[JOU]RNAL AND PROCEEDINGS

OF THE

HAMILTON ASSOCIATION

1882–1883.

EDITED BY THE HONORARY SECRETARIES.

VOLUME I. PART I.

Authors of Papers are alone responsible for the statements made and the opinions expressed therein.

PRINTED FOR THE HAMILTON ASSOCIATION
BY THE SPECTATOR PRINTING CO.

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HAMILTON ASSOCIATION.

OFFICERS FOR 1882-3.

PRESIDENT,

John D. Macdonald, M. D.

VICE-PRESIDENTS,

B. E. Charlton, H. B. Witton.

HONORARY SECRETARIES,

George Dickson, M.A., William Kennedy.

HONORARY TREASURER.

Richard Bull.

HONORARY CURATOR AND LIBRARIAN,

W. H. Ballard, M.A.

COUNCIL,

A. Alexander, A. Gaviller, A. F. Forbes, T. McIlwraith,
R. Hinchliffe.

MUSEUM AND LIBRARY,

James Street North, Hamilton,

NOTICE.

THE HAMILTON ASSOCIATION was instituted on 2nd November 1857, and continued its regular meetings to the close of the year 1860. During the period between 1861 and 1871 the meetings were held at irregular intervals, the office bearers of 1860 holding office in the meantime. During the years 1871, 2, 3, 4 and 5 the Association was more active in its work, regular meetings being held. An interregnum of four years ensued from 1875 to 1880, during which time the Council met at stated intervals. From 1880 to the present time the Association has been in active operation, during which period, in addition to the regular monthly meetings, special meetings have been held under the direction of the Council, the annual meeting held in May, 1884, being the one hundreth meeting of the Association.

The Association was incorporated in the year 1883.

OFFICE-BEARERS.

	President.	1st Vice-Pres.	2nd Vice-Pres.	Cor. Sec.	Rec. Sec.	Treas.	Libr. and Cur.
1857	Rev. W. Ormiston D. D.	John Rae, M. D.	J. B. Hurlburt, M.A., LL.D.	T. C. Keefer, C. E.	Dr. Craigie ..	W. H. Park..	A. Harvey
1858	John Rae, M. D.	Rev. W. Ormiston D. D.	J. B. Hurlburt, M.A., LL.D.	T. C. Keefer, C. E	Dr. Craigie ..	W. H. Park..	A. Harvey.
1859	Rev. W. Ormiston D. D.	J. B. Hurlburt, M.A., LL.D.	Chas. Robb....	T. C. Keefer, C. E.	Dr. Craigie ..	W. H. Park..	A. Harvey.
1860	Rev. W. Inglis, D. D.	T. McIlwraith..	Rev. W. Ormiston D. D.	Dr. Craigie..	Wm. Craigie..	W. H. Park..	Chas. Robb.
1861	Rev. W. Ormiston D. D.	J. B. Hurlburt, M.A., LL.D.	Rev. W. Inglis, D. D.	Dr. Craigie..	Wm. Craigie..	W. H. Park..	T. McIlwraith,
1871	W. Proudfoot ..	Judge Logie....	R. Bull........	J. M. Buchan, M. A.	I. B. McQuesten, M. A.	W. G. Crawford	T. McIlwraith,
1872	Judge Logie....	H. B. Witton, M. P.	R. Bull........	J. M. Buchan, M. A.	I. B. McQuesten, M. A.	W. G. Crawford	T. McIlwraith,
1873	H. B. Witton M. P.	J. M. Buchan, M. A.	A. T. Freed.. .	Geo. Dickson, M. A.	Geo. Dickson, M. A.	R. Bull......	T. McIlwraith,
1874	H. B. Witton, M. P	J. M. Buchan, M.A.	A. T. Freed...	Geo. Dickson, M.A.	Geo. Dickson, M. A.	R. Bull	T. McIlwraith,
1875	H. B. Witton...	J. M. Buchan, M. A.	W. H. Mills....	Geo. Dickson, M. A.	Geo. Dickson, M.A.	A. Macallum, M. A.	T. McIlwraith,
1880	T. McIlwraith...	Rev. W. P. Wright M. A.	H. B. Witton..	R. B. Hare, Ph. D.	Geo. Dickson, M. A.	R. Bull......	A. T. Freed.
1881	J. D. Macdonald, M. D.	R. B. Hare, Ph. D.	B. E. Charlton..	Geo. Dickson, M. A.	A. Robinson, M. A.	R. Bull......	W. H. Ballard, M. A.
1882	J. D. Macdonald, M. D.	B. E. Charlton.	J. A. Mullin, M. D.	Geo Dickson, M. A.	Wm. Kennedy	R. Bull......	W. H. Ballard, M. A.
1883	J. D. Macdonald, M. D.	B. E. Charlton.	H. B. Witton..	Geo. Dickson, M. A.	Wm. Kennedy	R. Bull......	W. H. Ballard, M. A.

MEMBERS OF COUNCIL.

1857—Judge Logie; Geo. Lowe Reid, C. E.; A. Braid; C. Freeland.

1858—Judge Logie: C. Freeland; Rev. D. Inglis, D.D.; Adam Brown; C. Robb.

1859—Rev. D. Inglis, D.D.; Adam Brown; Judge Logie; C. Freeland; R. Bull.

1860—J. B. Hurlburt, M.A., LL.D.; C. Freeland; Judge Logie; R. Bull; Wm. Boultbee; Dr. Laing.

1871—Geo. Lowe Reid, C.E.; Rev. W. P. Wright, M.A.; A. Macallum, M.A.; H. Strange, M.D.; Rev. A. B. Simpson.

1872—Judge Proudfoot; Rev. W. P. Wright, M.A.; John Seath, M. A.; H. D. Cameron; A. T. Freed.

1873—Judge Logie; T. McIlwraith; Rev. W. Wright, M. A.; A. Alexander; I. B. McQuesten, M.A.

1874—Judge Logie; T. McIlwraith; Rev. W. P. Wright, M.A.; A. Alexander; I. B. McQuesten, M.A.

1875—Judge Logie; T. McIlwraith; Rev. W. P. Wright, M.A.; A. Alexander; I. B. McQuesten, M.A.

1880—M. Leggat; I. B. McQuesten, M.A.: A. Alexander; Rev. A. Burns, D.D.

1881—T. McIlwraith; H. B. Witton; A. T. Freed; W. P. Wright, M.A.; A. F. Forbes.

1882—T. McIlwraith; H. B. Witton; A. T. Freed; A. F. Forbes; Rev. C. H. Mockridge, M.A., D.D.

1883—A. Alexander; A. Gaviller; A. F. Forbes; T. McIlwraith; R. Hinchliffe.

LIST OF MEMBERS

—OF THE—

Hamilton Association.

c, Members who have contributed Papers. The Numerals indicate the number of Contributions.

ELECTED.	
1872	Alexander, A., Accountant, P. O. Box 3, President of the Horticultural Society.
1880 c	Anderson, J. N., M. D. Burlington.
1882	Anderson, James, M. D., late Resident Physician, Hamilton Hospital.
1882	Armour, Robert, C. E., 79 Jackson St. West.
1882	Allan Richard.
1880	Balfour, James, Architect, Hannah St. W.
1880 c	Ballard, W. H., M. A., Mathematical Master, Collegiate Institute. 241 King St. West.
1880	Barr, John A., Druggist, cor. York and McNab Sts.
1881 c	Barton, G. M., Barrister, Dundas.
1880	Bickle, John W., Druggist, 36 Bold St.
1881	Boustead, W., Machinist, 95 Catharine St. North.
1881	Bowman, Wm., Wholesale Hardware Merchant, 56 Hunter St. West.
1883	Bingham, G. S., M. D., cor. Ferguson Avenue and King St. East.
1857	Brown, Adam, Wholesale Grocer, 13 Herkimer St. West.
1884	Brown, W. E., Cashier, Brown, Balfour & Co., 36 Jackson St. West.
1880	Black, George, Manager G. N. W. Telegraph Co.
1883	Buchanan, Harris, Barrister, 95 James St. South.
1857	Bull, Richard, Treasurer, 14 Hunter St. East.
1880	Burns, Rev. A., M. A., LL. D., D. D., President Hamilton Female College.

1880 Briggs, S., Superintendent Hart Emery Wheel Co., 10 Catherina St.
1880 Cameron, H. D., Treasurer Hamilton Provident and Loan Society.
1880 Campbell, P. S., M. A., Classical Master, Collegiate Institute. 40 Emerald St.
1880 Cummings, Jas., Ex-Mayor, Ex-Chairman, Board of Education, City Hall.
1880 Chittenden, C. S., D. D. S., 69 Bay St. South.
1881 Currell, J. G., Barrister, 140 Cannon St. East.
1881 Clappison, Thomas, Bookseller, 69 Herkimer St.
1880 C 2 Charlton, B. E., and Ex-Mayor, President Hamilton Vinegar works Co., 58 John N.
1880 Clark, J. C., Evening Times.
1883 Curran, Rev. Canon, W.B., M.A., St. Thomas Church.
1884 Carson, Rev., W. W., Centenary Church.
1884 Childs, W. A., 36 Bay St. South.
1880 Clark, J. A., Druggist, 46 Victoria Avenue South.
1881 C 1 Carmichael, Rev. Canon J., M. A., Montreal.
1872 C 1 Dickson, Geo., M. A., Principal of Collegiate Institute, Corresponding Secretary, 33 Bold St.
1880 Duggan, R. J., Solicitor, Wentworth St.
1881 DesBrissay, Rev. L., M. A., Rector All Saints Church, 126 Market St.
1880 Dillabough, E. H., M. D., 18 Gore St.
1880 Dingwall, Kenneth, B. A., LL. B., Barrister, 42 James St. North.
1882 Dalley, F. F., Druggist, 99 James Street North.
1881 Evans, J. DeVille, 121 Bay St. North.
1882 Edwards, W. A., Architect, 142 Hunter St. East.
1870 C 2 Freed, A. T., Editor Spectator, 14 Hannah St. West.
1880 Forbes, A. F., Stock Brocker, 2 Merrick St.
1880 Fletcher, Rev. D. H., 58 McNab St. South.
1880 Foster, W. C., Artist, 42 Hunter St. West.
1880 Foster, Charles, Food Inspector, 44 George St.
1881 Fearman, F. W., Chairman Board of Education, 58 Stinson Street.
1880 Fairgrieve, Hugh, Consulting Engineer, 40 Market St.

