouth.
Marl bogs. Common.

125. Limodorum tuberosum, Lin. Grass Pink.
Marl bogs. Common.

Class II. Dicotyledones.

Subclass I. Polypetalae.

Order XI. Salicales.

Family 21. Salicaceae.

126. Populus balsamifera, Lin. Balsam Poplar.
Wet grounds. Common.

127. Populus deltoides, Bartram. Cottonwood.
Wet grounds. A large tree with smooth branches. Frequent.

128. Populus grandidentata, Mx. Aspen.
Woods and thickets. Frequent.

129. Populus tremuloides, Mx. Poplar, White Poplar.
Thickets. Common.
The bark is a commercial article; it is used as a tonic, febrifuge, and diuretic; chiefly in intermittent fevers.

130. Salix alba, Lin. Willow.
Banks of streams. Rare.

131. Salix alba, Lin., Var., vitellina (Lin.) Koch. Willow.
An escape. Frequent.

132. Salix amygdaloides, Anders, Willow.
Borders of streams, etc. Frequent.

133. Salix candida, Fleugge.
Bogs and swamps. Common.

134. Salix cordata, Muhl., Var. angustata (Ph.) Anders. Willow.
Thickets. Common.

135. Salix discolor, Muhl. Willow.
Open woods and thickets. Frequent.

136. Salix fragilis, Lin. Willow.
Low grounds. Slowly spreading.
Probably was planted originally to form a wind break or hedge.

137. Salix longifolia, Muhl. Willow.
Wet banks. Rare.

138. Salix lucida, Muhl. Willow.
Thickets on low grounds. Rare.

139. Salix peptiolaris, Sm. Willow.
Thickets. Common.

140. Salix rostrata, Richards. Willow.
Thickets. Common.

141. Salix sericea, Marshall. Willow.
Thickets. Common.

142. Salix serissima (Bailey) Fernald. Willow.
Bogs and swamps. Rare.

143. Salix Wheeleri (Rowlee) Rydb. Willow.
Wet banks. Rare.

Order XII. Fagales.

Family 22. Corylaceae.

144. Carpiuns Caroliniana, Walt. Ironwood.
Thickets. Common.

145. Ostrya Virginiana (Mill.) Koch. Ironwood.
Thickets. Rare.

146. Corylus Americana, Walt. Hazelnut.
Thickets. Common.
There are two forms of this species; the common form from four to eight feet in height with the involucre open and spreading; and another, about 17 feet in height, with the involucral bracts erect or closed; the latter form was found on the edge of the upland woods with a sunny, southern exposure. I found the same thing at Algonac, but at this place it was in a dense, wet alder thicket. The leaves appear to be less leathery.

Family 23. Betulaceae.

147. Betula pumila, Lin.
Tamarack swamps. Common.

Familly 24. Castaneaceae.

148. Fagus grandifolia, Ehrh., Var. Caroliniana (Loud.) Fernald and Rheder. Beech.
Open woods. Frequent.

149. Quercus alba, Lin. White Oak.
Woods. Common.
The bark of this, as well as of other species, is a commercial article and is used in medicine as an astringent in treatment of diarrhoea, etc. It is official as *Quercus*.

150. Quercus ellipsoidalis, E. J. Hill. Black Oak.
Upland woods. Rare.

151. Quercus macrocarpa, Mx. Bur Oak.
Low grounds. Common.

152. Quercus velutina, Lam. Black Oak.
Woods. Frequent.

Order XIII. Urticalés.

Family 25. Ulmaceae.

153. Ulmus Americana. Elm.
Low grounds. Common.

Family 26. Urticaceae.

154. Urtica dioica, Lin. Nettle.
Waste places. Frequent.
The leaves and roots are commercial articles and are used in medicine as diuretics in cystitis, nephritis, etc.

155. Urtica gracilis, Ait. Nettle.
Low grounds. Frequent.

156. Urticastrum divaricatum (L) O. K. Wood Nettle.
Low grounds in open woods. Common.

157. Boehmeria cylindrica (Lin.) Swz. False Nettle.
Low grounds. Common.

Order XIV. Polygonales.

Family 27. Persicariaceae.

158. Rumex Acetosella, Lin. Sorrel, Sheep Sorrel.
Sterile grounds. Common.
Contains oxalic acid. It is a commercial article under the name of Sheep Sorrel and is used as a refrigerant and diuretic in treatment of inflammatory disease.

159. Rumex Britannica, Lin. Water Dock.
Swamps. Rare.

160. Rumex crispus, Lin. Curled Dock.
Fields. Common.
The root under the name of Yellow Dock is a commercial article and was official as *Rumex*. It is used as an alterative and tonic in treatment of skin diseases.

161. Rumex obtusifolius, Lin. Dock.
Fields. Common.

162. Polygonum aviculare, Lin. Knot Grass.
Waste places. Common.

163. Polygonum Convolvulus, Lin. Bindweed.
Waste places. Common.

164. Polygonum Persicaria, Lin. Lady's Thumb.
Waste places. Common.

165. Polygonum tenue, Mx. Sterile grounds. Frequent.

Order XV. Chenopodiales.

Family 28. Blitaceae.

166. Chenopodium hybridum, Lin. Goosefoot.
Waste places. Common.

167. Salsola Kali, Lin. Var., tenuifolia, G. F. W. Meyer. Russian Thistle.
Waste places. Common.

Family 29. Amaranthaceae.

168. Amaranthus graecizans, Lin. Tumble Weed.
Waste grounds. Common.

Order XVI. Caryophyllales.

Family 30. Alsinaceae.

169. Silene antirrhina, Lin. Catchfly.
Waste grounds. Frequent.

170. Silene dichotoma Ehrh. Catchfly.
Fields. Rare.
Not mentioned in Beal's Michigan Flora.

171. Silene noctiflora, Lin. Catchfly.
Waste places. Frequent.

172. Saponaria officinalis, Lin. Bouncing Bet.
Waste places. Frequent.

173. Stellaria media (Lin.) Cyr. Chickweed.
Waste places. Common.
A commercial drug. Used mostly as a poultice.

174. Cerastium vulgatum, Lin. Chickweed.
Waste places. Frequent.

175. Arenaria serpyllifolia, Lin. Sandwort.
Waste places. Common.

176. Arenaria stricta, Mx. Sandwort.
Sterile grounds. Rare.

Family 31. Portulacaceae.

177. Claytonia Virginica, Lin. Spring Beauty.
Open woods in moist situations. Common.

Order XVII. Ranunculales.

Family 32. Ranunculaceae.

178. Caltha palustris, Lin. Cowslip.
Swamps. Frequent.

179. Aquilegia Canadensis, Lin. Columbine.
Swamps. Common.
180. Anemone Canadensis, Lin. Windflower.
Banks. Frequent.
181. Anemone cylindrica, A. Gray. Windflower.
Sterile grounds. Frequent.
182. Anemona quinquefolia, Lin. Windflower.
Borders of woods. Frequent.
183. Anemone Virginiana, Lin. Windflower.
Banks. Frequent.
184. Clematis Virginiana, Lin. Virgin's Bower.
Low, moist grounds. Rare.
185. Ranunculus abortivus, Lin.
Low grounds and shady places. Common.
The species of this genus are called Crowfoots or Buttercups.
186. Ranunculus aquatilis, Lin., Var. capillaceus, D. C.
Streams. Common.
187. Ranunculus aquatilis, Lin., Var. caespitosus, D. C.
Rooting in mud. Frequent.
188. Ranunculus fascicularis, Muhl.
Sandy hills. Frequent.
189. Ranunculus hispidus, Mx.
Low grounds. Frequent.
190. Ranunculus Pennsylvanicus, Lin. f.
Low grounds. Frequent.
191. Ranunculus recurvatus, Poir.
Open woods. Frequent.
192. Ranunculus sceleratus, Lin.
Low grounds. Common.
193. Ranunculus septentrionalis, Poir.
Swampy grounds. Common.
194. Thalictrum dasycarpum, Fisch & Lall. Meadow Rue.
Banks of streams. Common.

Family 33. Berberidaceae.

195. Podophyllum peltatum, Lin. May Apple, Mandrake.
Open woods. Frequent.
The rhizome is an official drug under the name of *Podophyllum*. It is used chiefly as a laxative or purgative in torpidity of the liver.

Family 34. Lauraceae.

196. Euosmus Sassafras (Lin.) Nutt. Sassafras.
Upland woods. Rare.
A commercial drug. The bark of the root is used as a flavoring aromatic. Official under the name of *Sassafras*.

Order XVIII. Papaverales.

Family 35. Cruciaceae.

197. Sisymbrium altissimum, Lin. Tumble Mustard.
Waste grounds. Common.
198. Sisymbrium officinale (Lin.) Scop. Hedge Mustard.
Waste places. Frequent.
This form which has canescent or tomentose siliques is rather rare.

199. Sisymbrium officinale (Lin.) Scop., Var. leiocarpum, D. C. Hedge Mustard. Smooth siliques.
The common form and very plentiful everywhere in waste grounds.
200. Brassica arvensis (Lin.) B. S. P. Charlock.
A weed in waste grounds.
201. Brassica arvensis (Lin.) B. S. P. Var. orientalis, (Lin.) *Sinapsis orientalis*, Lin. Cent. Plant I. 53, Am. Ac. IV, 280, 1759.
Differs from the species in having the siliques pedicles and the plant more or less retrose hispid.
Not so common, but in similar situations.
202. Barbarea Barbarea (Lin.) MacM. Yellow Cress.
Low grounds. Frequent.
203. Barbarea Barbarea (Lin.) MacM., Var. longisiliquosa (Carion). *Barbarea vulgaris, Var. longisiliquosa* Carion, 1859 according to Fernald in Rhodora XI, 139, 1909.
Differs in having the siliques appressed to the rachis.
Low grounds. Common.
204. Cochlearia Armoracia, Lin. Horseradish.
Low grounds. Frequent.
A commercial drug. The root is a well known condiment. In medicine it is used in chronic atony of the digestive apparatus, and externally as a rubefacient.
205. Radicula Nasturtium-aquaticum (Lin.) Britten and Rendle. Water Cress. In streams. Common.
206. Cardamine bulbosa (Schreb.) B. S. P. Bitter Cress.
Open wet woods. Frequent.
207. Cardamine pratensis, Lin. Cuckoo-flower.
Low wet grounds. Rare.
208. Bursa Bursa-pastoris (Lin.) Britton. Shepherd's Purse.
Waste grounds. Common.
A commercial drug and employed as an astringent in diarrhoea, etc.
209. Camelina microcarpa, Andrz. False Flax.
Waste grounds. Common.
210. Camelina sativa (Lin.) Crantz. False Flax.
Waste grounds. Frequent.
211. Arabis laevigata (Muhl.) Poir. Rock Cress.
Sterile grounds. Rare.
212. Alyssum alyssoides, Lin. Yellow Alyssum.
Waste grounds. Common.

Order XIX. Sarraceniales.

Family 36. Sarraceniaceae.

213. Sarracenia purpurea, Lin. Pitcher Plant.
Marl bogs. Common.
A commercial drug. The rhizome is used as a stimulant tonic in diarrhoea, dyspepsia, etc.

Order XX. Rosales.

Family 37. Sedaceae.

214. Penthorum sedoides, Lin. Ditch Stonecrop.
Ditches. Frequent.
A commercial drug under the name of Virginia Stonecrop.

Used as an astringent and demulcent in diseases of the mucous membranes.

Family 38. Saxifragaceae.

215. Saxifraga Pennsylvanica, Lin. Swamp Saxifrage.
Swamps. Common.

216. Tiarella cordifolia, Lin. False Mitrewort.
Open woods. Common.

217. Heuchera hirsuticaulis (Wheelk.) Rydb. Alum Root.
Low grounds. Frequent.

218. Parnassia Caroliniana, Lin.
Marl bogs. Common.

219. Ribes Americanum, Mill. Black Currant.
Swamps. Frequent.

220. Ribes Cynosbati, Lin. Gooseberry.
Swamps. Common.

221. Ribes Cynosbati, Lin. Var., glabratum, Fernald. Gooseberry.
Swamps. Frequent.

222. Ribes oxyacanthoides, Lin. Gooseberry.
Swamps. Common.

Family 39. Hamamelidaceae.

223. Hamamelis Virginiana, Lin. Witch Hazel.
Open woods. Common.
The bark and leaves are official under the titles, *Hamamelidis Cortex* and *Hamamelidis Folia.* Tonic and astringent; employed in treatment of hemorrhoids, hemorrhages, diarrhoea, dysentery, etc. Externally in sprains, bruises, etc.

Family 40. Rosaceae.

224. Opulaster opulifolius (Lin.) O. K. Ninebark.
Banks of streams. Rare.

225. Spiraea alba, Du Roi, Meadow Sweet.
Swamps. Frequent.

226. Rubus Andrewsianus, Blanchard, Blackberry.
Open woods and thickets. Common.
The bark of the rhizome is official under the title, ***Rubus***. The rhizomes, also, are used. The commercial names are Blackberry Root and Blackberry Root Bark. Well known astringent and tonic employed in diarrhoea and other bowel complaints.

227. Rubus Enslenii, Tratt. Dewberry.
Sterile fields. Frequent.

228. Rubus hispidus, Lin. Swamp Dewberry.
Low grounds. Common.

229. Rubus occidentalis, Lin. Black Raspberry.
Swamps and thickets. Common.
The raspberry fruits were at one time official under the title *Rubus Idaeus*. The leaf is a commercial article and is employed in medicine similarly to Blackberry.

230. Rubus pubescens, Raf. Dwarf Raspberry.
R. triflorus, Richard.
Swamps. Frequent.

231. Rubus villosus, Ait. Dewberry.
R. procumbens Muhl.
Sterile grounds. Common.

232. Potentilla agrimonioides (Ph.) Farwell. Cinquefoil.
Potentilla arguta Ph.
233. Potentilla argentea, Lin. Silvery Cinquefoil.
Sterile grounds. Common.
234. Potentilla fruticosa, Lin. Shrubby Cinquefoil.
Wet or dry grounds. Common.
235. Potentilla Monspeliensis, Lin. Cinquefoil.
Swamps. Frequent.
236. Fragaria Americana (Porter) Britton. Strawberry.
Open woods. Rare.
237. Fragaria vesca, Lin. Strawberry.
Roadsides. Rare.
The leaf is a commercial drug used in medicine as an astringent and diuretic.
238. Fragaria Virginiana, Duchesne, Strawberry.
Fields. Common.
239. Waldsteinia fragarioides (Mx.) Tratt. Barren Strawberry.
Open upland woods. Rare.
240. Geum Canadense, Jacq. Avens.
Swamps and low grounds. Common.
241. Geum rivale, Lin. Water Avens.
Swamps. Common.
A commercial drug. The rhizome and roots are used as an astringent and tonic in diarrhoea, etc.
242. Geum strictum, Ait. Avens.
Low grounds. Frequent.
243. Geum vernum (Raf.) T. & G. Spring Avens.
Marl bogs. Common.
244. Geum Virginianum, Lin. Avens.
Low grounds. Common.
245. Agrimonia gryposepala, Wallr. Agrimony.
Thickets. Common.
246. Agrimonia pubescens, Wallr. Agrimony.
A. mollis (T. & G.) Britton.
Thickets. Frequent.
247. Rosa Carolina, Lin. Swamp Rose.
Swamps. Frequent.
248. Rosa humilis, Marsh. Rose.
Dry fields. Common.
249. Pyrus Malus, Lin. Wild Apple.
Thickets. Occasional.
The tree bark is a commercial drug employed as a febrifuge in treatment of fevers.
250. Amelanchier florida, Lindl. Shadberry.
Hillsides. Frequent.
251. Amelanchier sanguinea (Ph.) D. C. Shadberry.
Hillsides. Common.
252. Amelanchier stolonifera, Wiegand. Shadberry.
Sandy grounds. Frequent.
253. Crataegus attenuata, Ashe. Thornapple.
Low grounds. Common.

254. Crataegus opulans, Sargent. Thornapple.
Upland thickets. Rare.
255. Crataegus punctata, Jacq. Thornapple.
Low grounds. Common.
256. Crataegus punctata, Jacq., Var. aurea, Ait. Thornapple.
Wet thickets. Rare.
257. Crataegus structilis, Ashe. Thornapple.
Low grounds. Common.
258. Crataegus subvillosa, Schrad. Thornapple.
Hillsides. Frequent.
259. Prunus Americana, Marsh. Plum.
Low grounds. Frequent.
260. Prunus serotina, Ehrh. Black Cherry.
Low grounds. Frequent.
The bark is official under the title *Prunus Virginiana.* Commercially known as Wild Cherry. Employed as a bitter tonic and stomachic in gastric atony and general debility.
261. Prunus Virginiana, Lin. Choke Cherry.
Open woods and thickets. Frequent.
262. Amygdalus Persica, Lin. Peach.
An occasional escape. Fruit small and hard.
The leaves are a commercial article employed in medicine as a laxative, sedative, diuretic and anthelmintic. Used in treatment of Calculi, pertussis, inflammation of stomach and bowels, etc.

Family 41. Leguminaceae.

263. Medicago lupulina, Lin. Black Medic.
Low grounds. Common.
264. Medicago sativa, Lin. Lucerne.
Waste places. Occasional.
265. Melilotus alba, Medic. White Melilot.
Common on roadsides, etc.
This and other species of the genus are known commercially as Sweet Clover. They contain cumarin and develop when drying the well known vanilla like odor characteristic of this product. Employed as an antispasmodic in whooping cough.
266. Trifolium hybridum, Lin. Alsike Clover.
267. Trifolium pratense, Lin. Red Clover.
268. Trifolium repens, Lin. White Clover.
These species are all common in fields and meadows. The flowering heads of the last two named species are employed in medicine like Sweet Clover (White Melilot).
269. Meibomia Canadensis (Lin.) O. K. Tick Trefoil.
Open grounds. Common.
270. Vicia Americana, Muhl. Vetch.
Low grounds. Frequent.
271. Lathyrus myrtifolius, Muhl. Pea.
Low grounds. Frequent.
272. Lathyrus palustris, Lin. Pea.
Low grounds. Common.

273. Glycine Apios, Lin. Ground Nut.
Thickets. Occasional.

Order XXI. Geraniales.

Family 42. Linaceae.

274. Linum humile, Mill. Flax.
Roadsides. Frequent.

Family 43. Oxalidaceae.

275. Oxalis stricta, Lin. Wood Sorrel.
Fields. Common.

276. Oxalis corniculata, Lin. Wood Sorrel.
O. cymosa, Small.
Low grounds and borders of woods. Common.

Family 44. Geraniaceae.

277. Geranium maculatum, Lin. Cranesbill.
Swamps and open woods. Common.
Official under the name of *Geranium.* A powerful astringent employed in diarrhoea, dysentery, etc.

Family 45. Rutaceae.

278. Xanthoxylum Americanum, Mill. Prickly Ash.
Low grounds. Common.
The bark is official under the name of *Xanthoxylum.* The berries also constitute a commercial article. Employed as a stimulant, tonic and alterative, in chronic rheumatism, flatulent colic, syphilitic, and hepatic affections.

Family 46. Polygalaceae.

279. Polygala paucifolia, Willd. Flowering Wintergreen.
Bogs. Rare.

Family 47. Tithymalaceae.

280. Acalypha Virginica, Lin. Mercury.
Low grounds. Common.

281. Euphorbia corollata, Lin. Flowering Spurge.
Fields and roadsides. Common.
The root is a commercial drug employed in throat and lung troubles.

282. Euphorbia Cyparissias, Lin. Scotch Heath.
Roadsides. Common.

283. Euphorbia glyptosperma, Engelm. Spurge.
Railroad track. Frequent.

284. Euphorbia maculata, Lin. Spurge.
Fields. Common.

285. Euphorbia nutans, Lag.
Waste places. Common.

Order XXII. Sapindales.

Family 48. Pistaciaceae.

286. Rhus Canadensis, Marshall. Sweet Sumach.
Hillsides. Occasional.
The bark of the root is a commercial drug; in medicine it is employed as an astringent in diarrhoea, dysentery, etc.

287. Rhus glabra, Lin. Smooth Sumach.
Hillsides. Frequent.
The bark, leaves, and fruit are commercial drugs, the latter being official under the title of *Rhus Glabra.* Employed as an astringent in diarrhoea, dysentery, etc.

288. Rhus hirta (Lin.) Sudw., Var. typhina (Lin.) Staghorn Sumach.
R. typhina Lin. Cent. Pl. II, 139, in Amen. Acad. IV, p. 311, 1759.
The ordinary form with pinnate leaves. The typical form with more or less confluent leaflets is common at Algonac.

289. Rhus radicans, Lin. Poison Ivy. Poison Oak.
High climbing on trees, often 40 to 60 feet. Common.
The leaves are a commercial drug, and were official under the title of *Rhus Toxicodendron.* A stimulant narcotic employed in some skin diseases, dropsy, chronic rheumatism, etc. To some people poisonous to the touch, producing a skin eruption. Others are immune.

290. Rhus Vernix, Lin. Poison Sumach, Poison Elder.
Swamps. Common.

Family 49. Celastraceae.

291. Euonymus obovatus, Nutt. Strawberry Bush.
Open woods. Common.

292. Celastrus scandens, Lin. False Bittersweet.
Thickets. Occasional.
The bark of the root is a commercial drug; in medicine it is employed as an alterative and diuretic in tuberculosis, syphilis, hepatic, rheumatic and cutaneous affections.

Family 50. Aceraceae.

293. Acerum nigrum, Mx. Black Maple.
Woods. Common.

294. Acer rubrum, Lin. Red, Swamp or Soft Maple.
Woods. Common.
The bark is a commercial drug and is employed in medicine as a mild astringent.

Family 51. Balsaminaceae.

295. Impatiens biflora, Walt. Touch-me-not.
Low wet grounds. Common.
The leaves are a commercial drug under the name of Jewel weed, or Wild Celandine, and are employed in medicine as an astringent and diuretic in Rhus poisoning, scrofula and rheumatism.

Order XXIII. Rhamnales.

Family 52. Zyzyphaceae.

296. Rhamnus alnifolius, L'Her. Buckthorn.
Swamps. Common.

Family 53. Vitaceae.

297. Vitis vulpina, Lin. Grape.
Banks. Common.

298. Psedera vitacea (Knerr) Greene. Virginia Creeper.
Thickets. Occasional.
The bark of the root is a commercial drug under the name of American Ivy; alterative and expectorant; employed in dropsy and lung troubles.

Order XXIV. Malvales.

Family 54. Tiliaceae.

299. Tilia Americana, Lin. Bass Wood.
Woods. Common.

Order XXV. Violales.

Family 55. Hypericaceae.

300. Hypericum corymbosum, Muhl. St. Johnswort.
Low grounds. Rare.

Family 56. Cistaceae.

301. Helianthemum Canadense (Lin.) Mx. Frostwort.
Sterile grounds. Rare.

302. Helianthemum majus (Lin.) B. S. P. Frostwort.
Sterile grounds. Frequent.
These species are also known as Frostweed and Rock Rose. The herb is a commercial drug under the name of Frostwort and is employed in medicine as an astringent, tonic, and alterative, chiefly in scrofulous diseases.

303. Lechea villosa, Ell. Pinweed.
Hillsides. Frequent.

Family 57. Violaceae.

304. Viola conspersa, Reichb. Dog Violet.
Swamps. Common.
In summer the stems are elongated and creeping, bearing petaliferous flowers all through the summer and fall until covered by snow.

305. Viola cucullata, Ait. Marsh Violet.
Reed and mud swamps. Common.

306. Viola papilionacea, Ph. Blue Violet.
Open woodlands. Common.

307. Viola rostrata, Pursh. Long spurred Violet.
Swamps. Common.

308. Viola scabriuscula, (T. & G.) Schw. Yellow Violet.
Woodlands. Common.

309. Viola sororia, Willd. Violet.
Woodlands. Common.

310. Viola vagula, Greene. Violet.
Marl bogs. Frequent.

Order XXVI. Myrtales.

Family 58. Oenotheraceae.

311. Epilobium coloratum, Muhl. Willow Herb.
Swamps. Common.

312. Oenothera muricata, Lin. Evening Primrose.
Fields and waste places. Common.
A commercial drug and is employed as a nerve sedative or antispasmodic in whooping cough, hiccough and spasmodic asthma.

313. Circaea Canadensis (Lin.) Muhl. Enchanter's Nightshade.
Woods. Common.
The American plant appears to be readily distinguished from the European as follows: Calyx tube not over 1 mm. long; in the European it is about twice as long; calyx lobes broadly ovate, obtusish or acutish., two to three mm. long; in the European narrowly ovate or ovate lanceolate and acuminate, three to four mm. long; the fruit is about ½ larger and proportionately rounder, than in the European; stamens and style about equaling the petals;

in the European long exserted; the American plant, generally, has white flowers, while those of the European are pale rose or pink.

Order XXVII. Umbellales.

Family 59. Umbellaceae.

314. Daucus Carota, Lin. Carrot.
Waste grounds. Common.

315. Conioselinum Chinense (Lin.) B. S. P. Hemlock Parsley.
Swamps. Common.

316. Heracleum lanatum, Mx. Cow Parsnip.
Swamps. Common.
The root is a commercial drug under the name of Masterwort and is employed as a stimulant and antispasmodic in dyspepsia, epilepsy, asthma, palsy, etc.

317. Taenidia integerrima (Lin.) Drude. Pimpernel.
Open woods. Frequent.

318. Uraspermum Claytoni (Mx.) Nutt. Sweet Cicely.
Uraspermum aristatum (Thunb.) O. K. Rev. Gen. Pl. 270, 1891, but not the Chaerophyllum aristatum, Thunb. which is the next.
Open woods and thickets. Common.
The root is a commercial drug employed chiefly as an expectorant and stomachic in coughs and stomach troubles.

319. Uraspermum aristatum (Thunb.). Sweet Cicely.
Chaerophyllum aristatum, Thunb. Fl. Jap. 119, 1784.
Myrrhis longistylis, Torr. Fl. U. S. 310, 1824.
Thunberg's description calls for a plant with a smooth and glabrous stem, villous leaves, divaricate styles, and biaristate fruit. This can be no other than Torrey's M. longistyles.
Open woods. Scarce.

320. Zizia aurea (Lin.) Koch. Meadow Parsnip.
Swamps. Common.

321. Cicuta maculata, Lin. Water Hemlock.
Swamps. Common.
Poison. The leaf is a commercial drug and is often substituted for *Conium,* the Poison Hemlock. It is employed chiefly in nervous and sick headache. The root is tuberous and is often eaten by children for wild parsnip, with fatal effect.

322. Deringa Canadensis (Lin.) O. K. Hornwort.
Open woods. Common.

Family 60. Cornaceae.

323. Cornus alternifolia, Lin. f. Cornell, Dogwood.
Swamps. Common.

324. Cornus Amomum, Mill. Kinnikinnik.
Thickets. Occasional.

325. Cornus foemina, Mill. Dogwood.
C. candidissima, Marsh.
Low grounds. Common.

326. Cornus stolonifera, Mx. Red Osier Dogwood.
Low grounds. Common.
The bark is a commercial drug and employed as a tonic and astringent in dropsy, ulcers and fevers.

Subclass II. Monopetalae.

Order XXVIII. Ericales.

Family 61. Vacciniaceae.

327. Monotropa uniflora, Lin. Indian Pipe.
Hillsides. Frequent.

Order XXIX. Primulales.

Family 62. Anagallidaceae.

328. Nummularia ciliata (Lin.) O. K. Loosestrife.
Swamps. Common.

329. Nummularia quadriflora (Sims.) Loosestrife.
Lysimachia quadriflora Sims., Bot. Mag. T. 660, 1803.
Marl bogs. Common.

Order XXX. Gentianales.

Family 63. Jasminaceae.

330. Fraxinus Americana, Lin. White Ash.
Low grounds. Frequent.
The inner bark is a commercial drug and is employed as a stimulant to the vaso motor system.

331. Fraxinus lanceolata, Borck. Green Ash.
Low grounds. Scarce.

332. Fraxinus nigra, Marsh. Black Ash.
Low grounds. Frequent.
The bark is a commercial drug and is employed as an astringent and tonic.

333. Fraxinus Pennsylvanica, Marsh. Red Ash.
Low grounds. Frequent.

Family 64. Gentianaceae.

334. Gentiana crinita, Froel. Fringed Gentian.
Swamps. Common.

Family 65. Apocynaceae.

335. Apocynum cannabinum, Lin., Var. glaberrimum, D. C. Canadian Hemp.
Open woods and thickets. Frequent.
The rhizomes of this species constitute a commercial drug, which is official under the name of *Apocynum*. Emetic, cathartic, and diuretic. Used in dropsical affections, Bright's Disease, etc.

336. Apocynum medium Greene. Dogbane.
Dry, sandy grounds. Common.

Family 66. Asclepiadaceae.

337. Asclepias incarnata, Lin. Swamp Milkweed.
Swamps. Common.
The rhizome and root is a commercial drug under the name of White Indian Hemp, and is employed as an anthelmintic and alterative in rheumatism, syphilis, etc.

338. Asclepias Syriaca, Lin. Silkweed.
Low grounds. Frequent.
The rhizome is a commercial drug and is employed as a tonic, alterative, expectorant, and diuretic in scrofula, asthma and bronchial troubles, dropsies, and rheumatism.

339. Asclepias tuberosa, Lin. Pleurisy Root.
Fields. Frequent.
The root is a commercial drug and was official under the name of *Asclepias*. As the name indicates, it is used in pleurisy, also in other troubles of the respiratory organs.

Order XXXI. Polemoniales.

Family 67. Convolvulaceae.

340. Convolvulus Americanus (Sims) Greene. Bindweed.
Marl bogs. Occasional.

Family 68. Polemoniaceae.

341. Phlox divaricata, Lin. Phlox.
Rich woods. Common.

Family 69. Boraginaceae.

342. Cynoglossum officinale, Lin. Hounds Tongue.
Dry grounds. Frequent.
The leaf is a commercial drug and is employed as an anodyne, demulcent, and astringent in disorders of the mucous membranes.

343. Lappula Virginiana (Lin.) Greene. Strickseed.
Open woods. Common.

344. Lithospermum arvense, Lin. Corn Gromwell.
Waste places. Common.

345. Lithospermum canescens (Mx.) Lehm. Puccoon.
Hillsides. Frequent.

Family 70. Verbenaceae.

346. Verbena hastata, Lin. Blue Vervain.
Fields. Common.
A commercial drug. Both root and leaves are used as a tonic, emetic, expectorant, and sudorific in colds, and other similar troubles.

347. Verbena urticifolia, Lin. White Vervain.
Fields, etc. Common.
The root is a commercial drug and is employed in intermittent and remittent fevers.

Family 71. Labiaceae.

348. Scutellaria lateriflora, Lin. Skullcap.
Low grounds. Occasional.
The herb is a commercial drug and is official as *Scutellaria*. Generally used as a tonic, nervine, and antispasmodic in chorea, convulsions, tremors and nerve affections generally.

349. Prunella vulgaris, Lin. Heal All.
Low grounds. Common.

350. Prunella vulgaris, Lin., Var. albiflora (Bogenhard).
Flowers pure white.
Wet grounds. Occasional.

351. Leonurus Cardiaca, Lin. Motherwort.
Waste grounds. Common.
The herb is a commercial drug and is employed as an emmenagogue and nervine in suppressed secretions.

352. Stachys tenuifolia, Willd., Var. aspera (Mx.) Fernald. Hedge Nettle.
Wet grounds. Frequent.

353. Monarda fistulosa, Lin. Wild Bergamot.
Dry grounds. Frequent.
The leaf is a commercial drug, and is employed as a substitute for quinine.

354. Monarda mollis, Lin. Wild Bergamot.
Dry grounds. Frequent.

355. Monarda punctata, Lin. Horsemint.
Dry fields. Frequent.
The leaf is a commercial drug and is employed as a diaphoretic, diuretic, carminative and emmenagogue mostly in colds and affections arising therefrom.

356. Hedeoma hispida, Ph. Pennyroyal.
Dry fields. Frequent and rapidly spreading.

357. Koellia Virginiana (Lin.) MacM. Mountain Mint.
Swamps. Common.

358. Lycopus Americanus, Muhl. Bugleweed.
Swamps. Common.

359. Lycopus uniflorus, Mx. Bugleweed.
Swamps. Common.

360. Lycopus rubellus, Moench. Bugleweed.
Low grounds. Common.

361. Mentha Canadensis, Lin. Wild Mint.
Swamps. Common.

362. Mentha piperita, Lin. Peppermint.
Low grounds. Frequent.
A commercial drug and official as *Mentha Piperita*. Antispasmodic. Used in colic, nausea and vomiting.

Family 72. Solanaceae.

363. Physalis heterophylla, Nees. Ground Cherry.
Sandy Fields. Common.

364. Physalis heterophylla, Nees. Var. ambigua (A. Gr.) Rydb. Ground Cherry.
Sandy fields. Frequent.

365. Solanum Dulcamara, Lin. Bittersweet.
Swamps. Common.
The leaves and cut twigs are commercial drugs and the latter were official as *Dulcamara*. Poison. Chiefly used as a diuretic and alterative in scaly skin eruptions, catarrh and rheumatism.

366. Solanum nigrum, Lin. Black Nightshade.
Moist fields. Common.
Poisonous.

367. Lycium halimifolium, Mill. Matrimony Vine.
Roadsides. Occasional.

Family 73. Scrophulariaceae.

368. Verbascum Thapsus, Lin. Mullein.
Pastures and barren grounds. Common.
The leaf is a commercial article and is used as a demulcent, diuretic and antispasmodic in coughs, catarrhs, cystitis, diarrhoea, etc.

369. Linaria Linaria (Lin.) Karst. Butter and Eggs.
Waste places. Common.

370. Scrophularia leporella, Bicknell. Figwort. Carpenter's Square.
Open woods. Occasional.
The leaves of this and other species of the genus are known in commerce as Carpenter's Square and are employed as a diuretic and alterative in diseases of the skin and liver and in dropsy.

371. Chelone glabra, Lin. Balmony.
Swamps. Frequent.
The leaf is a commercial drug and is employed as a tonic and cathartic in jaundice, liver troubles, and disorders of the digestive organs.

372. Pentstemon hirsutus (Lin.) Willd. Beard Tongue.
Dry grounds. Common.

373. Pentstemon hirsutus (Lin.) Willd. forma albiflorus.
Flowers pure white.
With the species. Occasional.

374. Mimulus ringens, Lin. Monkey Flower.
Swamps. Common.

375. Veronica arvensis, Lin. Corn Speedwell.
Dry grounds. Common.

376. Veronica Virginica, Lin. Culver's Root.
Open woods and swamps. Common.
The rhizome and root is a commercial drug and is official as *Leptandra*. Employed as a cathartic and to prevent the return of intermittent fever after having been broken up by quinine.

Order XXXII. Plantaginales.

Family 74. Plantaginaceae.

377. Plantago aristata, Mx. Plantain.
Dry barren grounds. Common.

378. Plantago lanceolata, Lin. English Plantain, Rib Grass.
Whole plant strongly hirsute.
Fields and pastures. Common.

379. Plantago lanceolata Lin. Var. irrigua, D. C.
A form of the species that is glabrate or only sparsely hirsute.
Waste places. Common.

380. Plantago major, Lin. Plantain.

381. Plantago Rugeli, Dcne. Plantain.
Waste places and low grounds. Common.
The leaves of P. major and P. Rugeli constitute a commercial drug, which is employed as an alterative, diuretic, and haemostatic in diarrhoea, haematuria, etc.

Order XXXIII. Rubiales.

family 75. Aparinaceae.

382. Houstonia longifolia, Gaertn. Bluets.
Dry fields. Frequent.

383. Mitchella repens, Lin. Partridge Berry.
Open woods. Frequent.
The plant is a commercial drug under the name of Squaw Vine, and is employed as a diuretic and astringent in dropsy, diarrhoea, dysmenorrhoea, etc.

384. Galium Aparine, Line. Cleavers.
Open woods, etc. Frequent.
A commercial drug and employed as a diuretic in dropsy, jaundice, and scrofula.

Often adulterated with *G. triflorum.*

385. Galium asprellum, Mx. Bedstraw.
Wet thickets. Common.

386. Galium boreale, Lin. Bedstraw.
Swamps. Common.

387. Galium Claytoni, Mx. Bedstraw.
Swamps. Rare.

388. Galium tinctorium, Lin. Bedstraw.
Low wet grounds. Common.

389. Galium triflorum, Mx. Sweet Bedstraw.
Rich woods. Frequent.

Family 76. Caprifoliaceae.

390. Sambucus Canadensis, Lin. Elder.
Swamps and thickets. Common.
The flowers and bark are commercial drugs and the former was official as *Sambucus.* The bark is a hydragogue cathartic employed in dropsy; the flowers are stimulant, diaphoretic, and diuretic and employed in fomentations to erysipelas, glandular engorgements, etc.

391. Sambucus pubens, Mx. Red-berried Elder.
Swamps. Rare.

392. Viburnum pubescens (Ait.) Ph. Arrow-root.
Banks. Rare.

393. Triosteum aurantiacum, Bicknell. Horse Gentian.
Sandy hillsides. Rare.

394. Lonicera glaucescens, Rydb. Honeysuckle.
Swamps. Common.

395. Lonicera glaucescens, Rydb., Var. dasygyna, Rehder, Honeysuckle.
Swamps. Rare.

396. Lonicera Tartarica, Lin. Honeysuckle.
Banks of streams. Occasional.

397. Lonicera Tartarica, Lin., Var. alba, Regel, Honeysuckle.
Banks of streams. Occasional.

Family 77. Valerianaceae.

398. Valeriana edulis, Nutt. Valerian.

399. Valeriana uliginosa (T. & G.) Rydb. Valerian.
These two species are very common in the marl bog and in 1912 had a second flowering season beginning in October and continuing into December, until frozen by a sudden cold snap.

Order XXXIV. Campanulales.

Family 78. Bryoniaceae.

400. Citrullus Citrullus (Lin.) Karst. Watermelon.
Escaped. Occasional.

Family 79. Campanulaceae.

401. Campanula aparinoides, Ph. Marsh Bellflower.
Swamps. Common.

402. Campanula intercedens, Witasek. Bluebell.
Sandy hills, etc. Common.

Family 80. Lobeliaceae.

403. Lobelia Kalmii, Lin. Lobelia.
Marl bogs. Rare.

404. Lobelia leptostachys, A. D. C., Var. hirtella (A. Gr.) Lobelia.
Lobelia spicata Lam. *Var. hirtella* A. Gr. Syn. Fl. II, Pt. 1, 6, 1878.
The rough pubescence, strongly callous denticulate leaves and bracts, leafy-bracted spikes, and minutely auricled calyx lobes places the plant with this species rather than with L. spicata.
Low grounds. Common.

405. Lobelia syphilitica, Lin. Blue Cardinal Flower.
Low grounds. Common.
The leaves are a commercial drug and employed as a cathartic and emetic chiefly in dropsy.

Family 81. Composaceae.

406. Eupatorium maculatum, Lin. Queen-of-the-meadow.
Swamps. Common.
The leaves and roots are commercial drugs and employed as diuretics in gravel, strangury, etc.

407. Eupatorium perfoliatum, Lin. Boneset.
Low grounds. Common.
The leaves are a commercial drug and are official under the name of *Eupatorium*. Employed as a tonic, diaphoretic and laxative in colds, etc.

408. Lacinaria cylindracea (Mx.) O. K. Button Snake Root.
Hillsides. Frequent.

409. Lacinaria scariosa (Lin.) Hill. Button Snake Root.
Lacinaria scariosa (Lin.) Hill. *Var. corymbulosa,* Sheldon, Minn. Bot. Studies, I. Pt. 2, 77, pl. 6, 1894.
The Linnean type, is the form with the flower heads on elongated lateral pedicles. Rough-pubescent. Involucral scales scabrous and ciliate, greenish to dark purple.
Dry or moist grounds. Frequent.

410. Lacinaria scariosa (Lin.) Hill., Var aspera (Mx.)
Liatris aspera Mx. Fl. Bor. Am. II, 91, 1803.
Foliage very rough. Involucral scales usually pinkish obtuse and squarrose.. Heads sessile.
Fields. Frequent.

411. Lacinaria scariosa (Lin.) Hill., Var. spheroidea (Mx.)
Liatris spheroidea Mx. 1, c.
Leaves smooth; spikes of few to many large spherical or obconic heads, sessile or more or less stipitate; involucral scales, smooth, not ciliate, squarrose, obtuse, very pallid.
Fields. Common.

412. Lacinaria spicata (Lin.) O. K. Button Snake Root.
Swamps and bogs. Common.
The tuberous rhizomes of this and of some other species of the genus is the commercial drug known as Button Snake Root. Used as a diuretic and emmenagogue in gonorrhoea, dysmenorrhoea, amenorrhoea, Bright's Disease, etc.

413. Solidago altissima Lin. Goldenrod.
Low grounds. Common.

414. Solidago aspera, Ait. Goldenrod.
Dry fields and woods. Common.

415. Solidago aspera, Ait., Var. axillaris, N. Var.
Panicle elongated; most of the subtending leaves equalling or

exceeding their racemes. Bears the same relation to the species as the Var. villosa does to S. rugosa.

416. Solidago juncea, Ait., Var. scabrella (T. & Gr.) A. Gr. Goldenrod.
Sandy grounds. Common.
417. Solidago nemoralis, Ait. Goldenrod.
Sandy fields. Common.
418. Solidago Ohioensis, Riddell. Goldenrod.
Swamps. Common.
419. Solidago patula, Muhl. Goldenrod.
Swamps. Common.
420. Solidago rigida, Lin. Goldenrod.
Sandy hills. Common.
421. Solidago Riddellii, Frank. Goldenrod.
Swamps. Common.
422. Solidago rugosa, Mill. Goldenrod.
Wet grounds. Common.
423. Solidago rugosa, Mill., Var. villosa (Ph.) Fernald. Goldenrod.
Wet grounds. Frequent.
424. Solidago serotina, Ait. Goldenrod.
Thickets. Frequent.
425. Solidago serotina, Ait., Var. gigantea (Ait.) A. Gr. Goldenrod.
Low grounds. Occasional.
426. Solidago speciosa, Nutt. Goldenrod.
Dry fields. Frequent.
427. Solidago uliginosa, Nutt. Goldenrod.
Swamps. Common.
428. Aster azureas, Lindl. Aster.
Dry, sandy soil. Common.
429. Aster concinnus, Willd. (?) Aster.
Marl bogs. Frequent.
430. Aster cordifolius, Lin. Aster.
Thickets and open woods. Common.
431. Aster junceus, Ait. Aster.
Swamps. Common.
432. Aster laevis, Lin. Aster.
Dry, sandy places. Common.
433. Aster laevis, Lin., Var. amplifolius, Porter. Aster.
Open woods. Frequent.
434. Aster laevis Lin., Var. laevigatus (Hk.) A. Gr. Aster.
Moist places. Common.
435. Aster lateriflorus (Lin.) Britton. Aster.
Dry fields and hills. Common.
436. Aster lateriflorus (Lin.) Britton, Var. glomerellus (T. & G.) Burgess. Aster.
Dry hills. Frequent.
437. Aster lateriflorus (Lin.) Britton, Var. horizontalis (Desf.) Burgess. Aster.
Marl bogs. Common.
438. Aster lateriflorus (Lin.) Britton, Var. pendulus (Ait.) Burgess. Aster.
Marl bogs. Common.
439. Aster Novae-Angliae, Lin. Aster.
Low grounds. Frequent.

440. Aster Novae-Belgii (Lin.) (?) Aster.
Swamps. Frequent.
441. Aster paniculatus, Lam. Aster.
Swamps. Common.
442. Aster paniculatus, Lam., Var. bellidifolius, (Willd.) Burgess. Aster.
Swamps. Frequent.
443. Aster paniculatus, Lam., Var. simplex (Willd) Burgess. Aster.
Swamps. Occasional.
444. Aster puniceus, Lin. Aster.
Swamps. Common.
445. Aster sagittifolius, Willd. Aster.
Dry, sandy hills. Frequent.
446. Erigeron annuus (Lin.) Pers. Fleabane.
Low grounds. Common.
447. Erigeron Canadensis, Lin. Fleabane.
Sandy fields. Common.
The leaf is a commercial drug and is employed as a diuretic and astringent in dropsy, diarrhoea, etc.
448. Erigeron Philadelphicus, Lin. Fleabane.
Low grounds. Common.
449. Erigeron ramosus (Walt.) B. S. P. Fleabane.
Dry grounds. Common.
450. Antennaria ambigens (Greene) Fernald. Everlasting.
Fields. Common.
451. Antennaria bifrons, Greene. Everlasting.
Fields. Common.
452. Antennaria mesochora, Greene. Everlasting.
Fields. Common.
453. Gnaphalium obtusifolium, Lin. Life-everlasting.
Swamps. Common.
A commercial drug and employed as a tonic, diaphoretic and astringent in fevers, diarrhoea, etc.
454. Ambrosia elatior, Lin. Ragweed.
All the leaves bipinnatified.
455. Ambrosia elatior Lin., Var. artemisiifolia, (Lin.) Ragweed.
A. artemisiifolia Lin. Sp. Pl., 988, 1753.
The uppermost leaves of branches and stems undivided, otherwise as in the type.
456. Ambrosia elatior, Lin., Var. heterophylla (Muhl.) Ragweed.
A. heterophylla Muhl., Willd. Sp. Pl. IV. 378, 1805.
The lower leaves pinnatified, the upper undivided or with one or two lobes near the base. This form is more inclined to have the staminate inflorescence abnormally converted into a pistillate inflorescence. All the forms are more or less common in waste and cultivated fields.
The leaves and staminate flowers of this species are commercial drugs; the former is an astringent employed as an application to sores, wounds, etc.; the latter is employed in the treatment of hay-fever.
457. Heliopsis scabra, Dun. Ox-eye.
Swamps. Common.

458. Rudbeckia hirta, Lin. Yellow Daisy.
Dry fields. Common.
There is a gigantic form in swampy grounds with large, ovate lower leaves and involucral scales as long, or nearly so, as the rays.

459. Rudbeckea hirta, Lin., Var. pulcherrima, Farwell. Yellow Daisy.
Swamps. Occasional.
This form has the lower half of the rays a beautiful brownish red.

460. Rudbeckia laciniata, Lin. Cone Flower.
Low grounds. Rare.

461. Helianthus divaricatus, Lin. Sunflower.
Dry woods. Frequent.

462. Helianthus giganteus, Lin. Sunflower.
Swamps. Frequent.

463. Helenium autumnale, Lin. Sneezeweed.
Low grounds. Frequent.

464. Achillea occidentalis, Raf. Yarrow.
Fields and open woods. Common.
This plant is a commercial drug and is employed as a tonic, stimulant and astringent in disorders of the pelvic organs.