1880 Gaent, S. H., Clerk of the County Court and Deputy Clerk of the Crown, Court House.
1882 c Field, G. W., M.A., Barrister, Elora.
1880 Findlay, W. F., Accountant, 132 John St. South.
1882 Ferris, James, Hardware, 78 James St. South
1880 Gaviller, Alex., 21 Herkimer St.
1882 Gaviller, E. A., M.D., 8 Park St. South.
1883 Grossman, Julius, Music, 22 West Avenue South,
1883 Gibson, J. M., M. A., LL. B., M. P. P., Lt. Col., Barrister, 102 Main St. West.
1880 c 2 Hinchliffe, R., Electric Engineer, 302 York St.
1880 c Hare, R. B., B. A., Ph. D., Professor of Chemistry, Ontario Agricultural College, Guelph.
1880 Husband, G. E., M. D. 75 Main St. West.
1881 Howles, M., Hardware, 119 King St. West.
1881 Hynds, R. W., 115 King St. East.
1882 Harrison, C. W., M. A., W. F. College.
1882 Hoodless, John, Furniture Manufacturer, 51 King St. West.
1882 Hemming, G. E., Barton, City P. O.
1882 Harris, W. J., 14 Market Sq.
1882 Hobson, R., C. E., Chief Engineer G. T. Ry., Bay St. South,
1883 Hillyer, E. S., M. D., 9 Main St. East.
1884 Harvey, W. C., Wholesale Boots and Shoes, 3 Main St. West.
1880 Johnston, G. W., Head Master Model School, John St. South.
1882 Jelfs, G. F , Barrister, Hannah St. West.
1882 Jones, F. W., LL. B., Barrister, Hughson St. South.
1882 c 2 Kennedy, Wm., Bank B. N. A., Secretary of Ham. Ass'n.
1882 King, F. W., 91 Elgin St.
1880 Lemon, Charles, Barrister, 5 Catharina St.
1880 Leitch, John, Central Iron Works.
1880 c 2 Lyle, Rev. S., 20 Jackson St. West.
1880 Littler, John.
1880 Littlehales, Thos., Manager and Engineer, Hamilton Gas Light Co.
1880 Leslie, Jas., M. D., 37 Main St. West.
1857 Leggat, M., Wholesale Hardware, 5 Duke St.

1881 Lawson, A., Printer, 62 McNab St. South.
1882 Laidlaw, Rev. R. J., 85 Hughson St. South.
1880 Leitch, Andrew, Central Iron Works.
1884 Lavery, W. J., Solicitor, 4 Main St. West.
1880 Muir, John, M. A., Barrister, 37 Duke St.
1880 Moffat, J. Alston, Member of the Council of the Entomological Society of Canada.
1880 Moodie, John, 16 King St. West.
1881 c 2 Mockridge, Rev. C. H., M. A., D. D., Rector Christ Church.
1857 Malloch, A. E., M. D., 70 James St. East, Examiner in Surgery Toronto University.
1882 Munro, A., Com. Traveller, City.
1870 Mullen, J. A., M. D., Ex-President of the Dominion Medical and Surgical Society, 124 James St. North.
1870 Milne, Wm., Wine Merchant, Wentworth St.
1882 Morris, H. H., Canadian Bank of Commerce.
1883 Murton, J. W., Coal Merchant, East Hamilton.
1884 Mason, J. J., Mayor of Hamilton, 63 Hunter St. West.
1884 Murton, E. C., East Hamilton.
1837 McIlwraith, Thomas, Superintendent for Ontario of the Ornothological Society of N. America, Cairn Brae, City.
1880 McLean, W., Editor, Cornwall.
1880 McPhie, Donald, Sanitary Engineer, 57 East Ave., South.
1870 McQuesten, I. B., M.A., Barrister, 4 Bold St.
1880 Macdonald, John, D. M. D., President, Ex-President Ontario Medical Association, 10 Duke St.
1882 McKenzie, A., 61 George Street.
1880 McCulloch, D., Collector H. M. Customs.
1884 McCrae, Collin, 30 King St. West.
1880 Neil, A. T., Secretary, Geological Section, HAMILTON ASSOCIATION, Canada Life Chambers, City.
1882 Postell, N., Hess St. North, City.
1882 Powis, Alfred, Commission Merchant, Concession St.
1883 Pearson, John, Accountant, 213 James St. North.
1883 Philip, Wm., M. D. 56 Hess St
1880 Robinson, Alex., M. D., Fisherville.

1880 Robertson, C., M.A., Modern Language Master, Collegiate Institute, 40 Emerald St. North.

1881 Ross, A. M., Painter, 68 Colborne St.

1881 c Reynolds, T. W., M. D., 122½ James St. North.

1882 Roberts, E. Reas, 78 Market St.

1880 c Ryall, I., M. D., Physician Board of Health, 71 Main St. East.

1872 Roseburgh, J. W., M. D., 52 James St. South.

1882 Robinson, W. A., Iron Founder, Hamilton.

1883 Robertson, H. H., Barrister, Rannoch Lodge.

1880 Sutherland, Angus, Grocer, 56 King St. West.

1880 Scriven, P. L., Engraver, 111 Jackson St. West.

1882 Stewart, Rev. J. W. A., M. A., 107 Main St. West.

1882 Sinclair, J. S., Judge Division Court, 23 Herkimer St,

1882 Smith, Wm., 74 Catharine St. North

1872 Smith, J. H., Inspector of Schools, Ancaster.

1883 Stiff, James, 155 Park St. North.

1883 Slater, S., Treasurer Landed Banking and Loan Co.

1883 Sutherland, W. M., M. A., Collegiate Institute.

1880 Treble, S. G., King St. East.

1880 Thomson, John, Cannon St.

1880 Turnbull, W., City Assessor, 10 Wilson St.

1880 Teiper, Casper, C. E., 15 Colborne St.

1881 Thompson, Charles, 155 Main St. West.

1881 Tuckett, Geo. E. Alderman, King St. West.

1881 Townsend, S. B., Accountant, 80 King St. East.

1881 Tuckett, Geo. T., 35 Bay St. South.

Vernon, Elias, M. D., James Street South.

1872 Woolverton, A., M. A., M. D., 153 James St. North.

1857 c 2 Witton, H. B., H. M. Inspector of Canals, 12 Murray St. West.

1880 Watson, James, Sandyford place, Duke St.

1881 Williams, J. M., jr., 59 Hughson St. N.

1881 Wallace, J. M., M. D., Medical Superintendent, Assylum for the Insane.

1884 Young, Wm., 45 Jackson St. West.

CORRESPONDING MEMBERS.

1881 Clark, Chas. K., M. D., Rockwood Asylum, Kingston.

1881 c 1 Van Wagner, P. S., J. P., Stoney Creek.

1882 c 2 Buchan, J. M., M.A., Principal Upper Canada College, Toronto.

1882 Lawson, A., M.A., Geological Survey of Canada.

1881 c Spencer, J. W., Ba. Sc., Ph. D., F. G. S., Columbia, Mo., U. S.

1870 c 2 Wright, Pro. W. P., M. A., California.

1871 c 1 Seath, John, M. A., High School Inspector, St. Catharines.

HONORARY MEMBERS.

1881 Grant, Lt.-Col., John St. South.

1882 Macoun, John, M. A., Government Botanist and Naturalist, Geological Survey of Dominion of Canada.

CONSTITUTION AND BY-LAWS

NAME AND OBJECTS.

1. The main objects of the HAMILTON ASSOCIATION shall be the formation of a Library, Museum, and Art Gallery, the cultivation of Literature, Science and Art, and the illustration of Natural History and the Physical Characteristics of the country.

MEMBERS.

2. Honorary members must be men eminent for their literary and scientific attainments, and their election may be made at any regular meeting, their names being announced at a previous monthly meeting. They shall be exempt from payment of fees; they may attend the meetings of the society, and they shall be furnished with copies of transactions and proceedings when published, but shall not hold office.

3. Ordinary members are those who pay an annual contribution of two dollars; a payment of twenty dollars shall constitute an ordinary member for life.

4. Corresponding members are those who reside at a distance from the city, who are distinguished for Literary or Scientific attainments or who contribute to the objects of the Association. They shall have all the privileges of ordinary members, with the exception of being eligible for office.

5. Proposals for the admission of members may be made at any regular meeting, and decided by ballot at the next regular meeting.

6. A majority of votes cast shall determine every question.

7. Dissentients on any other point than the election of members, may have their reasons of dissent, if put in writing at the time, entered on the minutes—if given in afterwards, such reasons shall be read after the minutes, at the next meeting, and kept *in retentis*.

OFFICE-BEARERS.

8. The Officers shall be a President, two Vice-Presidents, a Corresponding Secretary, Recording Secretary, Treasurer, Librarian and

Curator of the Museum—all of whom, together with a Committee of five, shall form the Council.

9. They shall be elected at the Annual General Meeting on the second Thursday in May, and continue in office for one year, or until their successors are appointed. They may be re-elected to the same, or any other office.

10. The President, or Chairman of the meeting, shall have a casting vote, in addition to the ordinary vote.

MODE OF ELECTION.

11. The Office bearers and Committee shall be elected in the following manner, after *viva voce* nomination :—Each member shall write the name of the person he selects for the office, and put the paper, without signature, in the ballot box. The Secretaries, or two Scrutineers, specially appointed, shall report the number of votes for each nominee, and the person having the majority of votes shall be elected. In case there are more than two nominees for one office, and no one has a majority of the total number of votes, the one having the smallest number of votes shall be struck off the list, and a fresh ballot taken.

MEETINGS.

12. The Association shall meet on the second Thursday of every month, from November to May inclusive, at eight o'clock p. m., unless otherwise ordered by the Council—five members to constitute a quorum.

13. Special meetings may be held at any time, on the call of the President, in his own right, or on the requisition of three members—but no business shall be transacted except that for which the meeting is called.

SECTIONS.

14. To allow those members of the society, who devote attention to particular branches of science, fuller opportunities and facilities of meeting and working together with fewer formal restrictions than are necessary at the general monthly meetings of the society, Sections or Committees may be established in the following branches of science :—

Section A.—Mathematics, Mechanics, Physics, Meteorology and Astronomy.

SECTION B —Chemistry and Mineralogy, and their application to the Arts, Agriculture and Horticulture.

SECTION C.—Geology and Palæontology.

SECTION D.—Biology, *i. e.* Botany, Zoology and Entomology.

SECTION E.—Medical and Sanitary Science.

SECTION F.—Geography, Ethnology and Archæology.

SECTION G.—Literature and the Fine Arts.

There shall be for each section a Chairman to preside at the meeting, and a Secretary who shall prepare for the Secretary of the Association for the last meeting in May in each year, a report of the proceedings of the section during the year.

Meetings of sections may be called at any time by the Chairman.

No person who is not a member of the society shall have the privilege of joining any of the sections.

CONSTITUTION AND BY-LAWS.

15. No alteration or addition to the Constitution and By-Laws of this Association shall be made unless carried by a two-thirds vote at two successive ordinary meetings.

16. No alteration in the Constitution can be considered, except on the written motion of three members.

17. Should the Association at any time become inactive, the Library and Museum shall be preserved entire and deposited with some scientific or Educational Institution in the city.

PAYMENTS.

18. Members shall pay their entrance dues of two dollars, within one month after being notified of their election, and subscribe their assent to the Constitution and By-Laws. The annual dues shall be payable at the first meeting in November.

19. No ordinary member, in arrears for one year, shall be entitled to vote, or be eligible for office, and if after two years, his annual dues, remain unpaid, he shall, *ipso facto*, cease to be a member.

20 Corresponding members pay no dues—they may become ordinary members without a new election, by the payment of annual dues.

OFFICE-BEARERS.

PRESIDENT.

21. The President, when in the Chair shall inform the Association of the proceedings of the Council since last report, receive and

read motions and cause the sense of the meeting to be taken on them, preserve order, and direct the proceedings of the meeting in the regular course. An appeal may be made from any of his decisions to the meeting.

22. A Vice-President in the absence of the President, shall preside, perform his duties and have his privileges.

23. In the absence of the President and both Vice-Presidents a Chairman for the meeting shall be chosen by those present.

SECRETARIES.

24. The Corresponding Secretary shall conduct all the general correspondence, preserve letters received, and copies of letters written by him, announce the receipt of all letters and papers, and read such as the Council or Association may require.