465. Anthemis arvensis, Lin., Var. agrestis (Wallr.) D. C. Corn Chamomile.
Fields. Common.

466. Anthemis Cotula, D. C. Mayweed.
Waste places. Frequent.
A commercial drug and employed as a sudorific and antispasmodic.

467. Erechtites hieracifolia (Lin.) Raf. Fireweed.
Swamps. Frequent.
The leaf is a commercial drug and is employed as a tonic and astringent in disorders of the mucous membranes.

468. Senecio aureus, Lin. Life-Root.
Swamps. Common.
The leaves of this species is a commercial drug, which is employed in female complaints.

469. Senecio Balsamitae, Muhl. Ragwort.
Marl bogs. Common.
This is a glabrous form.

470. Senecio Sp. Floccose wooly throughout at flowering time; stem leaves few and reduced, lyrate, pinnatified or the uppermost entire; lower stem leaves and radical from orbicular to ovate, ½ to 3 Cm. long by ½ to 2 wide; petioles equalling or slightly longer than the blades. Dry or moist grounds. Rochester, Orion, Detroit.

471. Arctium minus (Hill.) Bernh. Burdock.
Waste places. Common.
The leaves, seed, and young root are commercial drugs, and are used as alteratives and diuretics in rheumatism, syphilis, leprosy, etc. The root of the first year is official as *Lappa.*

472. Carduus arvensis (Lin.) Robs. Canada Thistle.
Waste places. Common.
The rhizome is a commercial drug and is employed as an astringent in diarrhoea, etc.

473. Carduus lanceolatus, Lin. Bull Thistle.
Fields. Common.

474. Adopogon Virginicum (Lin.) O. K. Dwarf Dandelion.
Moist grounds. Frequent.

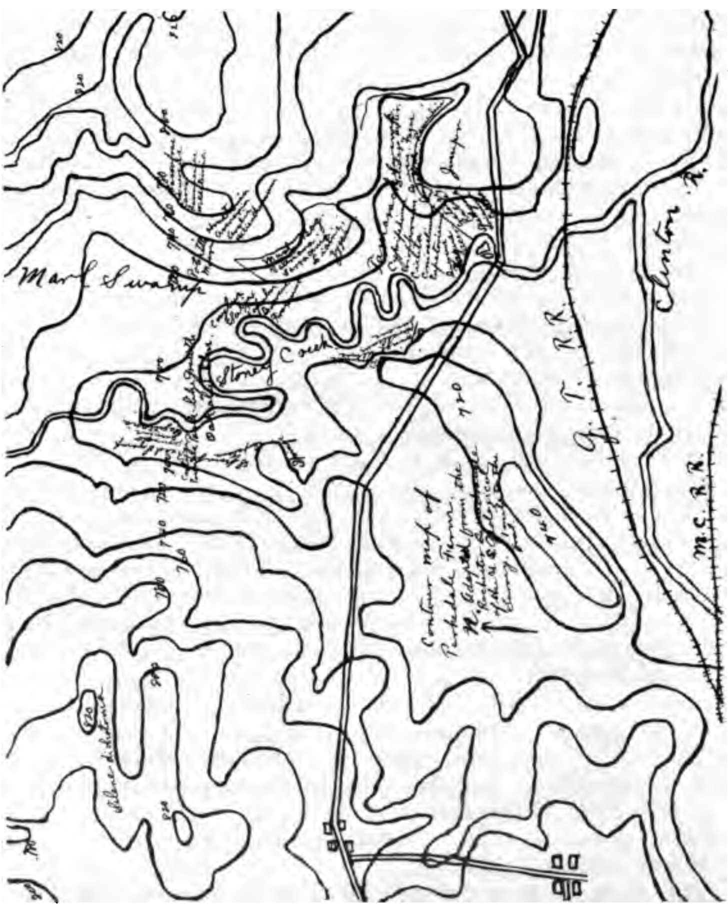
475. Tragopogon pratensis, Lin. Goat's Beard.
Waste grounds. Common.

476. Taraxacum Taraxacum (Lin.) Karst. Dandelion.
Fields. Common.
The herb and the root are commercial drugs employed as alteratives, diuretics and laxatives in hepatic derangements and their sequelae. The root is official as *Taraxacum*.

477. Lactuca Canadensis, Lin. Wild Lettuce.
Borders of thickets in damp soil. Rare.
The leaf is a commercial drug and is employed as a mild hypnotic.

478. Lactuca hirsuta, Muhl. Wild Lettuce.
Dry grounds. Common.

479. Prenanthes alba, Lin. Rattlesnake Root.
Swamps. Frequent.



CAR-WINDOW NOTES ON THE VEGETATION OF THE UPPER PENINSULA.

BY ROLAND M. HARPER.

In the summer of 1912, while occupying the position of research assistant in botany at the Biological Station of the University of Michigan, in Cheboygan County, I took a few days off for a trip across the upper peninsula, in order to make some comparisons between the vegetation fifty or more miles north of the station with that to the southward which I had already seen.

Landing at St. Ignace on the morning of August 3d, I went across to Sault Ste. Marie by the Duluth, South Shore & Atlantic Ry., turning an acute angle at Soo Junction, 43 miles from St. Ignace and 47 from "the Soo." Three days later I came back by the Minneapolis, St. Paul and Sault Ste. Marie Ry. to Trout Lake, a distance of 45 miles, and from there (after dark) by the same route as before to St. Ignace and the Lower Peninsula. This gave me a view of 135 miles of the Upper Peninsula, all in Mackinac and Chippewa Counties except a mile or two on either side of Soo Junction, which is in Luce. Very little botanical work seems to have been done in these counties, if one may judge from the infrequency with which they are mentioned in Beal's Michigan Flora (1904).

The vegetation types of the region traversed are shown with remarkable accuracy, though necessarily somewhat generalized on account of the small scale used, on the map of the Upper Peninsula in Dr. Charles A. Davis's report on peat (Rep. Geol. Surv. Mich. 1906, pl. 17. 1907), which is one of the best vegetation maps for an area of that size ever published. The surface geology of the same area is shown in an equally satisfactory manner on a colored map by Frank Leverett, drawn in 1911 and distributed in July, 1912.* Consequently it is unnecessary to give more than a brief and superficial description of the country here.

Between St. Ignace and Trout Lake, especially in the first few miles, outcrops of limestone are not infrequent; but they seem to have very little effect on the vegetation.† Elsewhere on the route the rocks are covered deeply by sand and clay mixed in various proportions, and in many places peat. Bogs, swamps and marshes abound, especially in the neighborhood of Soo Junction, indicating that the ground-water stands within a few feet of the surface, and does not fluctuate much with the seasons.

The country is comparatively level all the way, or at least not at all

*This map does not seem to have yet been included in any printed report, but it is a companion to the map of the Lower Peninsula by the same author in Publication 9 (Geological Series 7) of the Michigan Geological and Biological Survey, 1912.

†Nearly all the correlations between vegetation and mineral constituents of the soil—particularly limestone, which is one of the most widely distributed and easily identified—which have been published have been made in temperate and moderately humid climates, in this country especially in Kentucky, Tennessee, Alabama and Mississippi. In cold, hot and arid climates such correlations are either less obvious or at least have been made much less frequently.

mountainous. Small areas of undulating sandy moraines are frequent. About 25 miles west of Sault Ste. Marie the D. S. S. & A. Ry. passes for several miles through one such area which is wooded almost exclusively with jack pine, a most interesting sight to the phytogeographer, however uninviting it may be to the agriculturist. (The government has taken advantage of the uninhabited condition of this area in creating there the "Marquette National Forest," the southern border of which is skirted by the railroad.)

Most of the distance between Sault Ste. Marie and Trout Lake the surface is formed by a thick deposit of lake clay, in which the ground-water level lies deeper than it does on other parts of the route, as indicated by the fewer bogs and deeper stream valleys. Farms are rather common there, and the country much more densely populated than that traversed on the eastward journey.

Even where there are no farms in sight the lumbermen have been active in years gone by, as they have nearly everywhere else in Michigan, and have doubtless removed most of the white pine and a good deal of the other timber which made up the original forests. However, there is still enough native vegetation left to keep an observer busy writing plant names every moment while the train is in motion, which cannot be said of some places farther south.

The following list contains the names of all the plants identified more than once from the train on the whole journey of 135 miles. Of course it does not do justice to the herbs, but it ought to be reasonably complete for the trees, which are the most important part of the vegetation, not only from an economic and esthetic standpoint, but also ecologically, for they are subject to a greater variety of environmental conditions than the herbs are, on account of their larger size and longer life. (For example, the absolute minimum temperature may determine the northern limits of some trees, for they are exposed to all the weather there is; but it is probably immaterial to the herbs which are dormant beneath the ground and often also covered by snow when the minimum temperature occurs.)

The numbers prefixed to the names of the species indicate the number of times each was observed, between different mile-posts, except that where a species was noted as very abundant I have counted it twice in tabulating the returns. This method of quantitative analysis of vegetation is of course very crude, but it is much better than a mere qualitative list of the usual type; and it would probably take a person covering the same ground on foot at least a week to get more accurate results than I did in a few hours.

It is difficult enough to distinguish our two common species of *Picea* on close inspection (much more so for example than in the case of the two southeastern species of *Taxodium*, which many dendrologists still refuse to regard as distinct), and almost impossible to do so from a moving train, where one has to look pretty sharp even to distinguish *Picea* from *Abies*. I have therefore combined the figures for the two *Piceas*, and assumed that they both belong between 41 and 29.

The names of evergreens are printed in bold-face type, for reasons which will appear presently, and those of weeds are put in parentheses. The nomenclature used is mainly that of Robinson and Fernald's Manual (the so-called seventh edition of Gray's), 1908.

TREES.

60 Larix laricina
47 Betula papyrifera
44 **Pinus Banksiana**
44 Populus tremuloides
41 **Thuya occidentalis**
41 **Abies balsamea**
66 { **Picea Canadensis**
Picea Mariana }
29 Prunus Pennsylvanica
26 **Pinus Strobus**
23 Populus balsamifera
18 Sorbus Americana
17 Acer rubrum
17 Fraxinus nigra
15 **Pinus resinosa**
7 **Tsuga Canadensis**
7 Acer Saccharum
4 Populus grandidentata
3 Fagus grandifolia
2 Betula lenta?
2 Ulmus Americana

SHRUBS.

58 Alnus incana
26 **Chamaedaphne calyculata**
19 Salix sp.
(probably more than one).
17 Salix lucida
5 Diervilla Lonicera
4 Betula pumila
3 Comptonia peregrina
3 Myrica Gale
3 Sambucus racemosa
3 **Ledum Groenlandicum**
3 **Andromeda glaucophylla**
2 **Taxus Canadensis**
2 Vaccinium Pennsylvanicum
2 (Sambucus Canadensis)
2 Shepherdia Canadensis

HERBS.

81 Pteridium aquilinum
28 Typha latifolia
22 Solidago Canadensis?
17 Epilobium angustifolium
17 (Anaphalis margaritacea)
13 (Achillea Millefolium)
10 (Poa pratensis)
10 Scirpus cyperinus pelius?

9 Calamagrostis Canadensis
9 Eupatorium purpureum
8 Carex filiformis
8 Danthonia spicata
6 (Verbascum Thapsus)
5 (Chrysanthemum Leucanthemum pinnatifidum)
5 Iris versicolor
5 Eriophorum viridicarinatum
4 (Trifolium pratense)
4 Scirpus atrovirens?
4 Valeriana uliginosa
3 (Trifolium hybridum)
3 (Arctium minus)
3 (Hypericum perforatum)
3 Thalictrum dasycarpum
3 Aster macrophyllus
3 Solidago sp.
2 Juncus effusus
2 (Carduus arvensis)
2 Osmunda cinnamomea
2 Sium cicutaefolium
2 Calla palustris

The number of native herbs identified in this manner is rather large for such a well-wooded country, and compares favorably with the number that might be seen in traveling a similar distance through the pine-barrens of the southeastern states. In the hardwood country between the boreal and the southeastern coniferous forests the traveler by rail sees few herbs other than weeds, as I have pointed out elsewhere.*

Another noteworthy character of the flora of this region is the wide distribution of the species. All but one or two of those listed grow also in northern New England, about 800 miles farther east, and nearly as many are reported also from New Brunswick and Nova Scotia. Many are also represented in northern Eurasia by identical or closely allied species. Most of them also range several hundred miles farther north. (In the interior hardwood region of the eastern United States, and still more in the coastal plain, the species of plants are much more localized.)

More interesting still is the proportion of evergreens. Assuming that the figures given represent the relative abundance of the species in the primeval forests—a rather faulty assumption, to be sure, but one that will not be very misleading when comparisons are made between different sets of figures obtained in the same way—just about 46% of the trees, or 40½% of all the woody plants listed (i. e., individuals, not species) are evergreen.

The opinion seems to be prevalent among those ecologists who have given any thought to the matter that the proportion of evergreens in a given flora is determined primarily by some one or more climatic factors. But the fact that different habitats so close together that their climate must be essentially the same in all particulars often differ widely in the proportion of evergreens shows that it cannot be explained without reference to edaphic factors.

*Bull. Torrey Bot. Club 37:411-412, 423, 1910.

Evergreen trees, whether coniferous or broad-leaved (they happen to be all conifers in Michigan) seem to be just as characteristic of poor soil* as of any particular kind of climate. Certainly the parts of the eastern United States where agriculture had its greatest development before the days of commercial fertilizers had far fewer evergreens in their original forests than have those parts which are still thinly settled. In traveling across such predominantly agricultural states as Ohio or Illinois one sees almost no evergreens at all.

The relation of evergreens to soils is illustrated pretty well by some statistics obtained from my notes of this very trip. By dividing the itinerary into three nearly equal parts and calculating the percentage of evergreen trees for each I find that between St. Ignace and Soo Junction, where there are many limestone outcrops and a few farms, the percentage is 44. Between Soo Junction and Sault Ste. Marie, where the country is almost uninhabited, it rises to 56, while between Sault Ste. Marie and Trout Lake, where farms are most numerous, the evergreens constitute only 38%. As these statistics were all obtained in the same manner, and within a few days of each other, we are apparently justified in concluding that in this region, as farther south, the desirability of land for agricultural purposes is roughly inversely proportional to the percentage of evergreens in the forests.

Of course the objection might be raised that all that these figures indicate is that in the more populous areas more of the white pine has been cut out, leaving a larger proportion of the relatively worthless birch and aspen. But lumbering can be carried on just as well in a wilderness as in a populous region, topographic conditions being equal; and furthermore, *Pinus Strobus* was actually seen oftener in the third stage of the journey than in the second. The farmers have doubtless cleared the hardwood forests first, here as elsewhere, and yet the forests still standing in the more clayey soils contain proportionately more hardwood than do those a few miles farther north, where most of the pine has been removed by lumbermen.

The following trees and shrubs which are more or less common in the Lower Peninsula were conspicuous by their absence between St. Ignace and Sault Ste. Marie. (Where no specific name is mentioned it means that no species of that genus was seen.)

Juniperus Virginiana
Smilax
Juglans
Hicoria
Populus deltoides
Salix nigra
Carpinus
Castanea
Quercus alba
Quercus macrocarpa
Quercus coccinea
Quercus velutina

*By a poor soil is meant one which is deficient in one or more of the elements needed by growing crops, or in which some physical or toxic condition makes some of the essential elements relatively unavailable. Just what the soil constituent is that favors the growth of deciduous trees is not yet obvious, but it is probably either phosphorus or potassium.

Ulmus fulva
Celtis
Morus
Asimina
Liriodendron
Sassafras
Platanus
Crataegus
Malus
Prunus serotina
Rhus copallina
Rhus Vernix
Ceanothus
Vitis
Acer saccharinum
Acer Negundo
Cornus florida
Nyssa
Cephalanthus

The usual explanation of the absence or scarcity of these plants in the Upper Peninsula would probably be that the climate, especially the minimum temperature, is simply too cold. This may be correct in some cases, but it would not be safe to make a sweeping assertion to that effect without experimental proof, for many species of trees can be cultivated successfully several hundred miles farther north than they grow naturally. And the extremely irregular boundary between the boreal conifer forests and the temperate hardwood forests, in New England for example, can hardly be explained by temperature alone. Many if not most of the species and genera just listed prefer rather rich soils, and perhaps the soils of the Upper Peninsula are simply deficient in some element that they need. A series of soil analyses would be a great help in the further study of the problem.

PERMANENT VEGETATION QUADRATS AT DOUGLAS LAKE.

BY ADA K. DIETZ.

The following work was carried on during the summer of 1912 at the University of Michigan Biological Station at Douglas Lake, Michigan. In the season of 1911 the areas around the Station were studied in a superficial manner. The different associations were noted, frequency and abundance counts were made, but it was not until the following year that the permanent quadrats were laid out.

The method of placing the quadrats was as follows: First, a general survey of the area was taken, listing all species as to frequency and abundance. A typical spot was then located and a quadrat marked off, four iron pipes being driven into the corners and wire stretched around them to mark off accurately the space from the neighboring area.

The sun exposure and the physical condition of the soil, to a depth of four inches, were noted. All the plants in the quadrat were accurately measured and their location marked on cross-section paper. In order to facilitate this measuring, cord was used to divide the quadrat into sixteen smaller squares.

The symbol used to represent a plant on the paper was a small circle, and beside this was placed the first letter of the genus and species. When the plant formed a mat, an outline was drawn around the circle to show its size. If small trees were present, their height was measured and indicated in the table of symbols.

In most cases two-meter quadrats were laid out. This size was taken in preference to the one-meter quadrat of Clements, as it was considered that a more accurate and typical plot could be had. If a different size was taken it will be stated when describing the individual quadrats.

After the work was finished two 4 x 5 pictures, at right angles to each other, were taken of each quadrat.

The first quadrat was staked out in the Aspen Association. This association is most common in the vicinity of Dougas Lake. Fires have swept through many times, laying bare the ground, and the aspens are the first trees to come in. Here there are many species of the old pine vegetation as well as those of the incoming aspens. The first quadrat was placed in an unsheltered part, having direct sunlight all day. The soil was sandy and very dry, with no underbrush. *Pteris aquilina* was the most common species present, with *Vaccinium* next.

The second quadrat was likewise placed among the aspens but in a more sheltered part. It was laid out on a hillside where there were a great number of dead branches and underbrush. The soil contained more humus and there was more shade. There were many young aspens in the surrounding area, some being present in the quadrat. Besides the aspens, pine, birch, and oak trees were frequent near the quadrat.

Still a third quadrat was marked off in this association. The surrounding area contained a great number of birch trees and the quadrat was placed in the dense shade of one of them. The ground was mostly humus, though sand was present. *Pteris* was not the predominating species, but rather *Melampyrum.*

The quadrat laid out in the peat bog was made but one-half meter square. This size was taken owing to the great density and similarity of the vegetation. The quadrat was placed near the bog lake and in direct sunlight. *Chamaedaphne* and *Andromeda* were dominant, with *Vaccinium, Sarracenia, Chiogenes,* and many others as secondary species.

Two quadrats were staked out in a climax beech-maple hardwood, one in dense shade, the other on a hillside in moderate shade. The former quadrat contained little else besides the seedling of the trees, but the latter contained more species. The soil in both was very rich and had a thick covering of leaves. These woods are to be cut before the next season and the incoming plants of a cut climax hardwood will be closely tabulated. Unfortunately there are no hardwoods where the species of a climax association can be observed, for they are all to be cut this winter.

Two quadrats were placed in a burned over cedar bog. This bog was burned July 12, 1911, and many plants had come in during the one year; some of the old association, whose rootstocks had not been injured, and others of the new association. Both quadrats were in the direct sunlight. The ground was very wet and contained a great number of decaying logs. *Marchantia* and *Funaria* were very common.

In an association similar to the burned area, before the fire swept through it, was placed a seventh quadrat. This quadrat was made one meter square, every inch of ground containing a plant. The substratum was made up entirely of *Sphagnum;* cedar and tamarack trees kept the quadrat in dense shade. Many of the secondary species were the same as those of the burned area.

The last quadrat was placed on a slowly moving sand dune near the shore of Douglas Lake. It was marked out so that one side was on the clear sand, while the other had a great deal of *Scirpus* and other species. During the winter the water and ice are apt to cover this quadrat, but no marked ice action is had.

This work is simply the beginning. The same quadrats will be studied for many consecutive years in an attempt to learn the steps of succession in the different areas.

The region around the camp is especially fitted for such a study as it is rich in having many diverse types of vegetation. The fires have given an excellent chance for comparing burned with non-burned areas.

Next summer these same quadrats will be plotted, the results compared with those of last season, and conclusions will be drawn.

ROLE OF VEGETATION OF A MILL-POND.

BY FRED A. LOEW.

The data for this article were taken from an old mill-pond located in Salem township, Allegan County, Michigan. The dam which forms this pond was built about 46 years ago. The stream furnishing the water is small, not more than 10 or 15 feet wide and only from 8 to 12 inches deep, with the characteristic deep holes which are found in streams of this character in the glacial drift of Michigan. This stream is called the Little Rabbit river; one of the tributaries of the Kalamazoo river system.

The Little Rabbit river drains a large bog in the eastern part of Salem and western part of Dorr townships. This bog is of the high moor type; the water coming from springs, seepage and surface drainage. The swamp is sufficiently dry to permit of a good stand of soft maple, black ash and American elm. The stream flows from the northeast; the water entering it from the north and west comes from a district of loam soil 50 to 75 feet above the river bottom. The water coming from the south and east drains a sandy district. The flora of the mill-pond has probably been derived from swamps or ponds along this stream.

The flood plain where the dam is located is about 700 feet wide. The dam raised the water sufficiently to form a pond one mile long with an average width of about 700 feet and a depth of 6 feet at the dam. The pond is bordered by a bank from 10 to 15 feet high in places. The shore line is irregular. The channel which had an original depth of 6 to 10 feet is located near the middle of the pond. The original depth of the pond for nearly half its length above the dam was about 5 feet.

This whole area was covered with trees at the time it was flooded. Later these trees were cut leaving the stumps and refuse logs in the pond. (Fig. 1.)

As above stated the channel of the original stream extends the entire length of the pond in a winding course with a depth of from 3 to 8 feet. Also along the east side of the pond there are a few holes in which the water is from 7 to 10 feet deep. These holes are due to irregularities of the flood plain which have been formed by the old water course of the stream.

The current in the channel is very sluggish. In all parts of the pond where the water is over four feet deep there are only a few growing plants; a few plants of Ceratophyllum were found by dredging.

The present condition of this pond makes it possible to divide it into four different plant associations which are as follows: Potamogeton—Chara association; Typha—Sparganium association; Gramineae—Carex association and that association of plants growing on stumps and logs.

The Potamogeton—Chara (Pond-weed—Stonewort) association extends north from the dam to about the middle of the pond, covering its entire width with the exceptions of the channel and a few areas of deep water in other parts of the pond.

The average depth of that part of the pond covered by this association is 4 feet; the deepest places being near the east shore where the depth is about 8 feet; the shallowest places are not over 2 feet deep.

Measurements of the accumulated sediment showed a deposit of a foot or more near the middle portion of the association. This accumulated material no doubt is decayed remains of the dominant plant such as Potamogeton natans on the surface; (Fig. 2) P. pectinatus and Cerotophyllum demersum were found growing about 16 inches below the surface and Chara sp. was found in abundance growing with its tips submerged only a few inches. In places the Chara is very near the surface and in extremely dense masses from 2 to 3 feet thick.

The following is a list of species in this association: Cerotophyllum demersum, Potamogeton lucens, P. natans, P. pectinatus, Nymphaea advena, Castalia odorata, Ranunculus aquatilis.

Continuing from the upper end of the Potamogeton—Chara association for about 2000 feet and extending across the pond from shore to shore is the Sparganium—Typha (Burr-seed—Cat-tail) association.

The water covering this area is much shallower than that of the former association. The depth from the surface of the water to the surface of the loose and partial liquid sediment of plant material ranges from 2 to 8 inches; the depth of the sediment ranges from 12 to 24 inches. The sediment is not solid but a loose mushy mass of decaying plant material.

The dominant species of this association grow in clumps resembling islands and probably in time will form islands by the accumulation of debris; these plants having already accumulated sufficient material at places to raise the soil surface nearly out of the water. The most abundant species is Sparganium eurycarpum, which becomes more and more scattered and in smaller groups towards the dam showing that it is migrating towards deeper water. Other species growing in the same manner are: Typha americana, Sagitteria latifolia, Polygonum hydropiperoides, Scirpus validus and Rumex verticellata. Between these clumps are abundant growths of Potamogeton natans, Cerotophyllum demersum and Elodea canadensis besides a number of other scattered species. (Fig. 3.)

Sparganium, the dominant species of this association, has complete possession of the areas in which it started and is now growing so dense that all other species are kept out. The same is true of the other clumps mentioned but they are fewer in number. The conspicuous feature of this association is the exclusive grouping of the species.

The whole upper end of the pond for a distance of about 1200 feet with the exception of the stream feeding it is covered with the Gramineae—Carex (Grass—Sedge) association. Within the memory of the writer this area was open water; but now during the summer it is used for pasture. Besides the grasses and sedges there are willows and other swamp plants growing quite abundantly.

Another association of plants in this pond is located in a very abnormal situation. The stumps and logs which were left in the pond furnishes this abnormal place for plants to accumulate. As the logs and stumps decay the seeds and fruits which lodge on them gain a foot-hold and soon show a flora of its own.

The conditions for plant growth in this location are extreme and severe, for during the winter they are subjected to the severe winds and frosts without protection and in summer, unless their roots reach into the water, they suffer xerophytic conditions. These adverse conditions oppose the normal developement of the species growing there. Most of these plants are small and not true to type. Some of these stumps and logs are becoming very densely covered with plants so that they are beginnings of small islands. (Fig. 1.)

The following is a list of plants with the kind of fruit they produce found growing on the stumps and logs in the pond:

Latin Name	English Name	Kind of Fruit
Poa compressa	Canada Blue Grass	Caryopsis
Carex sp.	Sedge	Achene
Carex sp.	Sedge	Achene
Salix glaucophylla	Willow	Hairy seed
Pilea pumula	Clear Weed	Achene
Polygonum convolvulus	Black Bindweed	Achene
Ribes floridum	Wild Black Currant	Berry
Amelanchier Canadensis	Juneberry	Pome (fleshy)
Fragaria virginiana	Wild Strawberry	Achene on fleshy receptacle
Rubus occidentalis	Black Raspberry	Aggregate (fleshy)
Prunus pennsylvanicum	Pin Cherry	Drupe (fleshy)
Epilobium angustifolium	Fire-weed	Hairy seed
Cornus stolonifera	Red-Osier	Drupe (fleshy)
Vaccinium pennsylvanicum	Low Blueberry	Berry (fleshy)
Asclepias incarnata	Swamp Milkweed	Hairy seed
Lycopus virginicus	Water Hoarhound	Nutlet
Chelone glabra	Turtle Head	Capsule
Mimulus ringens	Monkey Flower	Capsule
Solanum dulcamara	Bittersweet	Berry (fleshy)
Galium trifida	Bedstraw	Busslike fruit
Solidago canadensis	Golden Rod	Achene (hairy)
Erigeron canadensis	Mare's Tail	Achene (hairy)
Bidens connata	Spanish Needles	Achene (barbed)
Bidens trichosperma	Tickseed Sunflower	Achene (barbed)

Of the above 24 species the seeds of 19 might have been carried by birds, 5 by wind.

SUMMARY.

1. Most of the filling material which is being deposited at present is plant remains.
2. Cerotophyllum, Potamogetons and Chara are the most active plant agents in filling this pond.
3. Sparganium eurycarpum is the most active species in gaining possession of the shallow water.
4. The channel of the original stream and those places in the pond over 4 feet deep are poor in plant life.

5. No doubt 75% of the plant species found on the stumps and logs were started from seeds carried by birds.
6. Potamogeton and Cerotophyllum are the least abundant near the dam but increase in abundance towards the upper end of the pond, becoming most abundant where the Sparganium becomes thick.
7. Sparganium is migrating towards the dam and has reached the middle of the pond.
8. In the Potamogeton—Chara association the sediment is one foot deep. In the Sparganium—Typha association it is two feet deep.

The present indications are that at the rate this pond is and has been filling the last 30 years, another period of equal length will entirely fill it with plant remains and sediment.

KEY TO THE SPECIES AND VARIETIES OF SOLIDAGO IN MICHIGAN.

BY CHAS. H. OTIS.

The following key is based upon a study of several hundred specimen sheets, principally from the University of Michigan and Michigan Agricultural College herbariums, supplemented by field work with growing specimens. The key is a result of some work along certain systematic lines directly under the supervision of Prof. H. A. Gleason.

Those who have had occasion to use the keys for identification of Solidago found in the manuals in common use must have been annoyed by the "unusableness" of such keys. The genus Solidago is not an easy one at best, there being so many gradations between one species or variety and another. While it is realized that the present key, in common with any other key, no matter how carefully it has been worked out, will not serve to identify absolutely any and every individual which may be found in the state, it is thought that it will quickly and easily distinguish the vast majority of specimens in the field. No explanation of the manner of using the key seems necessary, except to state that it is dichotomous throughout and that there are only three large types recognized. The first is characterized by clusters of flower heads in the axils of ordinary foliage leaves, the second by rounded or flat-topped inflorescences and the third by cylindrical or pyramidal inflorescences. These three types can be easily recognized with a little practice, when the minor divisions of the key can be handled with little difficulty. The habitat notes in parenthesis have been added solely to aid in the determinations and are not strictly a part of the key. The scientific names follow the usage of *Gray's New Manual of Botany*, seventh edition.

a. Heads chiefly in clusters or short racemes in the axils of ordinary foliage leaves, or the upper compacted into a leafy thyrse terminating the stem. (Compare with the thyrsoid type in *bb* under *aa*).

  b. Stem and both sides of the leaves essentially glabrous.

    c. Basal leaves abruptly narrowed to winged petioles.

      d. Involucre 2-5 mm. long, its bracts broadly ovate, obtuse; rays 3-4; achenes very pubescent. (moist woods) .... *S. latifolia.*

      dd. Involucre 8-12 mm. long, its bracts linear, acute; rays 8-10; achenes glabrous. (shore of Lake Superior) .... *S. macrophylla.*

    cc. Basal leaves not abruptly narrowed to winged petioles.

      d. Lower leaves lanceolate, acuminate, thin, sharply serrate; achenes pubescent.

        e. Stem usually simple; heads few, in very small clusters. (rich woods) .... *S. caesia, v. axillaris.*

ee. Stem usually diffuse-branched; heads rather more numerous, in larger clusters. (rich woods) .... *S. caesia*

dd. Lower leaves broadly oval, obtuse, thickish, crenate; achenes glabrous. (dry soil) .... *S. erecta.*

bb. Stem and both sides of the leaves more or less pubescent, or sometimes glabrous.

c. Rays white. (dry soil) .... *S. bicolor*

cc. Rays yellow. (dry soil) .... *S. hispida*

aa. Heads not in clusters or short racemes in the axils of ordinary foliage leaves; not thyrsoid.

b. Heads crowded at or near the ends of the branches at about the same distance from the base of the panicle, forming a rounded or flat-topped inflorescence.

c. Lower leaves ovate, oblong or oval, pinnately veined.

d. Stem and both sides of the leaves rough-pubescent. (dry, sandy soil) .... *S. rigida*

dd. Stem and both sides of the leaves glabrous. (bogs and swamps) .... *S. ohioensis*

cc. Lower leaves linear-lanceolate, 3-5-ribbed.

d. Heads few, in a small, corymbose cyme; leaves few, scattered. (lake shores) .... *S. Houghtonii*

dd. Heads many, in a large, dense, corymbose cyme; stem very leafy.

e. Leaves glabrous both sides.

f. Leaves folded, 8-20 mm. wide; basal leaves long-petioled. (swamps) .... *S. Riddellii*

ff. Leaves flat, 1-8 mm. wide; basal leaves not long-petioled.

g. Leaves 4-8 mm. wide, distinctly 3-5-ribbed. (moist soil) .... *S. graminifolia*

gg. Leaves 1-4 mm. wide, usually with prominent midrib only. (dry, sandy soil) .... *S. tenuifolia*

ee. Leaves hairy both sides. (damp soil) .... *S. graminifolia, v. Nuttallii*

bb. Heads more or less uniformly distributed along the length of the branches, forming a cylindrical or pyramidal inflorescence, never flat-topped.

c. Cauline leaves 2-5 below the inflorescence. (highest elevations of the Upper Peninsula) .... *S. Cutleri*

cc. Cauline leaves 5-many below the inflorescence.

d. Basal leaves much exceeding the greatly reduced upper ones.

e. Racemes or branches of the panicle either short and arranged along a more or less elongated central axis, or elongated and ascending, scarcely recurved, forming a narrow, more or less elongated panicle (cylindrical or thyrsoid type). (compare with *a*).

f. Leaves mostly entire, the uppermost usually without axillary fascicles. (dry, open woods) ...... *S. speciosa*

ff. Leaves mostly serrate, at least the basal ones, the uppermost usually with axillary fascicles.

g. Heads on pedicels 5-15 mm. long; achenes pubescent; stems usually clustered.

h. Basal leaves 7-12 cm. long, more or less crenate-serrate above the middle; thyrse rarely branched. (sand hills) .... *S. racemosa*

hh. Basal leaves 15-30 cm. long, coarsely and sharply serrate the entire length; thyrse paniculately branched. (sand hills and rocks along shore of Lake Michigan) .... *S. racemosa, v. Gillmannii*

gg. Heads on pedicels not over 5 mm. long; achenes glabrous or nearly so; stems usually solitary.

h. Leaves pinnately veined. (swamps) .... *S. uliginosa*

hh. Leaves 3-5-ribbed. (swamps) .... *S. neglecta*

ee. Racemes or branches of the panicle usually elongated, spreading outwards, usually recurved, forming a widened panicle (pyramidal type).

f. Both sides of the leaves pubescent or scabrous.

g. Stem and both sides of the leaves covered with a close, hoary, soft pubescence. (dry, sandy soil) .... *S. nemoralis*

gg. Stem glabrous throughout; leaves more or less scabrous on both sides. (dry or rocky soil) .... *S. juncea, v. scabrella*

ff. Both sides of the leaves not pubescent or scabrous.

g. Leaves very rough above, very smooth beneath; stem strongly angled. (swamps and bogs) .... *S. patula*

gg. Leaves smooth both sides; stem terete.

h. Branches of the panicle spreading, recurved, secund, with heads the whole length. (dry or rocky soil) .... *S. juncea*

hh. Branches of the panicle upright, hardly recurved, only slightly secund, with heads in short, terminal racemes. (dry or rocky soil) .. *S. juncea, v. ramosa*

dd. Leaves essentially uniform from base to summit of stem.

e. Stem more or less pubescent or hairy throughout.

f. Involucre 2-2.8 mm. long. (thickets and rich, open fields; roadsides) .... *S. canadensis*

ff. Involucre 3-5 mm. long.

g. Leaves pinnately veined, scabrous above, rather long-hairy beneath; more or less rugose-veined. (dry soil, or sometimes on borders of marshes) .... *S. rugosa*

gg. Leaves 3-5-ribbed, pubescent (but not scabrous) above, short-hairy beneath; not rugose-veined.

h. Stem and lower surface of leaves short-pilose; racemes strongly recurved. (rich, open ground) .. .. *S. altissima*

hh. Stem and lower surface of leaves hairy with distinct, loose, soft hairs; racemes scarcely recurved. (shores of Lake Superior) .. *S. altissima, v. procera*

ee. Stem glabrous, at least below the inflorescence.

f. Involucre 2-2.8 mm. long (thickets and rich, open fields, roadsides) .... *S. canadensis* ff. Involucre 3-6 mm. long.

g. Racemes or branches of the panicle either short and arranged along a more or less elongated central axis, or elongated and ascending, scarcely recurved, forming a narrow, more or less elongated panicle (cylindrical or thyrsoid type). (compare with *a.*); leaves entire or nearly so. (dry, open ground)............ ....*S. speciosa, v. angustata*

gg. Racemes or branches of the panicle usually elongated, spreading outwards, usually recurved, forming a widened panicle (pyramidal type); leaves distinctly serrate.

h. Leaves pinnately veined. (dry woods) .*S. ulmifolia*

hh. Leaves 3-5-ribbed.

i. Leaves glabrous both sides. (moist, rich soil).... ....*S. serotina*

ii. Leaves slightly pubescent beneath. (low ground) ....*S. serotina, v. gigantea*

AN EASY FORMULA FOR OBTAINING ALCOHOL OF ANY STRENGTH.

RICHARD DE ZEEUW.

For those who may have worked out a somewhat similar scheme, the following discussion may not have any particular interest. But I have not run across it anywhere in the literature. For that reason I thought it desirable to make a note of it here so that others might be enabled to make use of this convenient formula.

Let x = the alcohol to be used.
Let y = the alcohol to be made up.
Let z = any common divisor of both x and y.

$$\frac{x - y}{z} = \text{parts of water needed.}$$

$$\frac{y}{z} = \text{parts of x alcohol needed in making y alcohol.}$$

$$\frac{x - y}{z} + \frac{y}{z} = y \text{ (the alcohol desired).}$$

Example:

$$\frac{95\% - 70\%}{5} = 5 \text{ (parts of water).}$$

$$\frac{70\%}{5} = 14 \text{ (parts of 95\% alcohol).}$$

The advantage of this formula is that one can take any strength of alcohol that may happen to be at hand and dilute it to any other (lower) alcohol. Of course only alcohols of a lower percentage than the one used in making up another can be obtained.

Usually 95% alcohol is used to make the weaker alcohols. This is figured on a basis of 19 units. Each unit is equal to 5% alcohol in the weaker alcohol. Thus, as a short cut we may take as many parts of 95% alcohol as the result of the desired alcohol divided by 5. Then add enough water to make 19 parts.

East Lansing, Mich.

REPORT UPON THE PROGRESS OF THE BIOLOGICAL WORK OF THE MICHIGAN GEOLOGICAL AND BIOLOGICAL SURVEY DURING THE YEAR 1912-1913.

BY ALEXANDER G. RUTHVEN.

Mr. President and Members of the Academy:

The biological work of the Michigan Geological and Biological Survey during the past year has been along the lines described in my previous reports to the Academy. Every effort has been made to obtain exact data on the distribution, habitat and habits of the Michigan plants and animals, and to organize this data into monographs on the groups and reports upon the conditions in particular regions.

The field work of 1912 was in part carried on by the University Museum of Zoology and in part by the Survey, under the plan of coöperation that exists between the two institutions. The work done entirely by the Survey consisted of a botanical study of the shore of Lake Huron between Saginaw Bay and the Straits of Mackinac by C. K. Dodge. The aim of this study was to obtain a more detailed knowledge of the distribution of the species represented in that region. Mr. Dodge spent three weeks in the field and has submitted a preliminary report which shows that specimens representing about 700 species were collected and identified, and a large amount of notes on the distribution of the different forms was secured. The amount accomplished by Mr. Dodge in the time at his disposal is very creditable.

The field work done under the direction of the Museum was made possible by a gift from Hon. George Shiras 3d., Washington, D. C. Mr. Shiras assumed a part of the expenses of a preliminary investigation of the Whitefish Point region, in Chippewa County. The work was assigned to Norman A. Wood, Curator of Birds, and he spent the time between July 6 and August 14 in an examination of the vertebrate animals of the point. In addition to detailed notes on the fauna, Mr. Wood secured data on 32 species of mammals, 106 species of birds, 7 species of reptiles, and 6 species of amphibians, and this data has been prepared for publication. Some material of other groups was also obtained, and this will be published upon as soon as it has been sufficiently supplemented. The museum plans to continue this work by a study of the other groups of animals and the plants.

The manuscript reports that are completed and awaiting publication are as follows: C. K. Dodge on the flora of Mackinaw Island, and Lambton County and Point Pelee, Ontario, (three reports), Crystal Thompson and Helen Thompson on the amphibians and reptiles of the Whitefish Point region, N. A. Wood on the birds and mammals of the Whitefish Point region (two reports), A. W. Andrews on the beetles of the Charity Islands, W. W. Newcomb on a checklist of Michigan moths of the family Sphingidae, Bryant Walker on the molluscs of the Charity Islands, T. L. Hankinson on a collection of fish from Houghton County, and N. A. Wood on a check-list of Michigan mammals.

The uncompleted work to be published by the Survey is as follows: A report on botanical studies in southwestern Michigan in 1910, by C. H. Kauffman and L. H. Pennington; a monograph of the Agarics of Michigan, by C. H. Kauffman; a synopsis of the classification of the fresh water mollusca, by Bryant Walker; a report upon the beetle fauna of Wayne County, by A. W. Andrews; a report on the biological survey in Dickinson County in 1909; a report upon the flora of the east coast of Michigan, by C. K. Dodge; a catalog of Michigan mammals, by N. A. Wood; a synopsis of the larvae of Michigan amphibians, by Helen Thompson; reports upon the Mallophaga of the various surveys, by Charles A. Shull and E. P. Durrant; a synopsis of the Michigan fish, by Crystal Thompson; the lepidoptera of the Charity Islands, by W. W. Newcomb; and the ants of the Charity Islands, by Frederick Gaige.

The papers on the fauna and flora of the Charity Islands will be published in one report, which should be ready for the press next year.

The biological publications of the survey during the year are as follows:

The Herpetology of Michigan, by Alexander G. Ruthven, Crystal Thompson and Helen Thompson. Pub. 10, Biol. Ser. 3, Mich. Geol. and Biol. Surv., pp. 1-166, 20 plates and 55 maps.

Memoranda toward a Bibliography of the Archaeology of Michigan, by Harlan I. Smith. Pub. 10, Biol. Ser., 3, Mich. Geol. and Biol. Surv., pp. 167-180.

The White-tailed Deer of Michigan, by Alexander G. Ruthven and N. A. Wood. Science, N. S., XXXV, pp. 863-864.

The Breeding Birds of the Charity Islands, with Additional Notes on the Migrants, by Norman A. Wood. 14th. Ann. Rept. Mich. Acad. Science, 178-188.

Results of the Mershon Expedition to the Charity Islands, Lake Huron:

The Reptiles and Amphibians of Charity Island, by Crystal Thompson and Helen Thompson. Ibid., 156-158.

Checklist of Michigan Butterflies, Rhopalocera, by W. W. Newcomb. Ibid., 226-230.

Notes on the Mammals of Osceola County, Michigan, by O. J. Wenzel, Ibid., 198-205.

The Flora of the Douglas Lake Region, Cheboygan County, Michigan, by F. C. Gates, Ibid., 46-103.

The field work planned for the summer of 1913 is as follows: C. K. Dodge will continue his study of the flora of the east coast of the state north of Saginaw Bay, H. Hus and C. H. Otis will study the oaks of the southern part of the lower peninsula, Thomas Hankinson will investigate the fish fauna of the Whitefish Point region, A. W. Andrews will study the beetles of Whitefish Point, and Crystal Thompson and Helen Thompson will work on the herpetology of Monroe County.

The study of the fish and beetles of Whitefish Point will be carried on by the Museum. Mr. Shiras has again volunteered to support the work, and the results will contribute to the exhaustive survey of the area that we intend to make.

In past reports I have dwelt at some length on the advantages of cooperation between the survey and the private workers, schools, colleges, and museums in the state. Permit me to point out that there is a yearly increasing amount of such cooperation, and that the results are gratifying from every point of view. The University Museum is devoting to the work some of its appropriations and a considerable part of the time of its staff, the collections of the Agricultural College are at the disposal of the survey, at least five local naturalists are giving their best efforts to the work, and, what is by no means least important, we are receiving data and specimens from an increasing number of persons. In return, the survey is doing all it can, on the limited appropriations, to be of service to the people of the state, by publishing reports, by furnishing information on biological subjects, by loaning specimens, and by identifying material.

CHECK-LIST MICHIGAN LEPIDOPTERA.

II. SPHINGIDAE (HAWK MOTHS.)[1]

BY W. W. NEWCOMB.

The species of hawk-moths listed below are probably all which naturally occur in the state, either as breeders or rather common visitors. There are doubtless a few others which occasionally stray across our borders from the south, but such species cannot be regarded as regularly breeding here, even though they may do so at times. It is largely in these "southern strays" that additions to our list may be expected.

The writer has personally observed and collected all of the species listed. Three forms are known only in single examples, two of which belong to the "southern strays,"—one, *Cocytius cluentius,* occurring in Mexico, and the other, *Theretra tersa*, common in the southern states. The occurrence of *Cocytius cluentius* in southern Michigan is remarkable, only one other instance of its presence in the United States having been recorded, and well illustrates the extraordinary powers of flight of some members of the sphinx family. The third species known only in a single individual, *Deidamia inscriptum,* undoubtedly breeds here, as its food-plants, grape and Virginia Creeper, are common. Among the rarer species of Michigan Sphingidae, should be noted particularly *Sphecodina abbottii* and *Cressonia juglandis.*

Hoy[2] in his "Catalogue of Wisconsin Lepidoptera" gives the names of at least seven species of hawk-moths which have not yet been recorded from Michigan. Of these, four belong to the "southern strays." As the southern border of Michigan is some fifty or sixty miles farther south than the southern border of Wisconsin, it might be supposed that we should have as many of these "southern strays" as Wisconsin, but it should be noted, as Hoy says, that the territory which lies to the west of the Great Lakes enjoys much warmer summers than the territory in the same latitude which lies to the east of them.

One species which almost certainly occurs in the state, but for which there is no definite record as yet, is the tobacco sphinx, *Phlegethontius carolina.* Possible other additions to our list include *Lepisesia flavofasciata* Wlk., *Sphinx luscitiosa* Clem. and *S. plebeia* Fabr., *Lapara bombycoides* Wlk. and *L. coniferarum* S. & A. To these might be added the names of five or six southern species which occasionally find their way to the northern states, but this would not, in the writer's opinion, be justified.

[1]Prepared for the Michigan Geological and Biological Survey and published with the permission of the Chief Naturalist.

[2]P. R. Hoy, A Catalogue of Wisconsin Lepidoptera, Geological Survey of Wisconsin, Vol. 1, p. 408.

Our knowledge of the Sphingidae in the Upper Peninsula of Michigan is exceedingly meager. The writer observed only three species, namely, *Hemaris diffinis, H. thysbe* and *Smerinthus geminatus* in Dickinson County in 1909. No other species are known from the Upper Peninsula, but when this part of the state is thoroughly explored, probably a considerable number of those which occur in the Lower Peninsula will be found there.

LIST OF SPECIES.

SPINGIDAE.

Macroglossinae.

102.* **Hemaris diffinis** Bdv. **tenuis** Grt.
diffinis Bdv.
axillaris G & R.

103. **thysbe** Fabr. **ruficaudis** Kirby.
thysbe Fabr.

Choerocampinae.

104. **Amphion nessus** Cram.
105. **Sphecodina abbottii** Swains.
106. **Deidamia inscriptum** Harr.
107. **Deilephila gallii** Rott. **chamoenerii** Harr.
108. **lineata** Fabr.
109. **Theretra tersa** Linn.
110. **Pholus pandorus** Hbn.
111. **achemon** Dru.
112. **Ampelophaga choerilus** Cram.
113. **myron** Cram.
114. **versicolor** Harr.