25. The Recording Secretary shall take minutes of the proceedings at the meetings of the Association and Council, which, when read at the next meeting, and approved, shall be entered in separate minute books. He shall issue notices of the meetings of the Association and Council; in the former case, two days, in the latter, one day, before the meeting. He shall notify members of their election, see that they subscribe the Constitution, and, with the other Secretary, conduct the ballot when required.

TREASURER.

26. The Treasurer shall have charge of the funds, under the direction of the Council. He shall collect annual dues and fines, pay accounts approved of by the Council, make correct entries of income and expenditure, and submit a statement thereof to the Annual Meeting.

AUDITORS.

27. Two Auditors shall be appointed at the meeting, on the second Thursday in April, to examine the Treasurer's books, and and vouchers, and report to the Annual Meeting.

LIBRARIAN.

28. The Librarian shall have charge of the Library, under the direction of the Council, and be accountable for the books. He shall make a catalogue of the books, distinguishing those for circula-from books of reference.

29. Any member wishing to take out a book, must apply to the Librarian, at the times fixed by the Council, and the Librarian

shall enter, in a book kept for that purpose, the name of the borrower, the title of the book, and the dates of its being given out and returned. Any book (except periodical works) may be kept two weeks, and if not then returned, the member retaining the book shall be subject to a fine of 25 cts. for every succeeding week. Periodical works which have not been three months in the Library, can be retained only seven days, but those that have been in the Library for a longer time, shall be subject to the same rules as other books.

30. Books returned at the appointed time, may, if not wanted by another member, be re-issued to the same person for another fortnight.

31. No book shall be purchased for the Library, unless it treats of some subject connected with the objects of the Association ; but donations of books on any subject may be received.

32. Members shall have access to the Library to consult books of reference, at such reasonable times as may be specified by the Council.

CURATOR OF MUSEUM.

33. The Curator shall have charge of the Museum, subject to the orders of the Council. The Museum shall contain seven departments, corresponding to the seven sections of the Association, for each of which a separate catalogue shall be made of the specimens with their numbers. No specimens shall be taken out without the consent of the Council.

34. Duplicate specimens may be exchanged by order of the Council for an equivalent.

35. Donations to the Museum shall be entered on the catalogue of the department to which they belong, with the name of the donor.

36. Every member shall have access to the Museum, at the times specified by the Council, and any member may introduce visitors.

37. No case shall be opened without the sanction and presence of the Curator.

38. Special donations to the Library or Museum may be accepted on special conditions.

THE COUNCIL.

39 The Council shall have the management of the funds and

property of the Association, and of the Library and Museum, and shall submit a monthly report of current expenses, beyond which no money will be expended without first being sanctioned by a general meeting. They may choose their own chairman and three members shall constitute a quorum for the transaction of business. They shall keep minutes of their proceedings, and report to the Association.

40. The Chairman, in his own right, or at the request of any two members, may call a meeting.

41 The Council shall arrange the order in which papers, or other subjects for consideration, may be brought before the meetings of the Association, and may receive papers from strangers.

42. Any paper read before the Association and deemed worthy of preservation or publication shall become the property of the Association.

43. The Council shall prepare an annual report.

MEETINGS.

At the ordinary meetings the President shall take the chair at the appointed hour, or as soon thereafter as five members are present, and the following order of business shall be observed :

1. Reading, amending if necessary, and sanctioning the minutes of last meeting.

2. Transactions of any business arising out of the minutes, or lying over from the last meeting.

3. Announcement by the Corresponding Secretary of letters, papers, or other documents received since last meeting—and reading such of them as may be desired.

4. Report by the Curator and Librarian of donations to the Library or Museum.

5. Giving notice of motions and general business.

6. Balloting for admission of new members.

7. Proposals of members.

8. Introduction of visitors (by any member.)

9. Reading and remarks on essays and papers.

10. Announcing, as far as practicable, the business of next meeting.

Form No 1.)

APPLICATION FOR MEMBERSHIP.

Hamilton, ...188

To the Secretary of "The Hamilton Association:"

Sir,—Being desirous of becoming a member of the above named Association, I would be obliged if you would submit my name for acceptance, as such, promising to observe its rules and promote its interests.

Recommended by	......................Name.
....	.................Designation.
....	.................Residence·

APPLICATION

OF

....

ELECTED

.................................188

(Form No. 2.)

Hamilton,...........188

Dear Sir,—

I have the honor to inform you that you have this day been elected a member of the Hamilton Association, and I beg to forward to you a copy of the Constitution and By-Laws.

According to the Regulations of the Association you are required to pay your Admission Fee of $...............within one month after receipt of this notice.

I have, Etc.,

....

Secretary.

ACT OF INCORPORATION.

To all whom it may concern :

The undersigned, John D. Macdonald of the City of Hamilton, in the County of Wentworth, Doctor of Medicine, President; Benjamin Ernest Charlton of the City of Hamilton, Manufacturer, First Vice-President; John Alexander Mullin of the City of Hamilton, Doctor of Medicine, Second Vice President; George Dickson, M. A., of the City of Hamilton, Principal Collegiate Institute, Corresponding Secretary; William Kennedy of the said City of Hamilton, Bank Clerk, Recording Secretary; Richard Bull of the said City of Hamilton, Insurance Agent, Treasurer; William H. Ballard, M. A., of the said City of Hamilton, Curator and Librarian and Thomas McIlwraith of the said City of Hamilton, Forwarder; Anthony F. Forbes of the said City of Hamilton, Broker; A. T. Freed of the said City of Hamilton, Editor; Henry B. Witton, of the the said City of Hamilton, Canal Inspector; and Charles H. Mockridge of the said City of Hamilton, Doctor of Divinity; Members of the Council of the Association hereinafter referred to

DO HEREBY DECLARE

1st. That an Association known as "The Hamilton Association" was duly established on or about and has been continuously in existence since the second day of November, A. D. one thousand eight hundred and fifty-seven, and that such Association doth still exist.

2nd. That the several persons whose names and descriptions are hereinbefore set forth are the Trustees and Office-Bearers for the time being of said Association, and they do hereby declare that it is the desire of such association to become incorporated according to the provisions of the Revised Statutes of Ontario, "Chapter one hundred and sixty-seven," entitled "An Act respecting Benevolent, Provident and other Societies.

3rd. That the intended corporate name of the said Association, is "The Hamilton Association."

4th. That the purposes or objects of the said Association, are the formation of a Library, Museum, and Art Gallery, the cultivation of Literature, Science and Art, and the illustration of the Natural History and Physical Characteristics of the Country.

Annexed is a copy of the Constitution and By-Laws of the said Association.

IN TESTIMONY WHEREOF we have hereunto subscribed our names this twenty-ninth day of December one thousand eight hundred and eighty-two.

Signed in the presence of

[SIGNED,]
KING BARTON.

J. D. Macdonald, *President.*
B. E. Charlton, *1st Vice-President.*
John A. Mullen, *2nd Vice-President.*
Geo. Dickson, *Corresponding Secretary.*
Wm. Kennedy, *Secretary.*
Richard Bull, *Treasurer.*
W. H. Ballard, *Librarian and Curator.*
T. McIlwraith,
H. B. Witton,
A. F. Forbes,
A. T. Freed,
Chas. H. Mockridge,
Members of Council.

PROVINCE OF ONTARIO,
COUNTY OF WENTWORTH,
TO WIT :

I, the undersigned, Local Judge of the High Court of Justice, of Ontario, and Judge of the County Court, in and for the said County of Wentworth, certify that the within Declaration of the Hamilton Association within named, together with the hereunto annexed copy of the Constitution and By-Laws of the same, have been produced to me, and the same appear to me to be in conformity with section 5, and other provisions of Chapter 167 of the Revised Statutes of Ontario, entitled, "An Act respecting Benevolent Provident, and other Societies." Dated at my Chambers in the City of Hamilton, this 20th day of January, A.D., 1883.

(Signed) J. S. SINCLAIR,
L. J. High Court and County Court.

PROVINCE OF ONTARIO,
COUNTY OF WENTWORTH,
TO WIT:

I, John Crerer, of the said City of Hamilton, in the said County of Wentworth, Esquire, Clerk of the Peace in and for the said County, certify that the within is a true copy of an original Declaration of the Office-Bearers and Trustees of the Hamilton Association within named, which was together with a copy of the Constitution and By-Laws of the said Hamilton Association, duly filed with me as such Clerk of the Peace, at my office at Hamilton, aforesaid, on this 22nd day of January, A. D. 1883.

(Signed,) JOHN CRERAR,
Clerk of the Peace.

Per P. D. CRERAR,
Deputy.

PROCEEDINGS

OF THE

HAMILTON ASSOCIATION

SEASON 1883-1884.

FIRST MEETING

Twenty-sixth year, Thursday, Nov. 15th, 1883.

The President in the chair.

Minutes of last meeting read and approved of.

New members elected: J. W. Murton, S. Slater, W. M. Sutherland, M. A. Proposed for election: Wm. Philp, M. D.

The Annual Report of the Council, and subsidiary reports of the Treasurer, Librarian and Curator, and the Report of the Geological Section were read and approved of. The question of increasing the annual subscription, as recommended by the Council, was held over.

ANNUAL REPORT.

The Session opened Nov. 16th, with the following officers: J. D. Macdonald, M.D., President; B. E. Charlton, First Vice-President; J. Mullen, M.D., Second Vice-President; Geo. Dickson, M.A., Corresponding Secretary; Wm. Kennedy, Recording Secretary; R. Bull, Treasurer; W. H. Ballard, M.A., Librarian and Curator. These were assisted by a council of five members of the Association, namely: T. McIlwraith, H. B. Witton, A. F. Forbes, A. T. Freed, and Rev. C. H. Mockridge, D.D.

At the beginning of the Session there was a membership of 147. During the Session there were ballotted for and admitted as ordinary members, 18; as corresponding member, 1. There were struck off the roll of members, 23, leaving a membership of 143.

The Association had ten meetings during the Session, at which the following papers were read, namely: 1882, Nov. 16th, the President, Dr. Macdonald, Inaugural Address; 1882, Dec. 14th, J. Alston Moffat, Unity and Harmony of Nature; 1883, Jan. 11th, W. H. Ballard, M.A., Units; 1883, Feb. 8th, I. Ryall, M.D., Our Sanitary State; 1883, March 8th, R. Hinchcliffe, Dynamo Electric Machines; 1883, March 13th, C. W. Covernton, M.D., Sanitary Science in Ancient and Modern Times; 1883, March 27th, W. Oldwright, M.D., Healthy Homes, Ventilation and Drainage; 1883, April 10th, P. H. Bryce, M.A., M.D., Contagious Diseases and Some Methods for, and Results of Isolation; 1883, May 10th, H. P. Yeomans, B.A., M.D., The Blood in its Relation to Health and Disease. The last four lecturers are members of the Ontario Provincial Board for sanitary purposes, and these lectures were delivered before the public in the Macnab Street Presbyterian Church School. These papers are in course of preparation for publication, if the funds of the Association permit.

Regarding the financial condition of the Association, it will be seen from the Treasurer's last audited report, that there was a balance of $10.73 in the bank on May 1st, 1883.

From the report of the Librarian and Curator, the Association has stored in the Collegiate Institute 452 volumes, consisting chiefly of Government reports and scientific works.

The geological section of the Association held, during the year, frequent meetings in the Collegiate Institute, for the purpose of arranging, classifying and naming the various geological specimens. From their report the Association will see that the museum contains over 1,200 specimens.

The last meeting of the Association was held on May 17th, at at which the following officers and council were elected, namely:

J. D. Macdonald, President, re-elected.

B. E. Charlton, First Vice-President, re-elected.

H. B. Witton, Second Vice-President.

George Dickson, Corresponding Secretary, re-elected.

W. Kennedy, Recording Secretary, re-elected.

R. Bull, Treasurer, re-elected.

W. H. Ballard, Librarian and Curator, re-elected.

Council for 1883-84—Messrs. Alexander, Gaviller, Forbes, re-elected, McIlwraith, re-elected, Hinchliffe.

Auditors—W. H. Ballard and A. T. Neill.

During the year an effort was made to obtain a grant from the Ontario Government similar to that given to other societies of the same class throughout the Province, but we regret to say that so far this Association was not successful.

The Association was incorporated on the 20th day of January, 1883.

The council strongly recommend the increasing of the annual subscription. They also recommend that in future no name be submitted to the Association for election unless the application be laid before the Association signed by the party applying for membership, and by at least one member.

The Treasurer's report showed the receipts of the year to be $151.22, and the expenditure $140.49, leaving a balance of $10.73.

A committee consisting of Messrs. Mockridge, Briggs and Bull was appointed to obtain suitable accommodation for the Museum and Library.

The President, J. D. Macdonald, M. D., then read his inaugural address.

SECOND MEETING.

Twenty-Seventh year, 13th December, 1883.

The First Vice-President, B. E. Charlton, Esq., in the chair.

Minutes of last meeting read and approved of.

New members elected: Wm. Philp, M. D. Proposed for election: J. M. Gibson, M. A., LL. B., M. P. P.; Harris Buchanan, Barrister at Law; Rev. W. B. Curran, M. A.

Donations to Museum and Library; Photographs of Documents connected with the payment of the Alabama Claims, from Harris Buchanan; Great Trigonometrical Survey of India, Volumes VII, VIII and IX, from Secretary of State for India.

On the motion of Mr. A. T. Freed, seconded by Mr. G. M. Barton, a committee of members of the Association was formed to inquire into the practicability of establishing a Public Library in

Hamilton, and to report thereon at a subsequent meeting of the Association.

The Rev. C. H. Mockridge, D. D., then read a paper on the English Language.

THIRD MEETING.

Twenty-Sixth year, 10th January, 1884.

The President in the Chair.

Minutes of last meeting read and approved of.

New members elected : J. M. Gibson, M. A., LL. B., M. P. P., Harris Buchanan, Barrister at Law, Rev. W. B. Curran, M. A. Proposed for election : J. J. Mason, Mayor of Hamilton, Wm. Young, W. J. Lavery, Colin McRae.

The Committee appointed at last meeting to inquire into the practicability of establishing a Public Library in Hamilton, reported, through the President, that the Committee had met and decided not to move in the matter for the present.

The Committee appointed to look for suitable accommodation for the Museum and Library, reported that the members had looked at various rooms but were not at present in a position to recommend any.

The Committee appointed to revise the By-Laws and Constitution reported that it had met and agreed upon some slight alterations, but that the Committee was not yet in a position to present the Revised Constitution to the Association.

In accordance with a letter from J. M. Gibson, Esq., M. P. P. for Hamilton, a Committee consisting of the President, First Vice-President and Corresponding Secretary was appointed to accompany Mr. Gibson to Toronto to meet the Honorable, the Minister of Education, with the view of obtaining an annual grant to the Association from the Provincial Government.

Mr. G. W. Fields, M. A., then read a paper on the Honorable T. Darcy McGee.

FOURTH MEETING.

Twenty-Sixth year, 14th January, 1884.

In the absence of the President and Vice-Presidents, Mr. T. McIlwraith occupied the chair.

Minutes of last meeting read and approved of.

New members elected: J. J. Mason, Wm. Young, W. J. Lavery, Colin McRae. Proposed for election: E. S. Hillyer, M. D., H. H. Robertson.

Donations to the Museum and Library: By the Right Honorable the Secretary of State for India, Ferguson and Burgess' "Cave Temples of India," Cunningham's "Stupa of Bharhut," Cole's "Agra and Muttra," Illustrations, "Palaeontologia Indica;" a piece of petrified wood found in a consignment of coal from Ohio by W. A. Robinson; from Messrs. Spon of London, "Saturated Steam the Motive Power of Volcanoes," by Peacock, with the author's compliments.

T. W. Reynolds, M. D., then read a paper on "Food and Feeding."

FIFTH MEETING.

Twenty-Sixth year, 13th March, 1884.

The President in the Chair.

The minutes of last meeting read and approved of.

New members elected: E. S. Hillyer, M. D., H. H. Robertson. Proposed for election: W. E. Brown, Rev. W. W. Carson, W. A. Childs, Edward C. Murton.

The Secretary read a letter from Mr. Gibson announcing that the Association would receive a grant from the Provincial Government, and also a letter from Mr. Fletcher, of the Dominion Parliamentary Library, to Mr. Freed, acknowledging with thanks, the receipt of copies of the Association's papers sent to the Parliamentary Library.

Mr. William Kennedy, then read a paper on "Some Evidences of Commercial Transactions in Pre-Historic Times."

SIXTH MEETING.

Twenty-Sixth year, 3rd April, 1884.

The President in the chair.

Minutes of last meeting read and approved of.

New members elected: Rev. W. W. Carson, W. E. Brown, W. A. Childs, Edward C. Murton. Proposed for election, W. C. Harvey.

The Committee appointed to find suitable accommodation for the Museum and Library of the Association, reported that they had to recommend the Association to lease the Hall in the Alexandra Arcade, at an anuual rent of two hundred dollars, the proprietor paying all cost of heating and cleaning, and also all taxes, according to the terms of Mr. McQuesten's letter to the Secretary.

The Secretary read a letter from Mr. McQuesten offering the Hall in the Alexandra Arcade on the terms mentioned by the Committee. It was agreed to lease the Hall for the term of five years, with the option of breaking the lease at the end of the second year if the Association found the room unsuitable, and the Committee were authorized to see the room properly fitted up.

Mr. Witton drew the attention of the Association to the desirability of preparing and printing, for circulation, the transactions of the Association in a more suitable form them had hitherto been done.

A Committee was appointed to inquire into the standing of members in arrear with their subscriptions.

The Secretary read a letter from Mr. Gibson announcing the receipt by the Association of a grant of four hundred dollars from the Provincial Government, and also an extract from the printed list of Provincial Estimates to the same effect.

Mr. Robinson gave notice that at the next meeting he would make a motion that the annual subscription be increased.

Mr. R. Hinchliffe then read a paper on "Dynamo Electric Machines."

At the close of the meeting Mr. Witton exhibited a portion of the jaw of a fish found in coal from Pennsylvania.

Donations to Library and Museum: By Mr. Stanley McNider, Case of Photographic Views of Ruins at Copan, Central America, Box of Specimens of Gravel found in the bed of Lake Ilopango, Salvador, with report on the earthquake and volcanic phenomena, which dried the lake, and photograph of the volcano in action.

SEVENTH MEETING.

Twenty-Sixth year, Thursday, 15th May, 1884.

The President in the chair.

The minutes of last meeting read and approved of.

New member elected: W. C. Harvey. Proposed for election: Henry McLaren, James Lafferty, M. D.

Donations to Library and Museum: Vol. I. Transactions of the Royal Society of Canada, by Thomas Robertson, Esq. M. P. for Hamilton; Case of Birds' Eggs; Collection of Insects; Samples of Insect Architecture; Samples of Glasgow Method of Printing for the Blind; Nest of Chaetura Pelasgia, by Mr. J. Alston Moffat.

The Committee appointed to lease the hall in the Alexandra Arcade, reported that the hall had been taken for a term of five years, with the option of breaking the lease at the end of the second year in the event of its being unsuitable. The annual rent of two hundred dollars to include all costs of attendance, light, heating and taxes. The lease, which had been approved of by the Council of the Association was ready for signing.

The Committee appointed to collecte the subscriptions in arrear had no report.

The Secretary had on the table a copy of the act of incorporation, and a letter from Mr. Colmer, the secretary for the High Commissioner for Canada, in London, expressing his willingness to forward all parcels addressed to the Association, which might be left with him.

Applications for the use of the hall, were received from the St. Andrew's Society and the Hamilton Medical Association. These applications were referred to the Council.

Rev. Dr. Mockridge drew the attention of the Association to the forthcoming visit of the British Association to Canada, and proposed that the council of the Association should be empowered to extend to any member of this Association, such welcome as they should see fit. After some discussion the matter was placed in the hands of the President, who was empowered to act in the best interests of the Association.

A vote of thanks was tendered to Lieut.-Col. J. M. Gibson, M. P. P., for his successful efforts in obtaining an annual grant of four hundred dollars from the Provincial Government in aid of the funds of the asssociation.

The motion of Mr. W. A. Robinson, that the annual subscription to the Association should in future be two dollars was unanimously carried.

It was resolved on the motion of Mr. A. Alexander, that the Council of the Association be authorized to prepare an abstract of the Proceedings of the Association to be printed, along with a selection of the papers read before the Association, for circulation and distribution among similar Associations.

Mr. Geo. Dickson, M. A., read a paper on Meteorological Cycles.

This being the Annual Meeting, the Association then proceeded with the election of officers for the session 1884-5, when the following gentlemen were elected, viz :

President, - - -	J. D. Macdonald.
First Vice-President, - -	H. B. Witton.
Second Vice-President, -	Rev. C. H. Mockridge, D. D.
Corresponding Secretary, -	Geo. Dickson, M. A.
Recording Secretary, - -	A. Alexander.
Treasurer, - - - -	Richard Bull.
Librarian and Curator, - -	Wm. Turnbull.

Council—W. A. Robinson, Alex. Gaviller, A. F. Forbes, T. McIlwraith, R. Hinchliffe.

Auditors—A. T. Neill and W. H. Ballard, M. A.

HAMILTON ASSOCIATION

SESSION 1883-1884.

INAUGURAL ADDRESS

BY JOHN D. MACDONALD, M.D., PRESIDENT.

HEALTH.

Thursday, 15th November, 1883.

By your kind consideration it is my lot again to open the session of the Hamilton Association, and it is my pleasing duty to return my thanks to the friends by whom I see myself surrounded for the acceptable position in which by their decision I have been placed. It is a matter of no small moment to possess the good opinion of friends and neighbours after years of acquaintance, and I can assure the friends here, that I am most sensible of the nature of the resolution passed at our last meeting, by which I was again appointed to occupy the chair of their president.

It is gratifying to see the Association re-assemble in undiminished numbers, and it is surely fitting that, therefore, we should entertain feelings of thankfulness to the good providence by whose care we have been kept, and have now come together in bodily and mental health so good, as seems to promise us a season of social converse, which shall be useful and attractive to ourselves, and to such friends as from time to time attend our meetings.

Our Corresponding Secretary has informed us what the subjects are, of which we have promise for our occupation at our sittings during the season, and by an examination of his list you will see that our prospects of useful discusion are as good as at any previous opening of the session of the Society. He has also been able to acquaint us that we have become known beyond the borders of our own city. He presents us with reports and communications proving to us our recognition by societies of like character with our own, both at home and abroad. The knowledge of this recognition cannot but stimulate us to greater exertion and progress, in the course on which we have entered.