Sphinginae.

115. **Cocytius cluentius** Cr.
116. **Phlegethontius quinquemaculata** Haw.
117. **cingulata** Fabr.
118. **Sphinx kalmiae** S. & A.
119. **drupiferarum** S. & A.
120. **gordius** Cram.
121. **chersis** Hbn.
122. **eremitus** Hbn.
123. **Dolba hylaeus** Dru.
124. **Ceratomia amyntor** Geyer.
125. **undulosa** Wlk.

Smerinthinae.

126. **Marumba modesta** Harr.
127. **Smerinthus jamaicensis** Dru. **geminatus** Say.
128. **Paonias excaecatus** S. & A.
129. **myops** S. & A.
130. **Cressonia juglandis** S. & A.

*The numbers in this list are continued from the first part of the Checklist (covering the palocera), which was published last year in the 14th Annual Report of the Academy.

RESULTS OF THE SHIRAS EXPEDITIONS TO WHITEFISH POINT, MICHIGAN.

REPTILES AND AMPHIBIANS.

Crystal Thompson and Helen Thompson.

Museum of Zoology, University of Michigan.

During the summer of 1912, the Museum of Zoology was enabled, through the generosity of Hon. George Shiras 3d., to send Mr. N. A. Wood, Curator of Birds, to Whitefish Point, Chippewa County, Michigan, for the purpose of beginning a biological exploration of the region. Principal attention was given by Mr. Wood to the birds and mammals, but the amphibians and reptiles were studied in considerable detail, and a collection of seventy-nine specimens with detailed data was secured. We are indebted to Mr. Wood for the use of his notes, some of which are incorporated in this report.

A general account of the topography, climate and habitats of the region will be sufficient. The point is considered to extend from a line drawn from the Luce-Chippewa County line at Lake Superior to the Shelldrake River and down this river to its mouth. Generally speaking, it is made up of sandy ridges running parallel with the shore-line; and these ridges are more or less forested and are separated by wooded or grassy marshes, and ponds of varying extent. The vegetation of the ridges varies from an open jack pine forest near the end of the point to a dense birch-pine forest on the older ridges near the base; and in the older areas there are balsam-spruce forests and tamarack and cedar bogs in the low places. Small, swiftly-flowing streams usually connect the ponds with Lake Superior; and the Shelldrake River, a stream that varies from a width of about ten to fifteen feet near Vermilion to about one hundred feet at the mouth, is included in the region. It will be seen from this brief description and the latitude that the region is not a favorable one for the existence of reptiles and amphibians, and the thirteen species obtained are probably very nearly all that live in the region.

The data on the reptile-amphibian fauna of the Whitefish Point region is of interest for several reasons. Practically nothing has been known of the distribution of the two groups in the eastern half of the Upper Peninsula, and, while the territory worked was very restricted, the ecological conditions are so varied that the fauna is probably representative of much of the general region. There is in the general fauna of the western part of the northern peninsula a decided western element, but little is known of the eastern limit of these forms. So far the only known western form in these groups is *Chrysemys bellii,* the known range of which is now extended entirely across northern Michigan. It is also of interest to know whether any of the more southern forms that are known to exist in the northern part of the southern peninsula occur in this region. The work on Whitefish Point has added *Natrix sipedon* and *Hemidactylium scutatum* to the fauna of northern Michigan and has extended the known range of *Liopeltis vernalis,* previously known in this part only from Mackinac County, to Lake Superior. Finally the occurrence of the distinctly northern *Rana septentrionalis* at Whitefish Point indicates that it is probably generally distributed in northern Michigan, a point that has been in doubt.

LIST OF SPECIES.

AMPHIBIANS.

1. **Plethodon erythronotus** (Green). Red-backed Salamander.—Seven specimens of the red-backed salamander were taken from decayed logs in damp woods near the Whitefish Point postoffice, and one was collected in the birch-spruce forest.

2. **Hemidactylium scutatum** (Schlegel). Four-toed Salamander.—A single specimen of this (in Michigan) rare salamander was collected by Mr. Wood on Aug. 2. It was found under a moss-covered log in a dried-up water hole in the dense forest at the base of the point.

This record is very interesting in view of the uncertain distribution of the species in the state. The only Michigan records[2] are five specimens taken in Eaton County and five collected during the past three years in a woods six miles south of Ann Arbor. Moreover, as far as the writers have been able to determine, this is decidedly the northernmost record for the species. *H. scutatum* is fairly common in the east from as far south as Georgia. The most northern record has apparently been a specimen in the National Museum from St. Catherine's, Canada, collected by Dr. Beadle, and recorded by Cope.[3] We are informed by Dr. Leonhard Stejneger that there is no data with the specimen to show that it is St. Catherine's Ontario, rather than St. Catherine's, Quebec, that is referred to, but in the report of the Smithsonian Institution for 1861 (p. 64) it is stated that D. W. Beadle donated some specimens from "Canada West;" and Mr. C. W. Nash, Provincial Museum, Toronto, informs us that he knew Dr. Beadle, and that there can be little doubt that the specimen came from St. Catherine's, Ontario. Nash accepts this locality in his manual.[4]

3. **Bufo americanus** Le Conte. American Toad.—Four adult toads were found in a clearing, and recently transformed specimens were common in a shallow pond near the end of Beaver Lake. These are the only records secured.

4. **Rana pipiens** Schreber. Leopard Frog.—This form was found commonly around Beaver Lake, and about the transient ponds, and two specimens were taken in a hay field near Vermilion.

5. **Rana clamitans** Latreille. Green Frog.—Four green frogs were taken in the outlet to Beaver Lake.

6. **Rana cantabrigensis** Baird. Wood Frog.—This species was common about the edges of the grassy marshes and the small ponds which occupied the depressions between the sand ridges. One specimen was collected in the dense forest at the base of the point.

7. **Rana septentrionalis** Baird. Mink Frog.—Two specimens were collected from Clark's Brook at Vermilion.

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[2]Thompson, C. and H., The Amphibians of Michigan, Mich. Geol. and Biol. Surv., Pub. 10, Biol. Ser. 3, pp. 34-36.
[3]Cope, Batrachia of North America, Bull. U. S. Nat. Mus., No. 34, 1889, p. 132.
[4]Nash, C. W., Manual of Vertebrates of Ontario, Batr. and Rept., 1908, 6.

REPTILES.

8. **Storeria occipitomaculata** (Storer). Red-bellied Snake.—Five specimens of the red-bellied snake were collected,—one under a board walk in a clearing near the end of the point, three others under logs and boards near the marsh and near Beaver Lake, and one was taken from the stomach of a sparrow hawk.

9. **Natrix sipedon** (Linn.). Water Snake.—But one water snake was taken. It was found on the edge of the outlet to Beaver Lake. This is apparently the first record of the species for the northern peninsula.

10. **Liopeltis vernalis** (DeKay). Green Snake.—This was apparently the most common snake of the region, since a large series (sixteen specimens) was collected. They were found under boards on the sand ridges.

11. **Thamnophis sirtalis** (Linn.). Garter Snake.—Seven garter snakes were taken about the edges of transient ponds and marshes.

12. **Chelydra serpentina** (Linn.). Snapping Turtle.—The shell of a large snapping turtle, found in one of the small ponds in the marsh near Vermilion, has been presented to the museum by John Clark.

13. **Chrysemys bellii** Gray. Bell's Turtle.—The only place where this turtle was found was a pond near the postoffice.. The individuals observed were exceedingly shy, dropping from logs into water at the slightest disturbance. It should be stated that the two specimens examined are not typical. The plastral blotch is smaller than usual, and the color of the carapace is so dark as to obscure the light markings on the marginals, costals and vertebrals, except that a few of the costals have faint irregular yellowish marginal bands. Also the prominent light markings on the ventral face of the marginals do not extend outward to enclose the (in *C. bellii*) characteristic spots of black with pale centers. On the other hand, the large size (carapace length 165.7 mm. and 163.7 mm., width 124.9 mm. and 112.4 mm.) indicate that the specimens are to be referred to *C. bellii,* as does the absence of bright markings on the marginals.

THE FLOWERING PLANTS, FERNS AND THEIR ALLIES OF MACKINAC ISLAND.*

BY C. K. DODGE.

INTRODUCTION.

Mackinac Island is situated near the northern end of Lake Huron, in the Straits of Mackinac. It is about 3 miles from the shore of the northern peninsula and 7 or 8 miles from the shore of the southern peninsula. It is one of the historical places in Michigan, as it was visited by most of the early voyageurs and was the site of a federal fort from 1780 until ceded by the federal government to the State of Michigan, in 1895, for a park. It is now under the control of a state commission, and about one-half is used for park purposes, the other half being privately owned.

Little work has been done upon the fauna and flora of the island. A few species of plants have been recorded by travelers, but no attempt has apparently been made to list the flora as a whole. In the summer of 1912, the writer visited the island in the course of his work upon the flora of the east coast of Michigan, for the Michigan Geological and Biological Survey, and made as careful study of the plants as time permitted. Five days were spent on the island, from June 30 to July 2 inclusive, and Sept. 30 and Oct. 1, 1912.

TOPOGRAPHY.

The island is roughly quadrangular in shape, about 3 miles long in a north and south direction and 2 miles wide, and contains 2221 acres. Generally speaking the land rises from the beach to a high rocky area in the center that is much broken up by ravines. The highest point is 317 feet above the lake. Around most of the island the cliffs rise abruptly from a narrow beach; but on the north side the elevation is not abrupt and on the south side a succession of terraces leads from the bay to the bluff.

The underlying rock is limestone, which is in general covered by a thin layer of morainic material. One small area near the northwest shore is covered with a considerable deposit of morainic material, and the terraces at the south end are made up of recent lake deposits.

PRESENT PLANT COVERING.

Notwithstanding the long inhabitation of the island, Mackinac Island is still in a quite primitive condition as far as the flora is concerned. The original forests still remain substantially intact, except on the northern part where most of the large timber has been removed and a few pieces of land cleared and cultivated. In the dense forests of the

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interior the red oak, beech and sugar maple are often abundant and intermingled and in places the balsam, white spruce, and white cedar are abundant and usually associated. A large area of yellow birch stands by itself on high ground toward the east side. Canoe birch is scattering, and the white pine and red pine are not prominent.

Over 400 species have been noticed on the island and it is not probable that more than 100 species more grow there. Of the 415 reported in the present paper at least 60 are introduced plants, usually known as weeds, leaving 355 observed native species, so it appears that 450 is probably a close approximation of the number of native species and varieties on the island.

ACKNOWLEDGMENTS.

I am much indebted to Agnes Chase, Scientific Assistant in Systematic Agrostology, Bureau of Plant Industry, U. S. Department of Agriculture, for examining the various species of grasses, and to Kenneth Mackenzie, of New York City, for inspecting all species of Cyperaceae, Junci, and many other plants.

LIST OF SPECIES.

POLYPODIACEAE—FERN FAMILY.

Phegopteris dryopteris (L.) Fee. Oak Fern. Plentiful in rich shaded ground.

Adiantum pedatum L. Maidenhair. Often abundant in rich shaded ground.

Pteris aquilina L. Common Brake. Occasional in shaded or open ground.

Asplenium filix-femina (L.) Bernh. Lady Fern. Frequent in rich shaded ground.

Aspidium thelypteris (L.) Sw. Marsh Shield Fern. Common in damp shaded or open ground.

Aspidium marginale (L.) Sw. Evergreen Wood Fern. In rich shaded ground apparently rare.

Aspidium spinulosum (O. F. Müller) Sw. Spinulose Shield Fern. Occasional in shaded ground.

Aspidium spinulosum intermedium (Muhl.) D. C. Eaton. Spinulose Shield Fern. Frequent in rich shaded ground.

Cystopteris bulbifera (L.) Bernh. Bulblet cystopteris. Abundant on rocky shaded ground.

Onoclea sensibilis L. Sensitive Fern. In damp open or shaded ground.

OPHIOGLOSSACEAE—ADDER'S TONGUE FAMILY.

Botrychium virginianum (L.) Sw. Rattlesnake Fern. Common in rich shaded ground.

EQUISETACEAE—HORSETAIL FAMILY.

Equisetum arvense L. Common Horsetail. Frequent on the sandy beach and in damp open or shaded ground.

Equisetum sylvaticum L. Wood Horsetail. Frequent and often abundant in damp shaded ground.

Equisetum fluviatile L. Swamp Horsetail. In wet marshy open ground on the east side.

Equisetum hyemale L. Scouring Rush. Occasional in dry open or shaded ground.

Equisetum scirpoides Michx. Sedge-like equisetum. Common in moist shaded ground.

LYCOPODIACEAE—CLUB MOSS FAMILY.

Lycopodium lucidulum Michx. Shining Club Moss. In rich ground under evergreens.

Lycopodium complanatum L. Trailing Christmas-green. Occasional in dry shaded ground.

SELAGINELLACEAE—SELAGINELLA FAMILY.

Selaginella apus (L.) Spring. Creeping Selaginella. Occasional on damp open ground.

TAXACEAE—YEW FAMILY.

Taxus canadensis Marsh. American Yew. Common under evergreens especially on the west side under balsams and cedars.

PINACEAE—PINE FAMILY.

Pinus strobus L. White Pine. Common but not large.

Pinus resinosa Ait. Red Pine. Common and many large trees.

Larix laricina (DuRoi) Koch. Tamarack. Frequent in swampy ground, but trees small.

Picea canadensis (Mill.) BSP. White Spruce. Abundant in spots especially in rich ground on the west side and at the south end.

Abies balsamea (L.) Mill. Balsam. Abundant in spots associated with white cedar, especially on the west side.

Tsuga canadensis (L.) Carr. Hemlock. Frequent but trees usually small.

Thuja occidentalis L. White Cedar. Abundant in spots and associated with balsam.

Juniperus communis depressa Pursh. Low Juniper. Abundant under large trees especially on the east side.

Juniperus horizontalis Moench. Shrubby Red Cedar. Along and near the beach on the east side. Apparently rare.

TYPHACEAE—CAT-TAIL FAMILY.

Typha latifolia L. Common Cat-tail. Noticed in a few marshy places.

SPARGANIACEAE—BUR-REED FAMILY.

Sparganium eurycarpum Engelm. Broad-fruited Bur-reed. In low wet places.

JUNCAGINACEAE—ARROW GRASS FAMILY.

Triglochin maritima L. Seaside Arrow Grass. Occasional in marshy places and in damp sand.

Triglochin palustris L. Marsh Arrow Grass. In marshy places on the east side.

ALISMACEAE—WATER-PLANTAIN FAMILY.

Sagittaria latifolia Willd. Broad-leaved Arrow-head. Occasional in marshy places.

Alisma plantago-aquatica L. water plantain. Common in wet and muddy places.

GRAMINEAE—GRASS FAMILY.

Digitaria sanguinalis (L.) Scop. Crab Grass. About the village of Mackinac Island and on cultivated grounds.

Panicum capillare L. Old-witch Grass. Noticed about the village and on cultivated grounds.

Echinochloa crusgalli (L.) Beauv. Barnyard Grass. Occasional about the village.

Setaria glauca (L.) Beauv. Foxtail. About the village and on cultivated grounds.

Setaria viridis (L.) Beauv. Green Foxtail. Occasional about the village and on cultivated grounds.

Cenchrus carolinianus Walt. Sandbur. Noticed about the village.

Phalaris arundinacea L. Reed Canary Grass. In wet marshy places on the east side.

Hierochloe odorata (L.) Wahlenb. Holy Grass. In damp meadow-like places on the east side.

Milium effusum L. Millet Grass. In rich woods.

Oryzopsis asperifolia Michx. White-grained Mountain Rice. Frequent in dryish woods.

Muhlenbergia racemosa (Michx.) BSP. Marsh Muhlenbergia. Borders of wet open places on the east side.

Phleum pratense L. Timothy. In the village and throughout the island.

Agrostis alba L. Red Top. Bordering damp open places.

Calamagrostis canadensis (Michx.) Beauv. Blue-joint Grass. In marshy places on the east side.

Danthonia spicata (L.) Beauv. Common Wild-oat Grass. Frequent in dry open or slightly shaded places.

Dactylis glomerata L. Orchard Grass. More or less throughout the island.

Poa annua L. Low Spear Grass. In streets and lawns of the village.

Poa compressa L. Canada Blue Grass. In dry open or slightly shaded places throughout.

Poa triflora Gilib. False Red Top. In wet open ground on the east side.

Poa pratensis L. June Grass. In open or slightly shaded ground throughout.

Poa debilis Torr. Weak Spear Grass. Occasional in open woods.

Glyceria nervata (Willd.) Trin. Fowl Meadow Grass. In wet meadow-like open or slightly shaded places.

Festuca occidentalis Hook. Western Fescue Grass. Frequent in dry open woods.

Festuca ovina L. Sheep's Fescue. Common in dry open or slightly shaded ground.

Bromus ciliatus L. Fringed Brome Grass. In damp shaded places on the east side.

Bromus kalmii Gray. Wild Chess. In dry open ground on the east side.

Agropyron repens (L.) Beauv. Quack Grass. About the village and in cultivated grounds.

Agropyron caninum (L.) Beauv. Awned Wheat Grass. In dry open woods.

Elymus canadensis L. Nodding Wild-rye. Occasional on and near the sandy beach.

CYPERACEAE—SEDGE FAMILY.

Eleocharis palustris (L.) R. & S. Creeping Spike Rush. In very wet marshy ground.

Eleocharis tenuis (Willd.) Schultes. Slender Spike Rush. In damp meadow-like ground on the east side.

Eleocharis rostellata Torr. Beaked Spike Rush. Plentiful in wet marshy spots on the east side.

Scirpus americanus Pers. Three-square. In wet places and in wet sand fringing the beach.

Scirpus occidentalis (Wats.) Chase—Western Bulrush. In wet marshy places on the east side.

Scirpus atrovirens Muhl. Dark Green Bulrush. In wet marshy ground and in damp sand.

Eriophorum viridi-carinatum (Engelm.) Fernald. Tall Cotton Grass. In wet shaded places on the west side.

Rynchospora capillacea Torr. Capillary Beaked Rush. In boggy places on the east side.

Cladium mariscoides (Muhl.) Torr. Twig Rush. In wet meadow-like ground on the east side.

Carex scoparia Schkuhr. Painted Broom Sedge. Occasional in damp ground.

Carex tribuloides Wahlenb. Blunt Broom Sedge. Damp rich open ground on the east side.

Carex crawfordii Fernald. Crawford's Sedge. In open ground. F. W. Hunnewell 2nd.

Carex sterilis Willd. Little Prickly Sedge. In wet open places.

Carex scirpoides Schkuhr. Inland Sedge. In damp open ground.

Carex deweyana Schwein. Dewey's Sedge. Common in open woods.

Carex trisperma Dewey. Three-fruited Sedge. In shaded boggy ground on the west side.

Carex tenella Schkuhr. Stellate Sedge. Common in open dry woods.

Carex rosea Schkuhr. Soft-leaved Sedge. In swampy shaded ground on the west side.

Carex vulpinoidea Michx. Fox Sedge. In damp open or slightly shaded ground.

Carex stipata Muhl. Awl-fruited Sedge. In very wet open or shaded places.

Carex aquatilis Wahlenb. Water Sedge. In very wet places on the east side.

Carex stricta Lam. Tussack Sedge. In very wet open ground on the east side.

Carex aurea Nutt. Golden-Fruited Sedge. Frequent in open or slightly shaded ground.

Carex leptadea Wahlenb. Bristle-stalked Sedge. In swampy open or shaded ground.

Carex polygama Schkuhr. Brown Sedge. In wet marshy open ground on the east side.

Carex gracillima Schwein. Graceful Sedge. Frequent in open woods.

Carex albicans Willd. Northern Sedge. Frequent in open woods.

Carex communis Bailey. Fibrous-rooted Sedge. In open woods. F. W. Hunnewell 2nd.

Carex pennsylvanica Lam. Pennsylvania Sedge. Dry open or slightly shaded ground.

Carex tetanica Schkuhr. Wood's Sedge. In wet open ground on the east side.

Carex eburnea Boott. Bristle-leaved Sedge. Often abundant in rocky shaded ground especially on bluffs.

Carex laxiflora varians Bailey. Loose-flowered Sedge. Beach-maple woods.

Carex laxiflora blanda (Dewey) Boott. Loose-flowered Sedge. Rich shaded ground.

Carex grisea Wahlenb. Gray Sedge. Beach-maple woods. F. W. Hunnewell 2nd.

Carex granularis haleana (Olney) Porter. Shriver's Sedge. Open ground.

Carex flava L. Yellow Sedge. In very wet open ground on the east side.

Carex oederi pumila (Cosson & Germain) Fernald. Green Sedge. In damp sand along or near beach.

Carex capillaris L. Hair-like Sedge. In damp slightly shaded ground on the west side.

Carex capillaris elongata Olney. Hair-like Sedge. In slightly shaded ground. F. W. Hunnewell 2nd.

Carex arctata Boott. Drooping Wood Sedge. In open dryish woods.

Carex filiformis L. In very wet marshy places on the east side.

Carex hystericina Muhl. Porcupine Sedge. In wet open places.

ARACEAE—ARUM FAMILY.

Arisaema triphyllum (L.) Schott. Jack-in-the-Pulpit. Frequent in rich shaded ground.

JUNCACEAE—RUSH FAMILY.

Juncus tenuis Willd. Slender Rush. About the village and along the roads.

Juncus dudleyi Wiegand. Dudley's Rush. In wet open ground near the beach on the west side.

Juncus balticus littoralis Engelm. Baltic Rush. On and near the beach.

Juncus alpinus insignis Fries. Richardson's Rush. In damp sand along beach.

LILIACEAE—LILY FAMILY.

Zygadenus chloranthus Richards. Glaucous Zygadenus. In damp sandy ground near beach on the west side.

Lilium philadelphicum andinum (Nutt.) Ker. Western Red Lily. Abundant especially at north end. One stem noticed with nine flowers.

Erythronium americanum Ker. Yellow Adder's-tongue. In rich shaded ground.

Clintonia borealis (Ait.) Raf. Yellow Clintonia. In damp rich shaded ground.

Smilacina racemosa (L.) Desf. False Spikenard. Common in open woods.

Smilacina stellata (L.) Desf. Star-flowered Solomon's Seal. In rich shaded or open dry sandy ground.

Smilacina trifolia (L.) Desf. Three-leaved Solomon's Seal. In very wet shaded ground on the west side.

Maianthemum canadense Desf. False Lily-of-the-Valley. Common in open woods.

Streptopus amplexifolius (L.) DC. Clasping-leaved Twisted-stalk. In moist shaded ground on west side. F. W. Hunnewell 2nd.

Streptopus roseus Michx. Sessile-leaved Twisted-stalk. In rich shaded ground.

Polygonatum biflorum (Walt.) Ell. Small Solomon's Seal. Common in rich shaded ground.

Trillium grandiflorum (Michx.) Salisb. Large-flowered Wake Robin. Frequent in rich woods.

IRIDACEAE—IRIS FAMILY.

Iris versicolor L. Larger Blue Flag. Occasional in damp open ground, not far from the beach.

Iris lacustris Nutt. Lake dwarf Iris. Reported by W. D. Whitney. Not noticed in 1912.

Sisyrinchium angustifolium Mill. Painted Blue-eyed Grass. In a marshy place at north end.

ORCHIDACEAE—ORCHIS FAMILY.