Some of the bodies which have honored us with communications have been constituted for a very much longer time than we have been. They have had great experience and have enjoyed much success. The reports of their transactions, with which they have favored us, show their work to have been of a much higher order than it has been in our power to attempt as yet. Among places abroad, whence we have been favored in the way I have mentioned, I may particularise Norway, a country of great interest to one of the two kingdoms of which Great Britain is composed, because of nearness of neighborhood and of kindred, and similarity of conditions, physical and political. Norway is not the most populous country in Europe, and with respect to it our ruling impressions are of cold and barrenness, but the people are able and resolute in the maintenance of their liberty and their national institutions, and, if their climate is cold and barren, they themselves are neither the one nor the other, in any sense. In the reports from thence with which we are favored, we have proofs of their intellectual fruitfulness, which are fitted to cause us to bestir ourselves, if we seek to get into line with sister societies such as exist in that and other lands.

But though I thus exhort our literary, philosophic and scientific friends to look to their laurels, I do not propose in my own remarks which are to follow, to make any attempts in literature or philosophy. I shall make a only very humble attempt at what I shall call science, in order that my paper and myself may have the right to appear before you. I shall ask your attention for a few minutes to a prosaic, but most practical subject, that of our "*health.*"

There are a few of us here present, who have not learned to value health. Of those around me the greater number have had experience enough of life and its changes to enable them to appreciate very thoroughly that change which consists in the loss of health. Few there are who have not suffered from that loss in their own persons, or in those of their near friends, and no doubt there are many of them who are aware that by a little knowledge of disease and its causes, many a fatal illness might have been prevented. This subject of "*health*" in the abstract, has of late years come to take larger proportions in the eyes of men than of old. Formerly the consideration of it, and the provision for it, were left very much to the physician, that is to say as much of the question as was thought worthy of attention; as it was the duty of the physician to get men back from sickness to health, so in each particular case, it was his function to recommend measures tending to prevent a relapse from health into sickness. To this extent, no doubt the expectation was justified up to the measure of the opportunity and ability of the physician, but there was not much consideration given either by the medical profession or by the laity to the general subject of the prevention of disease. There is no profession, except perhaps the clerical, in some of its branches, which has earned a character for self sacrifice so fairly and fully as has the medical profession. But it is hard to see our duty, or to look for it, where our interest does not lie, and physicians, in common with other men, had become so accustomed to the sight of sickness, that they regarded it as a necessary evil, one "to which flesh was heir." It would seem that the idea of disease prevention took its strongest and clearest, though not its earliest hold on the minds of men who were not physicians. Some of the most ardent and successful workers in the field of preventive medicine have not been members of the medical profession—Hygiene, although it has not by any means gone out of the hands of the physician, is not left to him exclusively, and all may deal with it without exciting on his part any professional jealousy. Nay, we may be sure that there are in this Association, those, not of its medical members, who are as able as any to point out to us the claims upon our attention of preventive medicine; and no doubt the time shall come when general knowledge on the subject of the preservation of health shall so increase, that under the attention given to the details of private living on the one hand, and the duty of public co-operation for health purposes on the other, the sickness and mortality from which society now suffers, will be in greatly lessened proportion. In the meantime the amount of preventible disease is very great, yearly desolating families, producing suffering the most severe, and often the most loathsome, and running a course to a fatal issue, regardless of the anxious solicitude of friends, and unchecked by the best skill of the physician. It is worth our time, therefore, to take occasion to inquire what, on the whole, is the nature of those evils which cause so much suffering, and yet can be prevented, and what precautions are needful for their prevention.

These evils are of various kinds and they arise from a variety of causes. Some of these causes are faults on our part, faults of the sufferer, others are due to the conditions which surround us, and for which perhaps we cannot be wholly responsible, as individuals we cannot help them. And I may say that we need not suppose that by our best efforts at co-operation, we shall ever succeed in getting wholly freed from them. They exist in nature, and they are too abundant and too subtle to permit of the hope that our own coarse and limited methods can effect the destruction of them. Our whole endeavour must be to keep ourselves from contact with them, to effect, if we can, their disappearance from around us. Chief among the first set of causes which have been mentioned as resulting in deviations from health, those causes for which the sufferers are themselves responsible, is that habit of excess in eating and in drinking in which the English speaking race especially indulges—it is not intended to say anything which may be objectionable to our temperance friends, but it seems right to say that eating to excess is as injurious, as disagreeable and as immoral as drinking to excess. Some of our apologists have tried to account for this habit, so unwholesome and such a reproach, by laying it to the account of the vigorous character of the race. "Whatever the race does it does with its might," say they. Perhaps so, in eating and in drinking many of us too often seem to go beyond our might; we exceed our bodily powers of endurance; we becloud our intellect, blunt our morals, and upon the whole, injure and debase ourselves a good deal. We are all aware of the besetting sin of our people, so besetting as to have become in a measure a national boast. It may seem a waste of time to speak of it, it is so trite; but we may reflect that we are speaking of "Health," and that it would be dealing unfairly with our subject, if we omitted all mention of that which produces amongst us a fatality greater than some of the most appalling epidemics.

We may next mention as a removable cause of trouble, crowding in our abodes, more particularly in our sleeping places. This condition may arise from either parsimony or poverty. It was a defect in our economy which early drew the attention of sanitarians and philanthropists, and well known and universally respected names are associated with efforts, more or less successful, to correct it. In our day overcrowding has come to be regarded less as an immediate than as a predisposing cause of such diseases as are destructive to life, and its effects upon morals touch our minds more keenly than do those which it produces upon the health. The evils of an atmosphere rendered impure by exhalations from living bodies are very great, but it is wonderful how long we can endure impurity in the air which we breathe, engendered in this way, and continue to live. For this power to live we are indebted in part to the properties of the gases with which our breathing organs have to do, and impart to the power with which our bodies are endowed of eliminating hurtful substances. But though we live, and may be at our daily duty, we have deviated from health. Changes are going on within us, analogous to those, which, under certain circumstances, we call corruption. If in this condition we have to encounter "disease germs," these find in our bodies a very suitable shelter and breeding place, they multiply abundantly, and in not a few instances, to such a degree, that they come to deal with us, in effect, very much as maggots do with carrion.

If we are not overtaken by our foes, the disease germs, or do not succumb to their attacks, there are blood diseases of another kind in store for us, diseases which, in the meantime at least, are supposed to result from imperfect or impure secretion of the blood. Very young children are most likely to be the sufferers from such affections, owing in a great measure to their being kept much within doors; and, having had them, they suffer from them more or less through life, because when once affected, they are unable to avail themselves of open air occupations and amusements like their healthy brothers and sisters, and in course of time they become the parents of children unhealthy and stunted like themselves. Happily in our little city, we do not see the evils of atmospheric impurity in the manifold deformities of our children. Our city is too little, we have not made it the Birmingham we expected and desired. Yet though we have been of less size, we were not always in a condition in which we could say that we were free from atmospheric impurity. Time was when Hamilton was noted for its closeness, heat and unhealthiness, and when its condition was justly attributed to an unhealthy domestic economy not less than to local malarial influences. The children died in very great nnmbers. We may justly hope that there is not much danger that our city shall obtain the same reputation again or suffer the like experience. The public sanitary measures which have gradually been adopted, have, we may be sure, tended to improve our sanitary character and condition very much. Situated on a fine slope, having a porous soil for the most part, possessing an abundant supply of pure water and a system of drainage, which, although by no means sufficient, will soon, we hope, be both sufficient and complete ; having the shade of its numerous trees, Hamilton should be a healthy, pleasant city, and we think it compares favorably with all others in Canada in that respect. Our authorities will have to see to it, now that the very means of our happier condition do not turn to our renewed trouble. Bad water and imperfectly constructed, or choked drains will bring us grief again, and I think we have had, on one or two occasions, a warning that we have something to learn on the subject of the ventilation of drains.

It seems to be not out of place to allude to agencies existing amongst us, most beneficial to both physical and moral health. I mean the benevolent associations of the city. Those are well organized, and by their means the whole town is systematically visited, those who are really indigent are discovered; their sufferings ascertained, and their wants relieved—comfort is assured to many aged persons, and protection and instruction to great numbers of the young. Indeed with respect to the young, there seems some danger of benificence being carried to an excess and of some of them becoming accustomed to a degree of comfort and consideration, which, according to the experience of most of us, is not to be met with in our working world. We may suppose that the little evil here pointed out will cure itself, and in the meantime the charitable institutions are in every aspect of them worthy of support, and of active interest on the part of all.

So far, we have spoken of causes of disease from which it is possible to suppose that we might succeed in freeing ourselves entirely, temperance and fresh air being our agencies. We will now speak of those from which perhaps we may never be able to deliver ourselves by our utmost care, but we may so modify or weaken them in one way or other, as that the troubles which they originate may be of less moment than those which spring from our own misdoings. Our own misdoings are not the great causes at work here, or it would no doubt be worse for us. We speak of those causes which produce the infectious diseases, of which, as we know, the visitations are sometimes very destructive. They possess in various degrees the power of passing from one person to another, and this power they owe to the agency of certain vegetable spores or "disease germs," which entering the body and increasing at the expense of its fluids, produce more or less disorganization of these, and as a result, morbid processes which obtain certain specific names as diseases.

The medium in which for the most part, those "germs" find themselves at home is water; both in its fluid and in its vapour form, it seems to be their habitat. In vapour they flourish abundantly, especially if it is not disturbed, and so we may suppose that if the vapour approaches the precipitation point in certain localities, that is, if those places are damp, there "germs" abound. They seem to multiply like all objectionable vegetable life in still, moist and warm places. The experience of the unwholesomeness of damp situations is universal, but with all our experience it is doubful if we duly appreciate the power of such situations to produce mischief. For example, there is no disease from which we suffer so much as from consumption. We have long been in the habit of regarding this as a complaint due to heredity. For some time past the origin of consumption, in this way exclusively, has been questioned. It has been told us by trustworthy observers, that the disease has been known to originate and prevail with great intensity in localities in which there was, from any cause, a moist condition of the earth, such as a stiff impermiable clay, and that removal from such locality has been followed by happy results to suffering families. Many physicians who have made their observations in country places have adopted the theory that a cold, sour, damp soil, and exhalations thence arising produced consumption without heredity. With professional caution they did not say how it arose in those localities. On the other hand, physicians whose experience has been obtained in large towns were disposed to hold the opinion broached by Sir John Rose Cormac, a Scottish physician resident in France, that the disease arose from the breathing over and over again the same polluted air, an opinion which in other words agrees with those who say that the disease is one of those which are infectious. Lately a German physician has startled those of us who hold to old beliefs as to the nature of this malady, by proclaiming a discovery that with consumption there is associated a parasite which he and many with him regard as pointing to the origin of the disease in germ infection. If the German, Koch, is right in his conclusion it will be seen that the other observers were right too, as far as they went, and that water seems the habitat of the destructive organism according to all the theories of the causation of consumption.

Now, if those are right who tell us that so many of the most dangerous diseases by which we are affected are due to "germ infections," that is, to the introduction into our bodies of small seeds, or germs of a vegetable nature, does it not become us to carefully surround ourselves with conditions which are not favorable to the life of those deadly little organisms. These organisms are of various kinds, and each kind of them seems to make its presence known in its own peculiar way. They are invisible to ordinary sight and their national history cannot be said to be known, but, let us illustrate by what we can see and know of vegetation of larger growth, the mode in which this minute vegetation may come in contact with us, its victims. For example, we often see thistle down floating in the air, sometimes sailing into our houses. We express no surprise; we have seen that so often. We do not know, perhaps, of any thistles near us from which the down may come, and yet, when we see our houses entered by it, or in our gardens a growth of young thistles giving proof of "*thistle infection*," we raise no question with ourselves or others as to whence the trouble has come, we just proceed to clean up and root out. And we become watchful against the re-appearance of the intruders. Many of the mischief-causing little bodies which we are considering, seem to possess means of migration quite equal to those shown by thistle down. We need not be surprised, therefore, when we are unexpectedly visited by them, nor complain of the hardship of their presence, although there may have been all possible care on our part to prevent access by them to our dwellings. It looks as if they must have time, and be in quantity before much harm arises from them. Let us be always examining, turning over and cleaning as is our course when we wish to rid ourselves of thistles and their seeds. In addition to their very effective means of flight, many varieties of "disease germs" are judged to possess great power of vitality. The microscope reveals many organisms which appear to be indestructible by ordinary agencies. Water is the medium of their activity—but they do not die when deprived of water; they dry up, and yet survive for an indefinite time, reviving and becoming active as before on the occurrence of favorable conditions. There is reason to believe that many disease germs are equally tenacious of life. They may lurk about our dwellings till circumstances may cause them to resume their activity, when the signs of their presence appear sooner or later. They are no doubt always around us more or less. Perhaps we have an example of their abundance in what is observed in mildew, a fungus of which there are many varieties, all having this in common, that in favorable conditions they appear with promptness, and in great abundance. We know that in given circumstances we may expect crops of it in our cupboards and in other close places. The undisturbed contact of moist organic matter with air at any temperature short of freezing is sufficient for its appearance. It can be understood that disease producing fungi may, like mildew, be rapidly produced in organic refuse, lying undisturbed and unobserved about our dwellings, and that by being parasitical, they obtain entrance into our living organisms, assimilating to themselves such constituents as are useful to their own growth, not unfrequently destroy the bodies, at the expense of which they thrive and multiply. Among the diseases familiar to us, which are regarded as being due to germ infection are typhoid fever, scarlatina, and diphtheria, deadly troubles very often, as we all too well know, but all to a great degree capable of prevention or mitigation by judicious precaution.

Individual precaution is not of much avail, there being such a wide spreading cause to deal with. The means to be adopted must be by the general consent, and must be carried out as a public measure. There may be, among more or less near neighbors, some who may be propagating about their premises, poison enough for themselves and all around, but who, owing to the level of the soil, the prevailing winds or other causes, are not even suffering inconvenience from the state of things surrounding them, while others, perhaps among the most careful, are enduring the greatest suffering.

It is necessary that measures of prevention be as general and extensive as are the evils which they are intended to check. They must cover the whole community. We have all of us who have come to this conclusion, reached it somewhat slowly and reluctantly, for, in our first steps towards it, it seemed to involve an unpleasant interference with personal liberty and personal convenience. An Englishman's house is his castle, it was insisted, and a health officer would make short work of our castle theory. We had to adopt the health officer however, with all his intrusiveness, to save us from a worse visitor, and we are by degrees getting more and more persuaded that, after all, he is the less of two evils, of which we have the choice. His watchful aid is constantly needed within our houses as well as without and around them. It is astonishing how people often become familiarized with, almost attached to, filth of their own gathering, and live amongst it, and breathe its products, without feeling of offence or suspicion of evil. Such people are a destructive nuisance over a pretty extensive circle, of which they are the important but disagreeble centre, as may be witnessed in certain villages where every man does what is right in his own eyes, and but for a public health officer such centres would be numerous enough in every large town, to almost decimate its inhabitants every now and then.

Whether the germ theory of disease be right or wrong, whether germs be the product or cause of the changed conditions of the ancient system which we call disease, there can be no doubt of the necessity, with a view to preventing some of the most unmanageable diseases which assail us from time to time, as diphtheria, scarlatina, measles, typhoid fever, that we see to it that our own and our neighbors' surroundings are dry, and that they have not in or about them any of what most men call filth, but a few call material out of place; and farther, we may remember that having seen to those things, we have not been removing disease, but a nest of disease; that our own bodies are nests where such disease can thrive very well also, and therefore we must be careful not to put our own bodies in the way of affording shelter to passing germs of an obscene brood, in other words, we cannot use too great caution in approaching places where infectious diseases prevail. We have also to attend to personal cleanliness; the disease producing organisms are quite large enough apparently to be washed away, and on the other hand, small enough to secure an entrance to our bodies by unheeded cracks in the skin, or through the pores of certain absorbing surfaces to which they may become applied. In typhoid fever absolute cleanliness is an almost sure condition of freedom from infection, unless the infectious material comes to surround us in what we may call clouds, while in the other mentioned diseases there is no doubt but that it affords an additional security.

If then we would keep our families free from the danger attending infectious diseases, some of which set medical skill at defiance, let us attend to the cleanliness of our persons and places of abode; let us not have about our premises any quiet neglected corners, where organic matter may rest and become influenced by heat and moisture,and so in time come to give life and growth to organisms, whose neighborhood is often so dangerous to us, and let us remember too that in this matter each of us is to some extent his brother's keeper. We must keep a look-out on each other, and none of us need be annoyed if, now and then, a neighbor should personally, or through the authorities, call our attention to some neglect on our part, which is rendering all his carefulness of no effect, and threatening him with grievous disaster.

THE DISCOVERY OF BURLINGTON BAY,

With some Accounts of the Aborigines of the Province of Ontario and the State of New York.

BY B. E. CHARLTON.

Two and a half centuries ago, or to be more correct say about the year 1634, a glance at this portion of the continent of North America, finds the French re-established at Quebec, and also in a small way at Hochelaga, now Montreal. And the Dutch at New Holland and Manhattan, now respectively Albany and New York.

Of the Indian tribes, the two prominent nations were the Hurons, allies of the French, in the north, extending from lake Simcoe around the Georgian bay along the French and Ottawa rivers; and, on the other hand, the fierce Iroquois to the sonth, extending eastward from Niagara river, and south from Lake Ontario and the St. Lawrence. The former trading with the French at Montreal and Quebec, by way of the Ottawa; the latter trading with the Dutch on the Hudson, but hostile to everybody, their hand being against every man. Thus it occurred that while the Jesuit missionaries, those indomitable pioneers of discovery, became familiar (through following the return of Indian bands from their trading expeditions,) with the great northern waterway of the Ottawa and French rivers on the one hand, and Lake Champlain, the Hudson and Richelieu rivers on the other, the now greater waterway of the Upper St. Lawrence, Lakes Ontario, Erie, &c., was for a long period entirely unknown. This is to be accounted for by the fact that these, forming as they did, the dividing line between those two hostile nations, were too dangerous to be used as a thoroughfare.

Some four or five of those Jesuit missionaries had for several years been laboring among the numerous Huron towns along the east coast of the Georgian bay, then known as the Great Fresh Sea, with very indifferent success, but with a zeal and courage under hardships and cruelties worse than death, and even in martyrdom itself, that won respect even from their tormentors. They were in the habit of sending home periodically to their superiors in France, reports, or "*relations*," as they are called, of all their transactions, giving the most circumstantial details of every event which came under their notice, even to the surrepetitious baptizing of an infant of an unfriendly savage. These Jesuit relations, many of which have been published, afford us the earliest glimpses of Canadian history. The missionaries to the Hurons, though accustomed to make excursions in various directions up and down through the northern country, do not seem to have penetrated nearer to the ground upon which we now stand than Lake Simcoe, that being the northern limit of the Huron lands, for lying to the south of the Huron and along the north shore of Lake Erie, between the Niagara and Detroit rivers, was a small tribe called by the French the Neuters. This tribe, though considered a small one, had forty populous towns and villages. Situated as they were however, between the greater nations of the Hurons on the one side, and the Iroquois on the other, and fearful of giving offence to either, they rejected most decidedly all recorded attempts of the Jesuits to penetrate their country.

The intrepid Champlain, too, had made an excursion up the Ottawa and along the shores of the Georgian Bay, and being persuaded to join the Hurons in a foray against the Iroquois passed with the Indian army from Lake Simcoe through the chain of lakes in the vicinity of Lindsay along the Trent river to its mouth, through the Bay of Quinte, discovering Lake Ontario, and crossing the same in canoes to the Iroquois country, landing near Oswego, where they laid seige to an Indian town surrounded with a triple stockade, upon which there were mounted galleries for warriors, who fired arrows and stones and poured water upon fires built upon the outside, and defended their works generally with such courage that their assailants had to retire discomfited.

But some years later than the date above given, the Iroquois, becoming more formidable, burst across the Niagara river and Lake Ontario with a fierceness which nothing could withstand. They captured one Huron town after an other, slaughtering, torturing and sometimes eating their captives, till finally in 1649 a general massacre took place, ending in the destruction of the whole nation with the exception of two small bands, one of which went westward and became absorbed in the powerful tribes about Lake Superior, and the other followed the Jesuits to Quebec. At the present day, at the Indian village of Lorette, some few miles from Quebec, may be found the sole survivors of the once mighty Huron nation.

Some unpublished manuscripts, having reference to explorations in America, have lately been discovered in the Bibliotheque Nationale, in Paris, among which was a journal giving an account of an expedition in 1669 by De La Salle, whose name stands almost, if not quite, at the head of the intrepid explorers of this continent, and two Sulpician missionaries, who started from Montreal in canoes, passed up the St. Lawrence, along the south shore of Lake Ontario, and made a short stay on the shore of Burlington bay.

I shall beg leave to introduce to your attention this evening an extract from the journal in question as the basis of my present paper. The map annexed to the journal forms an interesting illustration of the knowledge acquired by the party of the form and size of the North American lakes during their long pioneer voyage from Montreal to Sault Ste. Marie. A copy of the original, which is in the possession of a gentlemen of Buffalo, measures 4½ feet in length by 2½ feet in breadth, and I am happy to say that I am in possession of a tracing of a small portion thereof, showing the localities of this vicinity exactly as they appear in the original. The map is covered with annotations in the French language.

The missionaries attached to the expedition were Francois Dollier de Casson, and Rene de Brehart de Gallinee, both attached to the order of St. Sulpice. The former had been a calvary officer under Marshall Turenne, and was at the date of the expedition superior of the seminary belonging to the order at Montreal. His strength was said to be so prodigious that he was said to be able to carry two men sitting one on each hand. Galinee, the historian of the enterprise, had no little reputation as a surveyor and astronomer. Both priests for the conversion of the heathen to the Roman faith, and long been waiting for some favorable opportunity to penetrate for that purpose the vast and unexplored regions of the west.

La Salle, then 26 years of age, had resided in Canada three years, and had not acquired the renown which his subsequent adventures and explorations affixed to his name, but the opportunities which he had enjoyed for intercourse with the Iroquois and other western tribes, who were accustomed to visit Montreal for the purpose of trade, had not been neglected. From them he had heard of the Ohio, the Mississippi and the the boundless forests and prairies through which they flowed. They told him of the vast lakes as yet unnavigated save by their frail canoes, on the borders of which were inexhaustible mines yielding the richest ores of iron and copper. His imagination kindled at the recital, and so great was his ambition to accomplish his favorite object, that he sold the possessions he had acquired in Canada to realize the means of defraying the expenses of an expedition to test the truth of the Indian narrations. He resolved to ascend the St. Lawrence, and passing through the chain of western lakes, to seek for the great river, that having its source in the Iroquois country flowed, according to Indian authority, into a far distant sea, and which Champlain and L'Escarbot had confidently hoped might be the western road to China and Japan.