Cypripedium parviflorum Salisb. Smaller Yellow Lady's Slipper. In damp rich ground and on shaded bluffs.

Cypripedium parviflorum pubescens (Willd.) Knight. Larger Yellow Lady's Slipper. On rich shaded ground.

Cypripedium hirsutum Mill. Showy Lady's Slipper. In damp shaded ground. Apparently rare.

Habenaria bracteata (Willd.) R. Br. Long-bracted Orchis. Frequent in beech-maple woods.

Habenaria flava (L.) Gray. Small Pale-green Orchis. In rich wet shaded ground on the west side.

Habenaria hyperborea (L.) R. Br. Tall Leafy Green Orchis. In boggy shaded ground on the west side.

Habenaria dilatata (Pursh) Gray. Tall White Bog Orchis. In wet shaded ground on west side.

Habenaria obtusata (Pursh) Richards. Small Northern Bog Orchis. In rich shaded ground on the west side.

Habenaria hookeri Torr. Hooker's Orchis. In rich shaded ground on the west side.

Habenaria orbiculata (Pursh) Torr. Large Round-leaved Orchis. In rich shaded ground on the east side. Apparently rare, only one specimen being noticed.

Habenaria lacera (Michx.) R. Br. Ragged Orchis. In open woods on the east side. Apparently rare.

Epipactis tesselata (Lodd.) A. A. Eaton. Checkered Rattlesnake Plantain. In rich shaded ground on the west side.

Epipactis decipiens (Hook.) Ames. Menzies' Rattlesnake Plantain. Frequent in rich woods especially on the west side.

Listera convallarioides (Sw.) Torr. Broad-lipped Twayblade. In rich moist woods on the west side.

Corallorrhiza trifida Chatelain. Early Coral Root. Common in open woods.

Corallorrhiza maculata Raf. Large Coral Root. Common in open woods.

Corallorrhiza striata Lindl. Striped Coral Root. Frequent in rich shaded ground.

Liparis loeselii (L.) Richard. Loesel's Twayblade. In damp sand on or not far from sandy beach.

Calypso bulbosa (L.) Oakes. Calypso. Reported by W. D. Whitney. Not noticed in 1912.

SALICACEAE—WILLOW FAMILY.

Salix amygdaloides Anders. Peach-leaved willow. Noticed by Frank A. Kengay, superintendent of park. Not common.

Salix lucida Muhl. Shining Willow. Frequent in wet open ground.

Salix glaucophylla Bebb. Broad-leaved Willow. On and near the sandy beach.

Salix syrticola Fernald, Furry Willow. Occasional near the sandy beach.

Salix discolor Muhl. Glaucous Willow. Frequent along edge of rocky bluffs.

Salix rostrata Richards. Bebb's Willow. Occasional on dryish open ground at north end.

Salix candida Flügge. Sage Willow. About and in wet places on the east side.

Populus tremuloides Michx. American Aspen. Occasional but nowhere abundant.

Populus grandidentata Michx. Large-toothed Aspen. Frequent throughout the island.

Populus balsamifera L. Balsam Poplar. Common especially on edge of woods near shore. A few large trees noticed.

MYRICACEAE—SWEET GALE FAMILY.

Myrica gale L. Sweet Gale. Abundant in spots on east side of island about and in wet places.

BETULACEAE—BIRCH FAMILY.

Corylus rostrata Ait. Beaked Hazelnut. Common throughout the island.

Ostrya virginiana (Mill.) K. Koch. Ironwood. Plentiful, growing with birch and maple.

Carpinus caroliniana Walt. Blue Beech. Noticed by Frank A. Kenyan, superintendent of park.

Betula lutea Michx.f. Yellow Birch. Abundant and large on the east side of the high part of the island, and scattering throughout.

Betula alba papyrifera (Marsh) Spach. Canoe Birch. Trees often large and growing with other trees throughout the island.

Alnus incana (L.) Moench. Speckled Alder. Frequent in wet spots throughout.

FAGACEAE—BEECH FAMILY.

Fagus grandifolia Ehrh. Common Beech. Abundant and trees large on the highest part of the island.

Quercus rubra L. Red Oak. Abundant and fair sized trees growing with beech and maples on the highest parts of the island.

URTICACEAE—NETTLE FAMILY.

Ulmus americana L. American Elm. In streets and yards of the village. Frank A. Kenyan, superintendent of park.

Urtica gracilis Ait. Slender Nettle. Frequent in damp open or shaded ground.

SANTALACEAE—SANDLEWOOD FAMILY.

Comandra umbellata (L.) Nutt. Bastard Toad-flax. Frequent in dry open or shaded ground. Perhaps this is doubtful and may be referred to next species.

Comandra richardsiana Fernald. Richards' Toad-flax. Plentiful on the east side in dry open or slightly shaded ground.

POLYGONACEAE—BUCKWHEAT FAMILY.

Rumex crispus L. Yellow Dock. In the village and on cultivated grounds.

Rumex obtusifolius L. Bitter Dock. About the village and occasional in open woods.

Rumex acetosella L. Field Sorrel. Occasional on dry ground in and near the village.

Polygonum aviculare L. Knotgrass. About the village and in cultivated grounds.

Polygonum acre HBK. Water Smartweed. Michigan Flora. Not noticed in 1912.

Polygonum persicaria L. Lady's Thumb. Occasional about the village and in cultivated grounds.

Polygonum convolvulus L. Black Bindweed. About the village and on cultivated grounds.

CHENOPODIACEAE—GOOSEFOOT FAMILY.

Chenopodium hybridum L. Maple-leaved Goosefoot. About the village and on cultivated grounds.

Chenopodium album L. Common Pigweed. About the village and on cultivated grounds.

Atriplex patula hastata (L.) Gray. Halberd- leaved Orache. In waste places about the village.

AMARANTHACEAE—AMARANTH FAMILY.

Amaranthus retroflexus L. Amaranth Pigweed. About the village and on cultivated grounds.

CARYOPHYLLACEAE—PINK FAMILY.

Arenaria serpyllifolia L. Thyme-leaved Sandwort. As an occasional weed about the village.

Stellaria media (L.) Cyrill. Common Chickweed. Only as an occasional weed about the village.

Cerastium arvense L. Field Mouse-ear Chickweed. Reported by G. H. Hicks. Not noticed in 1912.

Cerastium vulgatum L. Common Mouse-ear Chickweed. As a weed about the village and in cultivated grounds.

PORTULACACEAE—PURSLANE FAMILY.

Claytonia virginica L. Spring Beauty. Reported by W. D. Whitney. Not noticed in 1912.

Claytonia caroliniana Michx. Carolina Spring Beauty. In rich shaded ground.

Portulaca oleracea L. Common Purslane. Occasional as a weed about the village.

RANUNCULACEAE—CROWFOOT FAMILY.

Ranunculus sceleratus L. Cursed Crowfoot. Frequent in wet places.

Ranunculus abortivus L. Small-flowered Crowfoot. Common in rich open or shaded ground.

Ranunculus recurvatus Poir. Hooked Crowfoot. Frequent in open or slightly shaded ground.

Ranunculus acris L. Tall Crowfoot. A weed about the village, and growing in open woods like a native plant.

Hepatica triloba Chaix. Round-leaved Liverleaf. Frequent in open woods.

Hepatica acutiloba DC. Sharp-lobed Liverleaf. Common in beech-maple woods.

Anemone multifida Poir. Red Wind Flower. In dry open ground on the west side.

Anemone virginiana L. Tall Anemone. Common in open or slightly shaded ground.

Anemone canadensis L. Canada Anemone. Occasional in damp open ground.

Anemone quinquefolia L. Wood Anemone. In open woods and thickets.

Caltha palustris L. Marsh Marigold. In wet places and along small creeks on the west side.

Aquilegia canadensis L. Wild Columbine. In shaded places on rocky bluffs and in dry open ground.

Actaea rubra (Ait.) Willd. Red Baneberry. In rich shaded ground.

Actaea alba (L.) Mill. White Baneberry, Frequent in rich open woods.

PAPAVERACEAE—POPPY FAMILY.

Sanguinaria canadensis L. Bloodroot. Reported by W. D. Whitney. Not noticed in 1912.

FUMARIACEAE—FUMITORY FAMILY.

Adlumia fungosa (Ait.) Greene. Climbing Fumitory. Abundant on the shaded rocky bluff, east side.

CRUCIFERAE—MUSTARD FAMILY.

Draba arabisans Michx. Twisted Whitlow Grass. Shaded rocky bluffs on east side.

Lepidium virginicum L. Wild Peppergrass. As a weed about the village.

Capsella bursa-pastoris (L.) Medic. About the village and on cultivated grounds.

Brassica arvensis (L.) Ktze. Common Mustard. Occasional about the village.

Sisymbrium officinale leiocarpum DC. Hedge Mustard. Occasional as a weed about the village.

Braya humilis (C. A. May) Robinson. Low Rock-cress. Reported by G. H. Hicks. Not noticed in 1912.

Erysimum cheiranthoides L. Worm-seed Mustard. As a weed in the village and on cultivated grounds.

Radicula nasturtium-aquaticum (L.) Britton & Rendle. True Water Cress. Established in small brooks.

Barbarea orthoceras Ledeb. Yellow Rocket. Abundant near the beach east of the village and occasional in other places. See Rhodora XI-140.

Dentaria diphylla Michx. Two-leaved Toothwort. In damp shaded ground.

Arabis hirsuta (L.) Scop. Hairy Rock Cress. Noticed by F. W. Hunnewell 2nd.

DROSERACEAE—SUNDEW FAMILY.

Drosera rotundifolia L. Round-leaved Sundew. In wet mossy open ground on the east side.

CRASSULACEAE—ORPINE FAMILY.

Sedum acre L. Mossy Stonecrop. Occasional in dry open ground.

Sedum purpureum Tausch. Live-for-ever. Occasional in open or shaded ground.

SAXIFRAGACEAE—SAXIFRAGE FAMILY.

Mitella diphylla L. Two-leaved Bishop's Cap. In rich woods.

Mitella nuda L. Naked Bishop's Cap. In damp rich shaded ground.

Parnassia parviflora D. C. Small-flowered Grass-of-Parnassus. In wet marshy ground at the north end. F. W. Hunnewell 2nd.

Parnassia caroliniana Michx. Carolina Grass-of-Parnassus. Plentiful in marshy open ground.

Ribes cynosbati L. Prickly Gooseberry. In dryish shaded ground.

Ribes huronense Rydb. Lake Huron Gooseberry. In rich woods.

Ribes oxyacanthoides L. Smooth Gooseberry. Frequent in shaded or open ground.

Ribes oxyacanthoides calcicala Fernald. Smooth Gooseberry. Common in rich woods. F. W. Hunnewell 2nd.

Ribes floridum L'Her. Wild Black Currant. Common in rich damp open or shaded ground.

Ribes lacustre (Pers.) Poir. Swamp Black Currant. In rich damp woods and common on shaded rocky bluff, east side.

Ribes prostratum L'Her. Skunk Currant. Occasional on shaded rocky bluff.

HAMAMELIDACEAE—WITCH-HAZEL FAMILY.

Hamamelis virginiana L. Witch-hazel. Frequent on the east side.

ROSACEAE—ROSE FAMILY.

Physocarpus opulifolius (L.) Maxim. Nine-bark. In damp open ground on the east side.

Spiraea salicifolia L. Meadow-sweet. Frequent in damp open ground.

Pyrus malus L. Common Apple. Frequent throughout the island.

Pyrus americana (Marsh.) DC. American Mountain Ash. Quite a number of trees fringing the woods on the east side.

Pyrus sitchensis (Roem.) Piper. Western Mountain Ash. H. Mann in Michigan Flora.

Amelanchier sanguinea (Pursh) DC. Round-leaved Juneberry. Frequent in open woods. See Rhodora XIV-138.

Amelanchier laevis Wiegand. Early Juneberry. In open or slightly shaded ground throughout.

Crataegus punctata Jacq. Large-fruited Thorn. Frequent throughout the island in open or slightly shaded ground. A number of unidentified thorns were noticed.

Fragaria virginiana Duchesne. Common Strawberry. Common throughout the island.

Fragaria vesca americana Porter. American Wood Strawberry. Common in open or shaded ground.

Waldsteinia fragarioides (Michx.) Trattinick. Barren Strawberry. In beech-maple woods.

Potentilla monspeliensis L. Rough Cinquefoil. Occasional as a weed about the village and in cultivated grounds.

Potentilla fruticosa L. Shrubby Cinquefoil. In damp meadow-like ground on the east side.

Potentilla anserina L. Silver Weed. Common near the beach.

Geum canadense Jacq. White Avens. Frequent in open woods.

Geum virginianum L. Rough Avens. On border of woods.

Geum strictum Ait. Yellow Avens. In damp meadow-like ground on east side.

Geum rivale L. Water Avens. In wet open or slightly shaded places.

Rubus idaeus canadensis Richardson. Wild Red Raspberry. Common in dry open places. See Rhodora XI-236.

Rubus parviflorus Nutt. Salmon Berry. Frequent throughout the island; usually in shaded ground.

Rubus triflorus Richards. Dwarf Raspberry. In damp rich shaded ground.

Rubus allegheniensis Porter. High-bush Blackberry. Frequent in dry open or slightly shaded ground.

Agrimonia gryposepala Wallr. Tall Hairy Agrimony. Frequent in open woods.

Rosa acicularis Lindl. Prickly Rose. Common in dry open or shaded ground, and growing with R. blanda.

Rosa blanda Ait. Meadow Rose. In dry open or slightly shaded ground.

Rosa canina L. Dog Rose. O. A. Farwell in Michigan Flora.

Rosa rubiginosa L. Sweetbrier. In open ground especially near the village.

Rosa carolina L. Swamp Rose. Reported by W. D. Whitney.

Prunus virginiana L. Choke Cherry. Common throughout the island.

Prunus pennsylvanica L. f. Wild Red Cherry. Common throughout the island.

Prunus pumila L. Sand Cherry. Frequent on and near the beach.

LEGUMINOSAE—PULSE FAMILY.

Trifolium pratense L. Red Clover. Occasional about the village and in open or shaded ground throughout the island.

Trifolium repens L. White Clover. Frequent in the village and open ground.

Trifolium hybridum L. Alsike Clover. In and near the village.

Medicago lupulina L. Black Medick. Frequent and often abundant in spots.

Vicia cracca L. Tufted Vetch. Occasional in dry ground on borders of woods.

Lathyrus maritimus (L.) Bigel. Beach Pea. Along the sandy beach.

Lathyrus palustris L. Marsh Vetchling. In damp meadow-like ground throughout the island.

Lathyrus palustris pilosus (Cham.) Ledeb. Marsh Vetchling. Noticed by F. W. Hunnewell 2nd.

GERANIACEAE—GERANIUM FAMILY.

Geranium maculatum L. Wild Cranesbill. Common in open woods.

Geranium robertianum L. Herb Robert. Fringing the beach in the village, and on the rocky bluff, east side.

POLYGALACEAE—MILKWORT FAMILY.

Polygala paucifolia Willd. Fringed Polygala. In dry shaded ground.

EUPHORBIACEAE—SPURGE FAMILY.

Euphorbia hirsuta (Torr.) Wiegand. Hairy Spurge. O. A. Farwell in Michigan Flora.

Euphorbia helioscopia L. Wartweed. Plentiful in one spot on the bluff above the village.

ANACARDIACEAE—CASHEW FAMILY.

Rhus typhina L. Staghorn Sumach. Common throughout the island.

Rhus toxicodendron L. Poison Ivy. Abundant throughout the island.

CELASTRACEAE—STAFF TREE FAMILY.

Celastrus scandens L. Bittersweet. Common in woods and thickets.

ACERACEAE—MAPLE FAMILY.

Acer pennsylvanicum L. Striped Maple. In rich ground with other trees, especially on the west side.

Acer spicatum Lam. Mountain Maple. Abundant in rich ground with other trees.

Acer saccharum Marsh. Sugar Maple. Abundant on the highest part of the island with red oak, beech and yellow birch.

BALSAMINACEAE—TOUCH-ME-NOT FAMILY.

Impatiens biflora Walt. Spotted Touch-me-not. Abundant in shaded moist places and often in open damp ground.

VITACEAE—VINE FAMILY.

Psedera vitacea (Knerr) Greene. American Woodbine. Common in woods and thickets.

TILIACEAE—LINDEN FAMILY.

Tilia americana L. Basswood. Occasional in rich ground with other trees.

MALVACEAE—MALLOW FAMILY.

Malva rotundifolia L. Common Mallow. As a weed about the village.

HYPERICACEAE—ST. JOHN'S-WORT FAMILY.

Hypericum perforatum L. Common St. John'swort. About the village and in open ground.

Hypericum kalmianum L. Kalm's St. John'swort. In meadow-like ground on the east side.

VIOLACEAE—VIOLET FAMILY.

Viola nephrophylla Greene. Small Mottled Blue Violet. In a wet marshy place at the north end.

Viola renifolia brainerdii Fernald. Brainerd's Violet. Plentiful in rich shaded ground on the west side.

Viola pubescens Ait. Hairy Yellow Violet. In dry shaded ground on the high parts of the island.

Viola scabriuscula Schwein. Smooth Yellow Violet. In rich shaded ground.

Viola canadensis L. Canada Violet. Plentiful in rich shaded ground.

Viola conspersa Reichenb. American Dog Violet. Common in rich shaded ground.

ELAEAGNACEAE—OLEASTER FAMILY.

Shepherdia canadensis (L.) Nutt. Canadian Buffalo Berry. Frequent in dry open or shaded ground.

ONAGRACEAE—EVENING PRIMROSE FAMILY.

Epilobium angustifolium L. Great Willow-herb. Common in open or slightly shaded ground.

Epilobium adenocaulon Haussk. Northern Willow-herb. Frequent in damp open ground.

Oenothera biennis L. Common Evening Primrose. Common on and near the sandy beach.

Circaea alpina L. Smaller Enchanter's Nightshade. Frequent in rich shaded ground.

ARALIACEAE—GINSENG FAMILY.

Aralia racemosa L. Spikenard. Frequent in rich woods.

Aralia nudicaulis L. Wild Sarsaparilla. Common in rich shaded ground.

UMBELLIFERAE—PARSLEY FAMILY.

Sanicula marilandica L. Black Snakeroot. Common in rich shaded ground.

Osmorrhiza claytoni (Michx.) Clarke. Woolly Sweet Cicely. Common in rich shaded ground.

Osmorrhiza divaricata Nutt. Western Sweet Cicely. Rich woods. F. W. Hunnewell 2nd.

Conium maculatum L. Poison Hemlock. About the village in waste places.

Carum carvi L. Caraway. As a weed about the village.

Taenidia integerrima (L.) Drude. Yellow Pimpernel. In dry open or shaded ground.

Pastinaca sativa L. Parsnip. Frequent in and near the village.

Heracleum lanatum Michx. Cow Parsnip. Frequent in rich shaded ground, especially on the east side.

CORNACEAE—DOGWOOD FAMILY.

Cornus canadensis L. Dwarf Cornel. In damp rich woods.

Cornus circinata L'Her. Round-leaved Cornel. Common in dry ground and on rocky bluffs.

Cornus baileyi Coult. & Evans. Bailey's Cornel. Occasional in dry open ground and on or near the beach.

Cornus stolonifera Michx. Red-osier Dogwood. In damp open or shaded ground and often in damp sand.

Cornus paniculata L'Her. Panicled Cornel. Border of woods and in thickets.

Cornus alternifolia L. f. Alternate-leaved Cornel. Frequent in open woods.

ERICACEAE—HEATH FAMILY.

Chimaphila umbellata (L.) Nutt. Prince's Pine. Frequent in dry woods.

Pyrola secunda L. One-sided Wintergreen. Common in rich woods.

Pyrola chlorantha Sw. Greenish-flowered Wintergreen. In dry open woods. Apparently rare.

Pyrola elliptica Nutt. Shin Leaf. In dry woods. Apparently rare.

Pyrola asarifolia Michx. Liver-leaf Wintergreen. In damp shaded ground. F. W. Hunnewell 2nd.

Pyrola asarifolia incarnata (Fisch.) Fernald. Bog Wintergreen. Frequent in wet shaded places.

Monotropa uniflora L. Indian Pipe. Frequent in rich woods.

Ledum groenlandicum Cedar. Labrador Tea. In wet, boggy places on the east side.

Epigaea repens L. Trailing Arbutus. Under pines; apparently not common.

Arctostaphylos uva-ursi (L.) Spreng. Bearberry. Occasional on rocky bluffs.

Chiogenes hispidula (L.) T. & G. Moxie Plum. In boggy shaded ground on the west side.

PRIMULACEAE—PRIMROSE FAMILY.

Primula mistassinica Michx. Dwarf Canadian Primrose. Abundant in spots in wet open places on the east side.

Lysimachia thyrsiflora L. Tufted Loosestrife. In swampy open places.

Trientalis americana (Pers.) Pursh. Star Flower. Frequent in rich shaded ground.

GENTIANACEAE—GENTIAN FAMILY.

Gentiana procera Holm. Smaller Fringed Gentian. Abundant in marshy open ground on the east side.

Halenia deflexa (Sm.) Griseb. Spurred Gentian. Common in rich shaded ground.

APOCYNACEAE—DOGBANE FAMILY.

Vinca minor L. Common Periwinkle. In and about the cemetery north of the fort.

Apocynum androsaemifolium L. Spreading Dogbane. In dry open woods and open ground on the west side.

ASCLEPIADACEAE—MILKWEED FAMILY.

Asclepias syriaca L. Common Milkweed. In dry open ground but apparently rare.

BORAGINACEAE—BORAGE FAMILY.

Cynoglossum officinale L. Common Hound's Tongue. Frequent in waste places in the village and throughout the island.

Cynoglossum boreale Fernald. Northern Comfrey. Frequent in dryish open woods. F. W. Hunnewell 2nd.

Lappula virginiana (L.) Greene. Beggar's Lice. In rich woods and thickets.

Lappula echinata Gilibert. European Stickseed. Occasional in the village and cultivated grounds.

Myosotis virginica (L.) BSP. Spring Scorpion Grass. Occasional in dry open woods. F. W. Hunnewell 2nd.

Lithospermum officinale L. Common Gromwell. Common about the village and occasional throughout the island.

Echium vulgare L. Blue Weed. Occasional about the village.

LABIATAE—MINT FAMILY.

Prunella vulgaris L. Heal-all. Frequent in open or slightly shaded ground.

Galeopsis tetrahit L. Common Hemp Nettle. Winchell's Catalogue as reported by Michigan Flora. Not noticed in 1912.

Hedeoma hispida Pursh. Rough Pennyroyal. In prairie-like ground on the east side.

Satureja vulgaris (L.) Fritsch. Wild Basil. In dry open or slightly shaded places throughout the island.

Lycopus virginicus L. Bugle Weed. Occasional in rich moist open ground.

SOLANACEAE—NIGHTSHADE FAMILY.

Hyoscyamus niger L. Black Henbane. About the village.

SCROPHULARIACEAE—FIGWORT FAMILY.

Linaria vulgaris Hill. Butter and Eggs. About the village as a weed.

Pentstemon hirsutus (L.) Willd. Hairy Beard-tongue. In dry open woods.

Mimulus glabratus jamesii (T. & G.) Gray. James' Mimulus. In springy places and along small brooks, growing in water.

Veronica americana Schwein. American Brooklime. In ditches and along small brooks.

Veronica serpyllifolia L. Thyme-leaved Speedwell. In dryish open or shaded grassy ground.

Gerardia paupercula (Gray) Britton. Small-flowered Gerardia. Reported by W. D. Whitney.

Castilleja coccinea (L.) Spreng. Scarlet Painted Cup. In low open ground, especially on the east side.