In the summer of 1669 La Salle organized, with two Sulpicians, a joint expedition to accomplish their several purposes—the former to prosecute his discoveries in the west, and the missionaries to baptise the Neophytes they should secure among the tribes found in the valleys of the Ohio, the Mississippi and the lakes. When everything was ready for a speedy departure, the unfortunate assassination of an Iroquois chief by three French soldiers at Montreal, detained them fifteen days, and threatened a renewal of the war between the

Iroquois and French, which had just then happily terminated. The execution of the guilty soldiers propitiated the offended Iroquois. All fear of reprisals being allayed, the party started on the 6th day of July—La Salle with fifteen men in four canoes, and de Casson and Galinee with seven men in three canoes. They ascended the St. Lawrence, threading the intricate channels of the Thousand Islands, carrying their canoes and effects around the numerous and difficult portages they met by the way, and at length after twenty-seven days of incessant toil, in which they suffered severely from sickness and exposure, they reached the broad expanse of Lake Ontario. Coasting along its southern shore they landed on the 10th of August at the mouth of Irondequoit bay, four miles east of Genesee river, their intention being to procure a guide from the Indian town of Gannagaro, on what is now known as Broughton Hill, just south of Victor station, on the New York Central railway, and midway between Rochester and Canandaigua.

In the translation of the journal of Galinee, which follows, the original has been adhered to as closely as the obscure and antiquated French in which it is written would admit.

EXTRACT FROM THE JOURNAL OF GALINEE.

"After 35 days of very difficult navigation we arrived at a small river called by the Indians Karontagonat (the Iroquois name for Irondequoit Bay), which is the nearest point on the lake to Sonantouan, and about one hundred leagues southwest of Montreal. I took the latitude of this place on the 26th of August, 1669, with my jacobstaff. As I had a very fine horizon on the north, no land but the open lake being visible in that direction, I took the altitude on that side as being the least liable to error.

"We had no sooner arrived at this place than we were visited by a number of Indians, who came to make us small presents of Indian corn, pumpkins, blackberries and whortleberries, fruits of which they had abundance. We made presents in return of knives, awls, needles, glass beads, and other articles which they prize, and with which we were well provided.

"Our guides urged us to remain in this place till the next day, as the chiefs would not fail to come in the evening with provisions to escort us to the village. In fact, night had no sooner came than a large troop of Indians, with a number of women loaded with provisions, arrived and encamped near by, and made for us bread of Indian corn and fruit. They did not desire to speak to us in regular council, but told us that we were expected in the village, to every cabin of which word had been sent, to gather all the old men at the council, which would be held for the purpose of ascertaining the object of our visit.

"M. Dollier de Casson, M. de La Salle and myself consulted together in order to determine in what manner we should act, what we should offer for presents, and how we should give them. It was agreed that I should go to the village with M. de La Salle, for the purpose of obtaining a captive taken from the nation which we desired to visit who could conduct us thither, and that we should take with us eight of our Frenchmen, the rest to remain with M. Dollier de Casson in charge of the canoes. This plan was carried out, and the next day, August 12, had no sooner dawned, than we were notified by the Indians that it was time to set out. We started with ten Frenchmen and forty or fifty Indians, who compelled us to rest every league, fearing we should be too much fatigued. About half way we found another company of Indians who had come to meet us. They made us presents of provisions and accompanied us to the village, When we were within about a league of the latter the halts were more frequent, and our company increased more and more, until we finally came in sight of the great village, which is in a large plain, about two leagues in circumference. In order to reach it we had to ascend a small hill (now Broughton Hill) on the edge of which the village is situated.

"As soon as we had mounted the hill we saw a large company of old men seated on the grass, waiting for us. They had left a convenient place in front, in which they invited us to sit down.

"This we did, and at the same time an old man, nearly blind, and so infirm that he could hardly support himself, arose, and in a very animated tone, delivered a speech, in which he declared his joy at our arrival; that we must consider them as our brothers; that they would regard us as their's; and in that relation they invited us to enter their village, where they had prepared a cabin for us until we were ready to disclose our purpose.

"We thanked them for their civilities, and told them through our interpreter that we would on the next day declare to them the object of our expedition. This done, an Indian, who officiated as master of ceremonies, came to conduct us to our lodgings.

"We followed him and he led us to the largest cabin in the village, which they had prepared for our residence, giving orders to the women belonging to it not to let us want for anything. In truth they were at all times very faithful during our sojourn, in preparing our food and in bringing the wood necessary to afford us light over night.

"This village, like those of the Indians, is nothing but a collection of cabins, surrounded with palisades 12 or 13 feet high, bound together at the top and supported at the base, behind the palisade, by large masses of wood at the height of a man. The curtains are not otherwise flanked, but form a simple enclosure, perfectly square, so that these forts are not any protection. Besides this, the precaution is seldom taken to place them on the bank of a stream, or near a spring, but on some hill, where ordinarily they are quite distant from water.

"On the evening of the 12th we saw all the other chiefs arrive so as to be in readiness for the council which was to be held next day."

Here follows an interesting account of the council meeting, and of their stay of ten days in the village, but too lengthly for this paper.

He says: "During this interval the Indians obtained some brandy from the Dutch at New Holland, and many times the relatives of the person who had been killed at Montreal a few days before we left there, threatened in their intoxication to despatch us with their knives. In the meantime we kept so well on our guard that we escaped all injury.

"During this interval I saw the saddest spectacle I had ever witnessed. I was informed one evening that some warriors had arrived with a prisoner, and had placed him in a cabin near our own. I went to see him and found him seated with three women who vied with each other in bewailing the death of a relation who had been killed in the skirmish in which the prisoner had been captured He was a young man 18 or 20 years old, very well formed, whom they had clothed from head to foot since his arrival.

"I thought, therefore, that I would have an opportunity to demand him for our guide, as they said he was one of the Tongenhas (probably from Ohio). I then went to M. de La Salle for that purpose, who told me that these Indians were men of their word, that since they had promised us a captive they would give us one, that it mattered little whether it was this one or another, and it was useless to press them. I therefore gave myself no further trouble about it. Night came on and we retired.

"The next day no sooner dawned than a large company entered our cabin to tell us that the captive was about to be burned, and that he had asked to see the Frenchman.

"I ran to the public place to see him, and found he was already on the scaffold, where they had bound him hand and foot to a stake. I was surprised to hear him utter some Algonquin words which I knew, although from the manner in which he pronounced them they were hardly recognizable. He made me comprehend at last that he desired his execution should be postponed until the next day. I conversed with the Iroquois through our interpreter, who told me that the captive had been given to an old woman in the place of her son who had been killed, that she could not bear to see him alive, that all the family took such a deep interest in his suffering that they would not postpone his torture. The irons were already in the fire to torment the poor wretch.

"On my part I told the interpreter to demand him in place of the captive they had promised, and I would make a present to the old woman to whom he belonged, but he was not at any time willing to make the proposition, alleging that such was not their custom, and the affair was of too serious a nature.

"I even used threats to induce him to say what I desired, but in vain, for he was as obstinate as a Dutchman and ran away to avoid me.

"I then remained alone near the poor sufferer who saw before him the instruments of his torture. I endeavored to make him understand that he could have no recourse but to God, and that he should pray to him thus: 'Thou, who hast made all things, have pity on me. I am sorry not to have obeyed Thee, but if I should live, I will obey Thee in all things.'

"He understood me better than I expected. In the meantime I saw the principal relatives of the deceased approach him with a gun barrel, half of which was heated red hot. This obliged me to withdraw. I retired, therefore, with sorrow, and had scarcely turned away when the barbarous Iroquois applied the red hot gun barrel to the top of his feet, which caused the poor wretch to utter a loud cry. This turned me about and I saw the Iroquois, with a grave and sober countenance, apply the iron slowly along his feet and legs, and some old men who were smoking around the scaffold, and all the young people leaped with joy to witness the contortions which the severity of the heat caused the poor sufferer.

"While these events were transpiring, I retired to the cabin where we lodged full of sorrow at not being able to save the poor captive, and it was then that I realised, more than ever, the importance of not venturing too far among the people of this country, without know-their language, or being certain of obtaining an interpreter.

"As I was in my cabin, praying to God, and very sad, M. de La Salle came and told me he was apprehensive that, in the excitement he saw prevailing in the village they would insult us—that many would become intoxicated that day, and he had finally resolved to return to the place where we had left the canoes, and the rest of our people.

"We told the seven or eight of our people who were there with us, to withdraw for the day to a small village, half a league from the large one where we were, for fear of some insult, and M. de La Salle and myself went to find M. Dollier de Casson, six leagues from the village. There were some of our people barbarous enough to be willing to witness, from beginning to end, the torture of the poor prisoner, and who reported to us the next day, that his entire body had been burned with red hot irons for the space of six hours; that there was not the least spot left that had not been roasted. After that they had required him to run six courses past the place where the Iroquois were waiting for him, armed with burning clubs, with which they goaded and beat him to the ground when he attempted to join them.

"Many took kettles full of coals, and hot ashes, with which they covered him, as soon as, by reason of fatigue and debility, he wished to take a moment's repose. At length, after two hours of this barbarous diversion, they knocked him down with a stone, and throwing themselves upon him, cut his body in pieces. One carried off his head, another his arm, a third some other member, which they put in the pot for a feast.

" Many offered some to the Frenchmen, telling them there was nothing in the world better to eat, but no one desired to try the experiment.

" During our stay at that village we inquired particularly about the road we must take in order to reach the Ohio river, and they all told us to go in search of it from Sonnontaoun. That it required six days' journey by land.*

" This induced us to believe that we could not possibly reach it in that way, as we would hardly be able to carry, for so long a journey, our necessary provisions, much less our baggage. But they told us at the same time, that in going to find it by way of Lake Erie in canoes, we would have only a three days' portage before arriving at that river.

" We were relieved from our difficulties in regard to a guide, by the arrival from the Dutch of an Indian who lodged in our cabin. He belonged to a village of one of the five Iroquois nations, which is situated at the end of Lake Ontario, for the convenience of hunting the deer and the bear, which are abundant in that vicinity. This Indian assured us that we would have no trouble in finding a guide—that a number of captives of the nations we desired to visit were there, and he would very cheerfully conduct us thither.

" After departing we found a river† one eighth of a league broad and extremely rapid, forming the outlet or communication from Lake Erie to Lake Ontario. The depth of the river (for it is properly the St. Lawrence), is at this place extraordinary, for, on sounding close by the shore, we found fifteen or sixteen fathoms of water. This outlet is forty leagues long, and has, for ten or twelve leagues above its embrouchre into Lake Ontario, one of the finest cataracts, or falls of water in the world, for all the Indians of whom I have enquired about it, say, that the river falls at that place from a rock higher than the tallest pines, that is about two hundred feet. In fact we heard it from the place where we were, although from ten to twelve leagues distant, but the fall gives such a momentum to the water, that its velocity prevented our ascending the current by rowing, except with great difficulty. At a quarter of a league from

* The route they proposed to take was probably up the Genessee river to one of its sources crossing from thence to the head waters of the Alleghany River.