Pedicularis canadensis L. Wood Betony. In dryish shaded ground.

LENTIBULARIACEAE—BLADDERWORT FAMILY.

Utricularia intermedia Hayne. Flat-leaved Bladderwort. In a wet mossy place on the east side.

OROBANCHACEAE—BROOM-RAPE FAMILY.

Epifagus virginiana (L.) Bart. Beech-drops. Common under beech trees.

Conopholis americana (L. f.) Wallr. Squaw-root. In dry woods. Apparently rare.

Orobanche uniflora L. One-flowered Cancer-root. In damp open or slightly shaded ground. Abundant in spots.

PLANTAGINACEAE—PLANTAIN FAMILY.

Plantago major L. Common Plantain. Occasional about the village.

Plantago lanceolata L. English Plantain. About the village and in cultivated grounds.

RUBIACEAE—MADDER FAMILY.

Galium aparine L. Cleavers. Occasional in rich shaded ground.

Galium lanceolatum Torr. Wild Liquorice. In dry woods. Apparently not common.

Galium trifidum L. Small Bedstraw. In wet open places on the east side.

Galium triflorum Michx. Sweet-scented Bedstraw. In rich woods.

Mitchella repens L. Partridge Berry. Common in dry woods.

CAPRIFOLIACEAE—HONEYSUCKLE FAMILY.

Diervilla lonicera Mill. Bush Honeysuckle. Plentiful in dry open or shaded ground.

Lonicera canadensis Marsh. American Fly-honeysuckle. Frequent in open woods.

Lonicera hirsuta Eat. Hairy Honeysuckle. Frequent in damp open or shaded ground.

Lonicera glaucescens Rydb. Douglas' Honeysuckle. Occasional in dry open or slightly shaded ground.

Lonicera dioica L. Glaucous Honeysuckle. Common on rocky bluffs.

Symphoricarpos racemosus Michx. Snowberry. In dry open or shaded ground.

Linnaea borealis americana (Forbes) Rehder. Twin-flower. Very abundant on and at the foot of rocky bluffs.

Viburnum opulus americanum (Mill.) Ait. Cranberry-tree. Occasional in and on borders of woods.

Sambucus racemosa L. Red-berried Elder. Common in rich woods.

CAMPANULACEAE—BLUEBELL FAMILY.

Campanula rotundifolia L. Harebell. Frequent on and near the beach, and on rocky bluffs.

LOBELIACEAE—LOBELIA FAMILY.

Lobelia kalmii L. Brook Lobelia. In wet open spots on the east side.

COMPOSITAE—COMPOSITE FAMILY.

Solidago latifolia L. Broad-leaved Goldenrod. Common on shaded rocky bluffs and in damp open woods.

Solidago hispida Muhl. Hairy Goldenrod. Common in dry or slightly shaded ground.

Solidago juncea Ait. Early Goldenrod. Frequent in dry open ground.

Solidago altissima L. Tall Goldenrod. In rich open or slightly shaded ground.

Solidago graminifolia (L.) Salisb. In damp open ground, especially in damp sand on and near the beach.

Aster macrophyllus L. Large-leaved Aster. Very abundant in shaded ground.

Aster cordifolius L. Common Blue-wood Aster. Occasional in rich open or slightly shaded ground and on rocky bluffs.

Aster sagittifolius Wedemeyer. Arrow-leaved Aster. In dryish open or slightly shaded places and on rocky bluffs.

Aster lindleyanus T. & G. Lindley's Aster. Common in open or slightly shaded places.

Aster tradescanti L. Tradescant's Aster. In damp open places, especially in damp sand on and near the beach.

Aster paniculatus Lam. Tall White Aster. Common in damp sand on and near the beach.

Erigeron philadelphicus L. Philadelphia Fleabane. Occasional throughout the island in open or slightly shaded places.

Erigeron annuus (L.) Pers. Sweet Scabious. In dryish open or shaded ground.

Erigeron ramosus (Walt.) BSP. Daisy Fleabane. Occasional about the village and in cultivated ground.

Erigeron canadensis L. Horse-weed. As a weed in the village and waste places.

Antennaria canadensis Greene. Canadian Cat's-foot. Frequent in dry open or slightly shaded ground.

Antennaria fallax Greene. Tall Cat's-foot. In rich open or slightly shaded ground.

Antennaria neodioica Greene. Smaller Cat's-foot. Occasional in dryish open woods.

Anaphalis margaritacea (L.) B. & H. Pearly Everlasting. Common in dry open places.

Ambrosia artemisiifolia L. Common Ragweed. As a weed in the village and cultivated grounds.

Rudbeckia hirta L. Yellow Daisy. Occasional in dry open woods.

Coreopsis lanceolata L. Lance-leaved Tickseed. In dry open ground on the west side of the island. Apparently rare.

Achillëa millefolium L. Common Yarrow. Occasional about the village and in cultivated grounds.

Anthemis cotula L. Mayweed. Only as a weed about the village.

Chrysanthemum leucanthemum pinnatifidum Lecoq. & Lamotte. Ox-eye Daisy. Common throughout the island even in open woods like a native plant.

Artemisia caudata Michx. Tall Wormwood. On and near the sandy beach.

ADDENDA.

To the Mackinaw Island list of plants on page 218, the following observations, corrections, and additions should be made.

Equisetum pratense Ehrh. Thicket horsetail. Abundant at foot of rocky cliffs.

Lycopodium annotinum L. Occasional in woods.

Carex crawfordii Fernald, should be omitted and the following inserted.

Carex bebbii Olney. Bebb's sedge. Occasional in damp open ground.

Allium tricoccum Ait. Wild leek. In rich woods. Apparently infrequent.

Ulmus americana L. Three large native trees and a number of small ones noticed at the foot of the bluff near the Marquette monument.

Rumex mexicanus Meisn. Willow-leaved dock. In damp sand on and near the lake shore. Apparently infrequent.

Salsola kali tenuifolia G. F. W. Mey. Russian thistle. As a weed in the village.

Amaranthus graecizans L. Tumble weed. As a weed in gardens and about the streets of the village.

Amaranthus blitoides Wats. Prostrate amaranth. Streets of the village.

Stellaria longipes Goldie. (?). Long-stalked stitchwort. Thickly matted in one place on the east side of the island.

Claytonia virginica L. Noticed as frequent in 1913.

Thalictrum dasycarpum Fisch. & Lall. Purplish meadow rue. Occasional on borders of woods.

Aquilegia vulgaris L. Garden columbine. Double-flowered form growing wild on and near the lake shore.

Sanguinaria canadensis L. Noticed as occasional in 1913.

Lepidium apetalum Willd. Apetalous peppergrass. About the village.

Brassica oleracea L. Cabbage. Apparently growing wild near the water works.

Sisymbrium altissimum L. Tumble mustard. As a weed about the village.

Radicula armoracia (L.) Robinson. Horseradish. Noticed as an escape in several places.

Tiarella cordifolia. False miterwort. Occasional in rich woods on the west side.

Ribes oxyacanthoides L. is probably not on the island.

Pyrus americana (Marsh.) DC. is apparently not growing wild on the island, but there are perhaps 25 or more trees of P. sitchensis (Roem.) Piper. and this was noticed as far south as Alpena.

Melilotus officinalis (L.) Lam. Yellow melilot. Occasional as a weed.

Melilotus alba Desr. Sweet clover. Noticed along the streets of the village.

Medicago sativa L. Alfalfa. Occasional as an escape. It is being successfully cultivated on the island.

Robinia pseudo-acacia L. Common locust. Occasional as an escape.

Lathyrus palustris linearifolius Ser. Marsh vetchling. Bordering edge of bluffs. Plentiful.

Vicia angustifolia (L.) Reichard. Common vetch. Occasional in the village.

Linum usitatis simum L. Common flax. Occasional about the village.

Oxalis corniculata L. Lady's sorrel. In streets and gardens as a weed.

Malva moschata L. Musk mallow. Occasional as an escape.

Osmorrhiza longistylis (Torr.) DC. Smoother sweet cicely. Frequent in rich woods.

Gaultheria procumbens L. Wintergreen. Often abundant in dry shaded ground.

Vaccinium pennsylvanicum Lam. Low sweet blueberry. In dry open or slightly shaded ground.

Verbena hastata L. Blue vervain. Occasional along the roads.

Nepeta cataria L. Catnip. About the village.

Nepeta hederacea (L.) Trevisan. Ground ivy. In patches througbout the island.

Galeopsis tetrahit L. Abundant in spots on rocky bluffs.

Leonurus cardiaca L. Common motherwort. Occasional in and about gardens.

Hedeoma hispida Pursh, probably does not exist on the island.

Satureja glabra (Nutt.) Fernald, low calamint is plentiful in damp ground on the east side.

Mentha spicata L. Spearmint. Occasional in the village.

Mentha piperita L. Peppermint. Frequent in damp ground bordering the bluffs.

Verbascum thapsus L. Common mullein. Througbout the island.

Veronica officinalis L Common speedwell. Near the Indian settlement.

Plantago rugelii Dcne. Rugel's plantain. Frequent throughout the island.

Campanula rapunculoides L. Creeping bellflower. Escaping to the streets of the village.

Aster cordifolius is probably not on the island.

Ambrosia psilostachya DC. Western ragweed. Established in the village as a weed.

Sonchus asper (L.) Hill. Spiny leaved sow thistle. A weed in gardens.

Prenanthes altissima L. Tall white lettuce. Occasional in woods at the north end.

Hieracium scabrum Michx. Rough hawkweed. Occasional in dry open or slightly shaded ground.

Hieracium gronovii L. Gronovius' hawkweed. In dry open ground.

Hieracium umbellatum L. Narrow-leaved hawkweed. Frequent in open or slightly shaded ground.

Petasites palmatus (Ait.) Gray. Palmate-leaf Sweet Coltsfoot. In damp woods, especially on the west side.

Senecio vulgaris L. Common Groundsel. About the village. F. W. Hunnewell 2nd.

Senecio aureus L. Golden Ragwort. In wet shaded places, especially on the west side.

Senecio aureus gracilis (Pursh) Britton. Slender Ragwort. Occasional in damp ground. F. W. Hunnewell 2nd.

Senecio balsamitae Muhl. Balsam Groundsel. In dry open or slightly shaded ground.

Arctium minus Bernh. Common Burdock. Frequent and often abundant in open or shaded ground.

Cirsium lanceolatum (L.) Hill. Common Thistle. Occasional in open and cultivated ground.

Cirsium pitcheri (Torr.) T. & G. Pitcher's Thistle. Occasional along the sandy beach on the east side.

Cirsium discolor (Muhl.) Spreng. Field Thistle. In dryish open or slightly shaded ground.

Cirsium arvense (L). Scop. Canada Thistle. Noticed throughout the island in open or slightly shaded ground. In spots abundant.

Lapsana communis L. Nipple-wort. Plentiful on the bluff west of the fort and near the waterworks building on the east side.

Tragopogon porrifolius L. Oyster-plant. An escape about the village.

Tragopogon pratensis L. Goat's Beard. Occasional as a weed about the village.

Taraxacum officinale Weber. Common Dandelion. About the village and in cultivated grounds.

Sonchus oleraceus L. Common Sow Thistle. As an occasional weed about the village.

Lactuca canadensis L. Wild Lettuce. In rich open or slightly shaded ground.

Lactuca spicata (Lam.) Hitchc. Tall Blue Lettuce. In open woods throughout the island.

Prenanthes alba L. White Lettuce. Occasional in rich open woods.

Hieracium aurantiacum L. Orange Hawkweed. Occasional in open woods like a native plant.

REPORT OF THE LIBRARIAN OF THE MICHIGAN ACADEMY OF SCIENCE FOR THE YEAR 1912-1913.

ALEXANDER G. RUTHVEN.*

The work of the librarian during the fiscal year has consisted principally of the routine duties of his position. Considerable time has been expended in the correspondence with exchanges and the sending out of reports purchased by members and others, but the results are satisfactory. Seventeen exchanges have been added to the list as against thirteen dropped. A number of reports have been sold, and several persons have applied for membership in order to receive the reports. The annual report for last year (1911-1912) could not be sent out, as it is still in the hands of the printer.

The first report of the Academy (1894-1899) is now practically exhausted. There are but six copies in our possession, and these have been set aside that the Academy may not be without a few complete sets of the reports.

The present list of exchanges is appended:

LIST OF EXCHANGES.†

Aberdeen Natural History Society, Aberdeen, Scotland.
Aberdeen University Library, Aberdeen, Scotland.
Academia de Ciencias, Mexico City, Mexico.
Academia de Ciencias, Médicasy Fisicas, Havana, Cuba.
Academia de Ciencias Naturales, Lima, Peru.
Academia Nacional de Ciencias, Cordoba, South America.
Academia Polytechnica, Oporto, Portugal.
Academia Real das Sciences, Lisbon, Portugal.
Académie de Metz, Metz, Lorraine, Germany.
Académie des Belles-Lettres, Sciences, La Rochelle, France.
Académie des Sciences, Art et Belles-Lettres, Dijon, France.
Académie des Sciences, Belles-Lettres, Lyon, France.
Académie des Sciences, Belles-Lettres et Arts, Rouen, France.
Académie des Sciences et Letters, Montpellier, France.
Académie des Sciences Inscriptions et Belles-Lettres, Toulouse, France
Académie Nationale des Sciences, Caen, France.
Academy of Science, New Orleans, Louisiana.
Academy of Natural Sciences, Philadelphia, Pennsylvania.
Academy of Natural Sciences, St. Paul, Minn.
Accademia delles Scienze dell' Istituto, Bologna, Italy.
Accademia delle Scienze, Lettere ed Arti, Genoa, Italy.
Adrian Scientific Society, Adrian, Michigan.
Aix University Library, Aix-en-Provence, Bouches du Rhone, France.

*Address: Museum of Natural History, University of Michigan, Ann Arbor, Michigan, U. S. A.

†Address all exchanges "care of the Library of the University of Michigan, Ann Arbor, Michigan, U. S. A."

Akademija Umiejetnosci, Krakau, Austria-Hungary.
Alabama Geological Survey, University, Alabama.
Albion College, Library, Albion, Michigan.
Alma College, Library, Alma, Michigan.
Alpena Public Library, Alpena, Michigan.
American Academy of Arts and Sciences, Boston, Mass.
American Academy of Medicine, Easton, Pennsylvania.
American Association for the Advancement of Science, Washington, D. C.
American Entomological Society, Philadelphia, Pennsylvania.
American Geographical Society, New York City, New York.
American Geologist, Minneapolis, Minnesota.
American Gynecological Society, New York City, New York.
American Laryngological Association, New York City, New York.
American Midland Naturalist, Notre Dame, Indiana.
American Museum of Natural History, New York City, New York.
American Philosophical Society, Philadelphia, Pennsylvania.
Archives des Sciences Physiques et Naturelles, Geneva, Switzerland.
Asiatic Society of Bengal, Calcutta, India.
Astronomical Society of the Pacific, San Francisco, California.
American School of Classical Studies, Athens, Greece.
Atlanta University, Library, Atlanta, Georgia.
Bayerische Botanische Gesellschaft, Munich, Germany.
Baylor University, Library, Waco, Texas.
Beloit College, Library, Beloit, Wisconsin.
Berliner Entomologischer Verein, Berlin, Germany.
Besancon University, Library, Besancon, France.
Bibliotheca Nacional, Buenos Aires, Argentine Republic.
Bibliotheca da Faculdade de Direito da Universidade, Pernambuco, Brazil.
Bibliotheque Nationale, Paris, France.
Bibliotheca Nacional, Rio de Janeiro, Brazil.
Biblioteca Nazionale Centrale, Florence, Italy.
Biologiska Foerening, Stockholm, Sweden.
Birmingham School Board, Birmingham, England.
Bodleian Library, University of Oxford, Oxford, England.
Boston Medical Library, Boston, Massachusetts.
Boston Public Library, Boston, Massachusetts.
Boston Scientific Society, Boston, Massachusetts.
Boston Society of Natural History, Boston, Massachusetts.
Botanischer Verein, Freiburg-im-Breisgau, Germany.
Botanischer Verein, Koenigsberg, Prussia, Germany.
Botanischer Verein, Landshut, Germany.
Botanischer Verein, Provinz Brandenburg, Berlin, Germany.
Bowdoin College, Library, Brunswick, Maine.
Bradford Scientific Association, Bradford, England.
Bristol Naturalists' Society, Bristol, England.
British Association for the Advancement of Science, London, England.
British Museum, London, England.
Brooklyn Institute of Arts and Sciences, Brooklyn, New York.
Brown University, Library, Providence, Rhode Island.
Bryn Mawr College, Library, Bryn Mawr, Pennsylvania.

The Bryologist, Brooklyn, New York.
Buffalo Society of Natural Sciences, Buffalo, New York.
Calcutta University, Library, Calcutta, India.
California Academy of Sciences, San Francisco, California.
California University, Library, Berkeley, California.
Calumet Public Library, Calumet, Michigan.
Cambridge Philosophical Society, Cambridge, England.
Cambridge University, Library, Cambridge, England.
Canadian Institute, Toronto, Canada.
Catholic University, Library, Washington, D. C.
Central State Normal School, Library, Mt. Pleasant, Michigan.
Charleston Museum, Charleston, South Carolina.
Chicago Academy of Science, Lincoln Park, Chicago, Illinois.
Chicago University, Library, Chicago, Illinois.
Cincinnati Society of Natural History, Cincinnati, Ohio.
Cincinnati University, Library, Cincinnati, Ohio.
City of London Entomological and Natural History Society, London, England.
College of Physicians, Philadelphia, Pennsylvania.
Colorado College, Library, Colorado Springs, Colorado.
Colorado School of Mines, Library, Golden, Colorado.
Colorado Scientific Society, Denver, Colorado.
Colorado University, Library, Boulder, Colorado.
Columbia University, Library, New York City, New York.
Commerz-Biblothek, Hamburg, Germany.
Commissao Geographic e Geologica, San Paulo, Brazil.
Commissioneu for Ledelsen of Geolosiske og Geographiske, Copenhagen, Denmark.
Concilium Bibliographicum, Zurich, Switzerland.
Connecticut Academy of Arts and Sciences, Yale Station, New Haven, Connecticut.
Connecticut State Library, Hartford, Connecticut.
Cornell University, Library, Ithaca, New York.
Dalhousie College, Library, Halifax, Nova Scotia, Canada.
Davenport Academy of Natural Sciences, Davenport, Iowa.
Delaware County Institute of Science, Media, Pennsylvania.
Denison University, Scientific Laboratories, Granville, Ohio.
Denver University, Library, Denver, Colorado.
Department of Mines and Agriculture, Sidney, New South Wales.
Department of the Interior, Canadian Archives, Ottawa, Canada.
Detroit Public Library, Detroit, Michigan.
Deutsche Botanische Gesellschaft, Berlin, Germany.
Deutsche Geologische Gesellschaft, Berlin, Germany.
Deutscher u. Oesterreichischer Alpen-Verein, Munich, Germany.
Deutscher Wissenschaftlicher Verein, Santiago, Chili.
Deutsches Entomologisches Natural-Museum, Berlin, Germany.
Division of Entomology, Dept. of Agriculture, Ottawa, Canada.
Ecole Normale Supérieure, Paris, France.
Ecole Pratique des Hautes Etudes, Sorbonne, Paris, France.
Edinburgh Field Naturalists and Microscopical Society, Edinburgh, Scotland.
Edinburgh Geological Society, Edinburgh, Scotland.

Edinburgh University, Library, Edinburgh, Scotland.
Elgin Scientific Society, Elgin, Illinois.
Elisha Mitchell Scientific Society, Chapel Hill, North Carolina.
Elliott Society of Science and Arts, Charleston, South Carolina.
Elphinstone College, Library, Bombay, India.
Entomological Society, Cavendish Square, W. London, England.
Entomological Society of Canada, Quebec, Canada.
Entomological Society of Ontario, Guelph, Canada.
Entomologischer Verein, Stettin, Germany.
Entomologiska Foerening, Stockholm, Sweden.
Essex Institute, Salem, Mass.
Field Museum of Natural History, Chicago, Illinois.
Finska Vetenskap Societet, Helsingfors, Finland.
Folia Bibliographica, Berlin, Germany.
Franklin & Marshall College, Library, Lancaster, Pennsylvania.
Geographical Society of Australia, Queensland Branch, Brisbane, Australia.
Geographical Society of California, San Francisco, California.
Geographical Society of Finland, Helsingfors, Finland.
Geographical Society of Philadelphia, Philadelphia, Pennsylvania.
Geographical Society of Quebec, Quebec, Canada.
Geographische Gesellschaft, Bremen, Germany.
Geographische Gesellschaft, Greifswald, Germany.
Geographische Gesellschaft fuer Thueringen, Jena, Germany.
Geological Society of South Africa, Johannisburg, South Africa.
Geological Survey, Department of Mines and Agriculture, Sidney, New South Wales.
Geological Survey of Missouri, Jefferson City, Missouri.
Geological Survey of Newfoundland, St. Johns, Newfoundland.
Geological Survey of New Jersey, New Brunswick, New Jersey.
Geological Survey of New Zealand, Wellington, New Zealand.
Geological Survey of Victoria, Melbourne, Victoria, Australia.
Geologische Gesellschaft fuer Ungarn, Budapest, Hungary.
Geologiska Commissionen i Finland, Helsingfors, Finland.
Georg-Augusts Universitaet, Goettingen, Germany.
Georgia University, Library, Athens, Georgia.
Glasgow Geological Society, Glasgow, Scotland.
Glasgow School Board, Glasgow, Scotland.
Glasgow University, Library, Glasgow, Scotland.
Government Botanist, Melbourne, Victoria, Australia.
Government Fisheries Station, Tuticorin, India.
Grand Rapids Public Library, Grand Rapids, Michigan.
Grossherz Bad. Albert-Ludwigs Universitaet, Bibliothek, Freiburg, Germany.
Grossherz Hessische Ludwig-Universitaet, Bibliothek, Giessen, Hessen, Germany.
Grossherz Ruprecht-Karls Universitaet. Heidelberg, Germany.
Grossherz Saechsische Gesant Universitaet, Bibliothek, Jena, Germany.
Gulf Biological Station, Baton Rouge, Louisiana.
Hackley Public Library, Muskegon, Michigan.
Hall Fowler Memorial Library, Lonia, Michigan.
Harvard Museum of Comparative Zoology, Cambridge, Massachusetts.

Harvard University, Gray Herbarium, Cambridge, Massachusetts.
Havana University, Library, Havana, Cuba.
Hillsdale College, Library, Hillsdale, Michigan.
Hrvatsko Prirodosloyno Drustvo, Agram, Croatia, Austria-Hungary.
Hull Literary and Philosophical Society, Hull, England.
Idaho University, Library, Moscow, Idaho.
Illinois Geological Survey, Urbana, Illinois.
Illinois State Laboratory of Natural History, Urbana, Illinois.
Illinois State Museum of Natural History, Springfield, Illinois.
Illinois University, Library, University Station, Urbana, Illinois.
Imperial Charkovskii Universitet, Bibliothek, Charkow, Russia.
Imperial Varsavskij Universitet, Bibliothek, Warsaw, Russia.
Imperial Institute of the United Kingdom, London, England.
Imperial Iurjeyskij Universitet, Bibliothek, Dorpat, Russia.
Imperial Moskovskij Universitet, Moskow, Russia.
Imperial Moskofskoie Obshchestvo Iestestvo-Ispytatelei. Moskow, Russia.
Imperial Sankt-Petersburgskoie Mineralogicheskoie Obshchestvo, St. Petersburg, Russia.
Imperial University of Tokyo, Library, Tokyo, Japan.
Indiana Academy of Science, Indianapolis, Indiana.
Indiana Geological Survey, Indianapolis, Indiana.
Indiana University, Library, Bloomington, Indiana.
Inspectorate General of Customs, Statistical Department, Shanghai, China.
Institute de France, Paris, France.
Institute des Mines, St. Petersburg, Russia.
Institute Luxembourgeois, Section des Sciences Naturelles, Luxemburg, France.
Institute of Jamaica, Kingston, Jamaica.
Istituto Historico, Geographico y Ethynographico, Rio de Janeiro, Brazil.
Institution of Civil Engineers, Great George St., London, England.
Iowa Academy of Sciences, Des Moines, Iowa.
Iowa Geological Survey, Des Moines, Iowa.
Iowa University, Library, Iowa City, Iowa.
Iron Mountain Carnegie Library, Iron Mountain, Michigan.
Istituto Geografico Militare, Florence, Italy.
Istituto Scientifico della R. Universita, Rome, Italy.
Jackson Public Library, Jackson, Michigan.
Jagellonische Universitaet, Bibliothek, Karkau, Austria-Hungary.
Jardin Botanique de l'Etat, Bruxelles, Belgium.
Jenaische Zeitschrift fuer Medicin u. Naturwissenschaften, Jena, Germany.
John Crerar Library, Chicago, Illinois.
Johns Hopkins University, Baltimore, Maryland.
K. Bayerische Botanische Gesellschaft, Regensberg, Germany.
K. Boehmische Gesellschaft der Wissenschaft, Prag, Austria-Hungary.
K. K. Deutsche Karl-Ferdinand Universitaet, Bibliothek, Prag, Austria, Hungary.
K. K. Geographische Gesellschaft, Wien, Austria-Hungary.
K. K. Geologische Reichsanstalt, Wien, Austria-Hungaria.

K. Leopoldinisch-Caroloninische Deutsche Akademie der Naturforschen, Halle-an-der-Saale, Germany.
K. K. Leopold-Franzens Universitaet, Bibliothek, Innsbruck, Tyroll, Austria.
K. Magyar Természettudományi Társulat, Tarsulat, Austria-Hungary.
K. K. Universitaet, Bibliothek, Wien, Austria-Hungary.
K. K. Zoologische-Botanische Gesellschaft, Wien, Austria-Hungary.
K. Zoologische Genootschap "Natura Artis Magistra," Amsterdam, Netherlands.
Kais Universitaet Bibliothek, Kasan, Russia.
Kaiser-Wilhelms-Universitaet, Bibliothek, Strassburg, Germany.
Kaiserliche Universitaet, Bibliothek, St. Petersburg, Russia.
Kalamazoo College, Kalamazoo, Michigan.
Kansas Academy of Science, Topeka, Kansas.
Kansas State Historical Society and Department of Archives, Topeka, Kansas.
Kansas University, Lawrence, Kansas.
Kantonale Universitaet, Bibliothek, Bern, Switzerland.
Kentucky State College, Agricultural Experiment Station, Lexington, Ky.
Kjbenhavns Universitet, Bibliothek, Copenhagen, Denmark.
Kongl. Albertus Universitaet, Bibliothek, Koenigsberg, Prussia, Germany.
Kongl. Alexanders Universitetet I Finland, Bibliothek, Helsingfors, Finland.
Kongl. Bayerischen Ludwig-Max.-Universitaet, Munich, Germany.
Kongl. Christian-Albrechts Universitaet, Kiel, Germany.
Kongl. Eberhard-Karls-Universitaet, Bibliothek, Tuebingen, Germany.
Kongl. Fredericks Universitet, Bibliothek, Christiana, Norway.
Kongl. Friedrich-Alexanders Universitaet, Bibliothek, Erlangen, Bayern, Germany.
Kongl. Friedrich-Wilhelms Universitaet, Bibliothek, Berlin, Germany.
Kongl. Julius-Maximilians Universitaet, Bibliothek, Wurzburg, Germany.
Kongl. Karolinska Universitetet, Bibliotheket, Lund, Sweden.
Kongl. Ungarische Universitaet, Bibliothek, Budapest, Hungary.
Kongl. Universitaet, Bibliothek, Breslau, Germany.
Kongl. Universitaet, Bibliothek, Greifswald, Germany.
Kongl. Universitaet, Muenster in Westfalen, Preussen, Germany.
Kongl. Universitetet I Upsala, Bibliothek, Upsala, Sweden.
Kongl. Zoologisches Institut, Friedrich-Wilhelms Universitaet, Berlin, Germany.
Kongliga Svenska Vetenskap Akademien, Stockholm, Sweden.
Laudwirtschaftliche Versuchstation, Freudenthal, Selesia, Austria.
Laval University, Library, Quebec, Canada.
Leeds University, Library, Leeds, England.
Leland Stanford University, Library, Stanford University, California.
Linnean Scientific and Historical Society, Lancaster, Pennsylvania.
Linnean Society of London, Burlington House, W. London, England.
Linnean Society of New South Wales, Sydney, New South Wales.
Linnean Society of New York, New York City, New York.
Liverpool Geological Society, Liverpool, England.

Liverpool University, Library, Liverpool, England.
Lloyd Library, Cincinnati, Ohio.
London School Board, London, England.
McGill University, Library, Montreal, Canada.
Magyar Ornithologiai Koezpont, Budapest, Austria-Hungary.
K. Magyar Természettudományi Társulat, Budapest, Austria-Hungary.
Maine University, Library, Orono, Maine.
Manchester Geographical Society, Manchester, England.
Manchester Geological Society, Manchester, England.
Manchester University, Library, Manchester, England.
Manila University, Library, Manila, Philippine Islands.
Manitoba Historical and Scientific Society, Winnipeg, Manitoba, Canada.
Manitoba University, Library, Winnipeg, Manitoba, Canada.
Marine Biological Laboratory, Wood's Holl, Massachusetts.
Maryland Geological Survey, Baltimore, Maryland.
Massachusetts Board of Cattle Commissioners, Boston, Massachusetts.
Massachusetts Horticulture Society, Boston, Massachusetts.
Massachusetts Agricultural College, Amherst, Massachusetts.
Medicinische Naturwissenschaftliche Section des Siebenbuergischen Museum Verein, Klausenburg, Austria-Hungary.
Melbourne University, Library, Melbourne, Australia.
Michigan Agricultural College, Library, East Lansing, Michigan.
Michigan College of Mines, Library, Houghton, Michigan.
Michigan Geological and Biological Survey, Lansing, Michigan.
Michigan State Normal School, Library, Marquette, Michigan.
Michigan State Normal School, Library, Ypsilanti, Michigan.
Milwaukee Public Museum, Milwaukee, Wisconsin.
Minister of Public Instruction, Paris, France.
Minnesota Academy of Natural Science, Minneapolis, Minnesota.
Minnesota University, Library, Minneapolis, Minnesota.
Missouri Botanical Garden, St. Louis, Missouri.
Missouri Bureau of Geology and Mines, Rolla, Missouri.
Missouri University, Library, Columbia, Missouri.
Montana University, Library, Missoula, Montana.
Museo Civico di Storia Naturale; Trieste, Austria-Hungary.
Museo Nacional, Montevideo, Uruguay.
Museo Nacional de Buenos Aires, Buenos Aires, South America.
Museo Nacional de Historia Natural, Mexico City, Mexico.
Museu Paraense de Historia Natural, Para, Brazil.
Museu Paulista, San Paulo, Brazil.
Museum fuer Natur-u. Heimatkunde, Magdeburg, Germany.
Museum of Geology and Archaeology, Princeton, New Jersey.
Museum of Natural History, Springfield, Massachusetts.
National Academy of Sciences, Washington, D. C.
National University, Library, Athens, Greece.
Natural History and Philosophical Society, Belfast, Ireland.
Natural History Society, Exeter, New Hampshire.
Natural History Society, Montreal, Canada.
Natural History Society of Glasgow, Glasgow, Scotland.
Natural History Society of New Brunswick, St. Johns, New Brunswick.

Natural History. Society of Northumberland, Newcastle-upon-Tyne, England.

Le Naturaliste Canadien, Quebec, Canada.

Naturforschende Gesellschaft, Bamburg, Germany.

Naturforschende Gesellschaft, Basel, Switzerland.

Naturforschende Gesellschaft, Bern, Switzerland.

Naturforschende Gesellschaft, Gorlitz, Germany.

Naturforschende Gesellschaft, Leipzig, Germany.

Naturforschende Gesellschaft in Luzern, Switzerland.

Naturforschende Gesellschaft, Zuerich, Switzerland.

Naturforschender Verein, Bruenn, Austria-Hungary.

Naturhistorische Gesellschaft, Hanover, Prussia, Germany.

Naturhistorische Gosellschaft, Nurnburg, Bavaria, Germany.

Naturwissenschaftlicher Verein f. Schwaben U. Neuberg, Augsburg, Germany.

Naturwissenschaftliche Gesellschaft, Chemnitz, Saxony, Germany.

Naturwissenschaftliche Gesellschaft, St. Gall, Switzerland.

Naturwissenschaftlicher Verein, Bremen, Germany.

Naturwissenschaftlicher Verein, Frankfurt-an-der-Oder, Prussia, Germany.

Naturwissenschaftlicher Verein, Hamburg, Germany.

Naturwissenschaftlicher Verein, Karlsruhe, Germany.

Naturwissenschaftlicher Verein, Lueneburg, Prussia, Germany.

Naturwissenschaftlicher Verein, Magdeburg, Saxony, Germany.

Naturwissenschaftlicher Verein, Osnabrueck, Prussia, Germany.

Naturwissenschaftlicher Verein, Regensburg, Bavaria, Germany.

Naturwissenschaftlicher Verein fuer Saechsen u. Thueringen, Halle-an-der-Saale, Prussia, Germany.

Naturwissenschaftlicher Verein fuer Schleswig-Holstein, Kiel, Prussia, Germany.

Naturwissenschaftlicher Verein fuer Steiermark, Graz, Austria.

Nebraska University, Library, Lincoln, Nebraska.

Nederlandsche Entomologische Vereeniging, Leiden, Holland.

Nevada University, Library, Reno, Nevada.

New York Academy of Medicine, New York City, New York.

New York Botanical Gardens, Bronx Park, New York City, New York.

New York Public Library, New York City, New York.

New York State Library, Albany, New York.

New York State Museum of Natural History, Albany, New York.

Norges Geologiske Undersoegelse, Christiania, Norway.

Northampton Institute, St. Johns Street Road, London, England.

North Carolina Geological Survey, Raleigh, North Carolina.

North Carolina University Library, Chapel Hill, North Carolina.

North Dakota Experiment Station, Agricultural College, Fargo, North Dakota.

North Dakota University, Library, Grand Forks, North Dakota.

Northwestern University, Library, Evanston, Illinois.

Nova Scotian Institute of Science, Halifax, Nova Scotia, Canada.

Oahu College, Honolulu, Hawaii.

Oberhessiche Gesellschaft fuer Natur-u. Heilkunde, Giessen, Hesse, Germany.

Oberlin College, Library, Oberlin, Ohio.

Observatorio do Rio de Janeiro, Rio de Janeiro, Brazil.
Oesterreichischer Reichs-Forst Verein, Wien, Austria-Hungary.
Ohio Mechanics Institute, Cincinnati, Ohio.
Ohio State Academy of Science, Page Hall, Ohio State University, Columbus, Ohio.
Ohio State Archaeological and Historical Society, Columbus, Ohio.
Ohio State University, Library, Columbus, Ohio.
Ohio Wesleyan University, Library, Delaware, Ohio.
Oklahoma University, Library, Norman, Oklahoma.
Olivet College, Library, Olivet, Michigan.
Onondaga Academy of Science, Syracuse, New York.
Ontario Minister of Education, Ottawa, Canada.
Oregon University, Library, Eugene, Oregon.
Orto Botanico, Palermo, Italy.
Oschshestvo Iestestvo-Ispytalelei pri Imper. Kazanskom Universitetie, Kazan, Russia.
Oxford University Entomological Society, Oxford, England.
Peabody Academy of Science, Salem, Massachusetts.
Peabody Institute, Library, Baltimore, Maryland.
Peabody Museum of American Archaeology and Ethnology, Cambridge, Massachusetts.
Pennsylvania University, Library, Philadelphia, Pennsylvania.
Perthshire Society of Natural Science, Perth- Scotland.
Petermann, Dr. A., Geographischer Mitteilungen, Gotha, Germany.
Petoskey Public Library, Petoskey, Michigan.
Phillips Academy, Department of Archaeology, Andover, Massachusetts.
Philosophical Society of Glasgow, Glasgow, Scotland.
Popular Science Monthly, Sub-station 84, New York City, New York.
Portland Society of Natural History, Portland, Maine.
Princeton Academy of Science, Princeton, Illinois.
Princeton University, Library, Princeton, New Jersey.
Provinzial-Verein fuer Wissenschaft-u. Kunst, Muenster, Prussia, Germany.
Public Gardens and Plantations, Gordon Town, Jamaica.
Public Library, Bay City, Michigan.
Public Library, Traverse City, Michigan.
Public Library and Museum, Brighton, England.
Public School, Library, Adrian, Michigan.
Purdue University, Library, Lafayette, Indiana.
Queen's College, Library, Belfast, Ireland.
Queen's College, Library, Galway, Ireland.
Queen's University, Library, Kingston, Canada.
Real Academica de Ciencias Exactes, Fisicas y Natureals, Madrid, Spain.
Real Academia de Ciencias y Artes, Barcelona, Spain.
R. Accademia delle Scienze e Belle Lettere, Naples, Italy.
R. Accademia di Scienze, Lettere ed Art, Padua, Italy.
R. Accademia di Scienze, Lettere Belle-Arti, Palermo, Italy.
Regia Superiore d' Agricoltura Biblioteca, Portici, Italy.
Regia Università degli Studi, Biblioteca, Bologna, Italy.
Regia Università degli Studi, Genoa, Italy.

Regia Università degli Naples, Biblioteca, Naples, Italy.
Regia Università degli Studi, Biblioteca, Padau, Italy.
Regia Università degli Studi, Biblioteca, Palermo, Italy.
Regia Università degli Studi, Biblioteca, Parma, Italy.
Regia Università degli Studi, Biblioteca, Pavia, Italy.
Regia Università degli Studi, Biblioteca, Pisa, Italy.
Regia Università degli Studi, Biblioteca, Rome Italy.
Regia Università degli Studi, Biblioteca, Turin, Italy.
Regio Istituto Veneto di Scienze, Venice, Italy.
Rheinische Friedrich-Wilhelms Universitaet, Bibliothek, Bonn, Germany.
Ryks Herbarium, Leiden, Holland.
Rijksuniversiteit, Bibliothek, Groningen, Holland.
Rijks Universiteit, Bibliothek, Leiden, Holland.
Rijks Universiteit, Bibliothek, Utrecht, Holland.
Rivista Argentina, La Plata, South America.
Rivista Italiana di Scienze Naturali, Siena, Italy.
Rochester Academy of Science, Rochester, New York.
Royal Astronomical Society of Canada, Toronto, Canada.
Royal Botanic Garden, Edinburgh, Scotland.
Royal Botanic Garden, Kew, England.
Royal Botanic Garden, Sibpur, Near Calcutta, India.
Royal Botanic Society, Inner Circle, Regents Park, London, England.
Royal Dublin Society, Dublin, Ireland.
Royal Geographical Society, London, England.
Royal Geographical Society of Australasia, Adelaide, South Australia.
Royal Geological Society of Cornwall, Penzance, England.
Royal Irish Academy, Dublin, Ireland.
Royal Istituto Botanico, Palermo, Italy.
Royal London Ophthalmic Hospital, City Road, E. C. London, England.
Royal Medical and Chirurgical Society, London, England.
Royal Microscopical Society, Kings College, W. C. London, England.
Royal Society of Arts, John St., Adelphia, London, England.
Royal Society of Canada, Ottawa, Canada.
Royal Society of Edinburgh, Edinburgh, Scotland.
Royal Society of New South Wales, Sydney, New South Wales.
Royal Society of Queensland, Brisbane, Queensland, Australia.
Royal Society of Tasmania, Hobarton, Tasmania, Australia.
Royal Society of Victoria, Melbourne, New South Wales.
Saellskepet pro Fauna et Flora Fennica, Helsingfors, Finland.
Sage Library, Bay City, Michigan.
Saginaw East Side Public Library, Saginaw, Michigan.
St. Andrews University, Library, St. Andrews, Scotland.
St. Francis Xavier's College, Antigonish, Nova Scotia, Canada.
St. Louis Academy of Science, St. Louis, Missouri.
San Diego Society of Natural History, San Diego, California.
School of Mines, Ballerat, Victoria, Australia.
Schweizer Entomologischen Gesellschaft, Bern, Switzerland.
Schweizerischer Forst-Verein, Zurich, Switzerland.
Scottish Natural History Society, Edinburgh, Scotland.
Seattle Public Library, Seattle, Washington.

Sheffield University, Library, Sheffield, England.
Smith College, Library, Northampton, Massachusetts.
Smithsonian Institution, Washington, D. C.
Smithsonian Institution, Bureau of International Catalogue of Scientific Literature, Washington, D. C.
Sociedad Agricola Mexicana, Mexico City, Mexico.
Sociedad Cientifica "Antonio Alzate," Mexico City, Mexico.
Sociedad Cientifica Argentina, Buenos Aires, Argentine Republic.
Sociedad de Ciencias Fisicas y Naturales, Caracas, Venezuela.
Sociedade de Geographica, Rio de Janeiro, Brazil.
Sociedad Scientifica, San Paulo, Brazil.
Società Adriatica di Scienze Naturali, Trieste, Austria-Hungary.
Società Entomological Italiana, Florence, Italy.
Società Italiana delle Scienze, Rome, Italy.
Società Italiana di Scienze Naturali, Milan, Italy.
Società Toscana di Scienze Naturali, Pisa, Italy.
Societas Scientiarum Natüralium, Croatica, Austria.
Societas pro Fauna et Flora Fennieca, Helsingfors, Finland.
Société Belge d' Astronomie, Bruxelles, Belgium.
Société Belge de Géographie, Bruxelles, Belgium.
Société Belge de Geologie, Bruxelles, Belgium.
Société de Bilogique, Paris, France.
Société de Botanique du Grand-Duché de Luxembourg, Luxemburg, France.
Société de Geographie, Toulouse, France.
Société des Naturalistes de Bessarbie, Kishcinew, Russia.
Société des Sciences, Agriculture et Arts de la Basse-Alsace, Strassburg, Germany.
Société de Sciences de Nancy, Nancy, France.
Société des Sciences Historiques et Naturelles de la Corse, Bastia, France.
Société des Sciences Historiques et Naturelles de l'Yonne, Auxerre, France.
Société des Sciences Naturelles, Neuchatel, Switzerland.
Société des Sciences Naturelles, Versailles, France.
Société des Sciences Physiques et Naturelles, Zurich, Switzerland.
Société Entomologique de Belgique, Bruxelles, Belgium.
Société Entomologique de France, Paris, France.
Société Géologique de Belgique, Liege, Belgium.
Société Géologique de France, Paris, France.
Société d'Histoire Naturelle, Autun, France.
Société d'Horticulture et de Botanique, Havre, France.
Société d'Horticulture et de Botanique, Marseilles, France.
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Société Linnéenne de Lyon, Lyon, France.
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Société Linnéenne du Nord de la France, Amiens, France.
Société Nationale des Sciences Naturelles, Cherbourg, France.
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Société Royale des Sciences, Liege, Belgium.
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Société Scientifique de Bruxelles, Bruxelles, Belgium.

Société Scientifique de Chevtshénko, Lemberg, Austria-Hungary.
Société Zoologique de France, Paris, France.
Society for the Development of Experimental Science, Moscow, Russia.
South African Association for the Advancement of Science, Johannesburg, South Africa.
South African Journal of Science, Cape Town, South Africa.
South Dakota Geological Survey, Vermillion, South Dakota.
Stadtbibliothek, Bern, Switzerland.
State Board of Forestry, Indianapolis, Ind.
State Historical Society of South Dakota, Pierre, South Dakota.
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Trinity College, Library, Dublin, Ireland.
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Washington Academy of Sciences, Washington, D. C.
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Washington Anthropological Society, Washington, D. C.
Washington University, Library, Seattle, Washington.
Washington University, Library, St. Louis, Missouri.
Western Reserve University, Library, Cleveland, Ohio.
Western State Normal School, Library, Kalamazoo, Michigan.
Wisconsin Academy of Science, Madison, Wisconsin.
Worcester Natural History Society, Worcester, Massachusetts.
Yale University, Forestry School, New Haven, Connecticut.
Yale University, Library, New Haven, Connecticut.
Yale University, Observatory, New Haven, Connecticut.
Yorkshire Geological and Polytechnical Society, Halifax, England.
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Zoological Society, Fairmount Park, Philadelphia, Pennsylvania.
Zoologischer Anzeiger, Leipzig, Germany.
Zurich University, Library, Zurich, Switzerland.

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HORE.

Fig. 1. Ripple Marked Quartzite. Nipissing Mine.

Fig. 2. Nipissing Mine.

Fig. 3. Nipissing Mine.

Fig. 4.

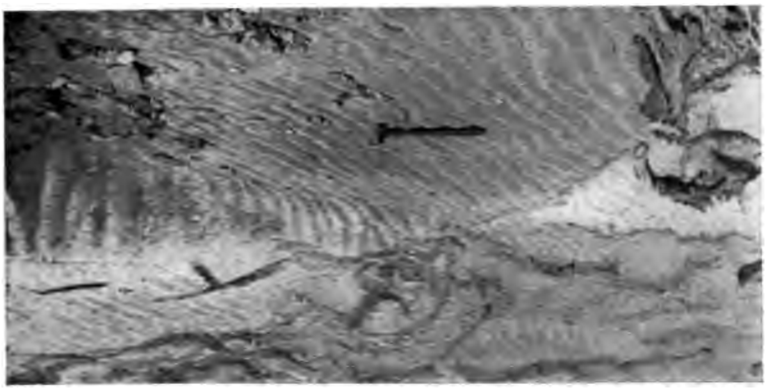

Fig. 5.

Fig. 6.

SMITH.

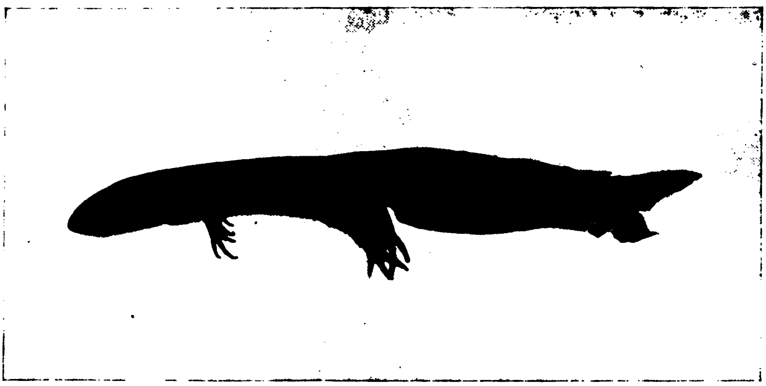

Fig. 1. Diemyctylus with bifurated tail. Life size.

LOEW.

Fig. 1. Stumps still standing in the pond. Some of the stumps and logs are covered with plants forming small islands.

Fig. 2. Shows the dense covering of the water by Potamogeton natans.

Fig. 3. Shows clumps of Sparganium and Scirpus with Potamogeton natans on the surface of the water, between.