† Niagara.

the outlet where we were, it grows narrower, and its channel is confined between two very high, steep, rocky banks, inducing the belief that the navigation would be very difficult up the cataract. As to the river above the falls, the current very often sucks into this gulf, from a great distance, deer and stags, elk and roebucks, that suffer themselves to be drawn from such a point in crossing the river, that they are compelled to descend the falls, and to be overwhelmed in its frightful abyss.*

"Our desire to reach the village called Otinaoustettaoua prevented our going to view that wonder, which I consider is so much the greater in proportion as the river St. Lawrence is one of the largest in the world. I will leave you to judge if that is not a fine cataract into which all the water in that river having its mouth three leagues broad,† falls from a height of 200 feet, with a noise that is heard not only at the place where we were, 10 or 12 leagues distant, but also from the other side of Lake Ontario, opposite its mouth, where M. Trouve told me he had heard it.

"We passed the river, and finally, at the end of five days travel, arrived at the extremity of Lake Ontario, where there is a fine large sandy bay, at the end of which is an outlet of another small lake, which is there discharged.

"Into this our guide conducted us about half a league, to a point nearest the village, but distant from it some 5 or 6 leagues, and where we unloaded our canoes.‡

"We waited here until the chief of the village came to meet us with some men to carry our effects. M. de La Salle was seized, while hunting, with a severe fever, which, in a few days reduced him very low.

"Some said it was caused by the sight of three large rattlesnakes which he had encountered on his way while ascending a rocky eminence. At any rate it is certain that it is a very ugly spectacle, for those animals are not timid like other serpents, but firmly wait for a person, quickly assuming an offensive attitude, coiling half the body

* Galinee's description of the falls is probably the earliest on record. His account, which is wholly derived from the Indians, is remarkably correct. If they had been visited by the Jesuits, prior to the time of this expedition, they have failed to relate the fact, or to describe them in their journals. The Niagara river is alluded to under the name of Ongniaehra, as the celebrated river of the Neuter nation, but no mention is made the cataract.

† At the Gulf of St. Lawrence.

‡ Oaklands.

from the tail to the middle as if it were a large cord, keeping the remainder entirely straight, and darting forward, sometimes 3 to 4 paces, all the time making a loud noise, with the rattle which it carries at the end of its tail. There are many in this place as large as the arm, six or seven feet long, and entirely black. It vibrates its tail very rapidly, making a sound like a quantity of melon or gourd seeds shaken in a box.

"At length after waiting three days, the chiefs and some fifty Indians and Squaws came to see us.

"We gave presents to obtain two captive slaves, and a third for carrying our effects to the village. The savages made us two presents. The first of fourteen or fifteen deerskins, to assure us they were going to conduct us to their village, the second of about 5,000 shell beads, and afterwards, two captives for guides. One of them belonged to the Codonas (Shawnees), and the other to the Nez Perces. They were both excellent hunters, and seemed to be well disposed. Conducted by the Indians we proceeded to the village of Otinaoustettaona, arriving there on the 24th Sept., 1669."

Dropping the journal of Galinee at this point, I might say that at this place, then but a small Iroquois village though twenty years before, an important Neuter town, the missionaries had received such a hearty welcome as made one of them think seriously of spending the rest of his days there.

While there they provided their captive guide (the one allotted to the priests) with a coat, blanket, pot and knife, as equipment for their future journey. An Indian arrived, however, from the Dutch, with a keg of brandy, and it was soon discovered that the said guide had sold or pledged his coat for ten mouthfuls. This greatly annoyed the worthy Father Galinee, who immediately seized the hypothecated coat and discharged the guide. The latter expressed great contrition, but finding he had no chance of being restored to favor, brought back all the things which had been given him, and introduced a fellow captive from the same tribe, who was accepted in his stead. As the affair made a good deal of stir in the village, the chiefs held a council and presented the missionaries with two thousand beads in order to cause them to forget the matter, and further made a great feast.

This Indian village appears to have been situated on the borders of a small lake in the township of Nelson, about 10 miles from Hamilton, known as Lake Medad, not far beyond Waterdown. Some seven years ago, the writer having learned that an ancient Indian ossuary or bone pit had been discovered at this point, through the burrowing of a small animal called a wood-chuck, had the curiosity to visit the place, and found it a most interesting one. The lake itself, a pretty sheet of water of some eight acres in extent is fed by abundant natural springs. On one side, beneath an abrupt, rocky bank, and from a rocky basin which may have been widened and cleared of loose stones ages ago, bursts out a noble spring of clear, cold water, sufficient in capacity to supply the wants of a small city. A steep pathway cut deeply into the rock and earthy embankment by the feet of both wild animals and Indians in prehistoric times, leads from the spring up to a sloping plain of considerable extent, on which as yet but little modern civilization has been accomplished.

You can see scattered over this slope curious rounded heaps of about forty to one hundred feet long and ten wide, a spade at once reveals that they are heaps of ashes, containing many fragments of Indian pottery, bones of animals, and broken weapons. On a portion of the plain Indian corn had probably been cultivated. Here at some distant period had evidently been situated an important Indian town of the Neuter nation. This tribe, as before mentioned, occupied the country between the Niagara and the Detroit rivers. In their wars with the Indians of Michigan they acted with more ferocious cruelty than even the Huron or Iroquois, roasting and eating their prisoners of war of both sexes. The men going without clothing of any kind in summer. Their time of destruction, however, followed quickly upon that of the Hurons, for after the slaughter of the latter, the Iroquois turned all their fury upon the Neuters and left no survivors whatever.

Proceeding to the highest point of the plain quite at one side of the clusters of ash heaps, were discovered the Ossuaries. They consisted of three pits. One measuring forty feet long by seventeen wide, and five in depth, and the two others circular about 12 feet in diameter and 7 feet in depth. Upon the former were two large pine stumps, the rings of growths of the larger numbering 125. All these pits were situated within a few yards of each other. In them were found partially decayed bones of several hundreds of persons of all ages, together with many curious articles, such as some 30 copper and brass kettles, varying in size from 3 to 26 inches in diameter, containing in one case two skeletons; in another a small bronze spoon, in several others the dust of a wooden spoon, and traces of food. Also 8 or 10 large tropical shells, brought probably from the coast of Florida, and evidently used in the manufacture of antique shell beads or wampum.

Many hundreds of these shell beads were also obtained, together with beads made from porcelain, glass, stone, baked clay, obsidian, shale, etc., some round, others square, others oblong, and several inches in length, of all sizes imaginable. With these were found antique pipes of stone and clay, many of them bearing extraordinary devices, figures of animals, and of human heads wearing the conical cap, noticed on similar relics found in Mexico and Peru.

There were also found the remainder of several axes of the old French pattern; specimens of Indian pottery in the shape of vases or pots, made of coarse sand and clay, well baked and constructed evidently with the view of being suspended over a fire. Two very handsome ones were obtained entire. In portions of the pits, skeletons were found entire or nearly so, and placed somewhat regularly, not only side by side but in layers upon each other; but in other parts all the small bones appeared to be wanting, and skulls and large bones mingled in the greatest possible confusion.

It seems quite clear that these pits were places of ancient Indian sepulture, and that on this spot were celebrated one or more of these ceremonies called "Feasts of the Dead," which the Huron and other Indian tribes were in the habit of performing once in ten or twelve years. One of these feasts was witnessed by Father Brebeuff, a Jesuit missionary, in the year 1636 at the Indian town of Ossossane, a little east of Collingwood. He describes it in the following language: "At each village the corpses were lowered from their scaffolds and raised from their graves. Their coverings were removed and the hideous relics arranged in a row surrounded by the weeping, shrieking, howling concourse. Thus were gathered all the village dead for the last 10 or 12 years. Each family reclaimed its own, and immediately addressed itself to removing what remained of flesh from the bones. These were wrapped in skins, and, together with the recent corpses—which were allowed to remain entire, but which were also wrapped carefully in furs—were now carried to one of the largest cabins, and hung to the numerous cross poles, which like rafters, support the roof.

"Here the concourse of mourners seated themselves at a funeral feast, and as the squaws distributed food, a chief harangued the assembly, lamenting the loss of the deceased, and extolling their virtues. This solemnity over, the mourners began their march for Ossossane, uttering at intervals in unison a dreary wailing cry; and as they stopped to rest at night at some village on the way, the inhabitants came forth to meet them with a mournful hospitality. From every town processions like these were converging toward Ossossane, and thither, on the urgent invitation of the chiefs, we repaired. The capacious bark houses were filled to overflowing, and the surrounding woods gleamed with camp fires. Funeral games were in progress, the young men and women practicing archery, and other exercises for prizes offered by the mourners in the name of their dead relatives. Some of the chiefs conducted us to the place prepared for the ceremony—a cleared area in the forest many acres in extent. In the midst was a pit about 10 feet deep and 30 wide. Around it was reared a high and strong scaffolding, and on this were placed several upright poles, with cross poles extended between, for hanging the funeral gifts and the remains of the dead.

"We were lodged in a large bark house where more than a hundred of these bundles of mortality were hanging from the rafters. Amidst the throng of the living and the dead we spent a night which the imagination and the senses conspired to render almost insupportable. At length the officiating chiefs gave the signal to prepare for the ceremony. The relics were taken down, opened for the last time, and the bones caressed and fondled by the women amid paroxysms of lamentations. Then all the processions were formed anew, and, each bearing its dead, moved towards the area prepared for the last solemn rites. As they reached the ground they defiled in order, each to a spot assigned to it. Here the bearers of the dead laid their bundles on the ground. Fires were now lighted, kettles slung, and around the entire circle of the clearing the scene was like a fair or caravansary. This continued till three in the afternoon, when the gifts and bones were re-packed. Suddenly at a signal from the chiefs, the crowd ran forward from every side towards the scaffold scaled it by rude ladders, and hung their relics and gifts to the forests of poles which surrounded it. Then the ladders were removed, and a number of chiefs standing on the scaffold harangued the crowd below, while other functionaries were lining the grave throughout with rich robes of beaver skin. Three large copper kettles were next placed in the middle and then ensued a scene of hideous confusion. The bodies which were left entire were brought to the edge of the grave, flung in and arranged in order at the bottom by ten or twelve Indians stationed there for that purpose, amid the wildest excitement and uproar of many hundred mingled voices. When this part of the work was done night was fast closing in. The concourse bivouacked around the clearing and lighted their camp fires under the brows of the forest which hedged in the scene. We withdrew to the village, when an hour before dawn we were aroused by a terrible clamor. One of the bundles of bones, tied to a pole on the scaffold, had chanced to fall into the grave. This accident precipitated the closing act and perhaps increased its frenzy. Guided by the unearthly din, and the broad glare of the flames, fed with heaps of fat pine log, we soon reached the spot and saw what seemed to us an image of pandemonium. All around blazed countless fires, and the air resounded with discordant outcries.

"The naked multitude, on, under and around the scaffold were flinging the remains of their dead, pell mell into the pit, where we discovered men who, as the ghastly shower fell around them, arranged the bones in their places with long poles. All was soon over ; earth logs and stones were cast upon the grave, and the clamor subsided in a funeral chant, dreary and lugubrious."

Such was the origin of those numerous and strange sepulchres which have been the wonder and perplexity of the early settlers of the county of Simcoe, similar in every respect to the one at Lake Medad where stood the Iroquois village visited by La Salle as before mentioned in the year 1669.

Briefly in closing I might add, that La Salle finding the season far advanced, and seeing before him the uninviting prospect of a winter camp in the woods, parted from the Sulpicians at Otinaoustettawa after solemn mass and probably returned to Montreal. We hear of him nine years later, in company with Father Hennepin, building the "Griffin" above the Falls of Niagara, the first schooner which floated on Lake Erie.

The missionaries having parted from La Salle, left Otinaoustettawa on the 1st October, with their retinue, accomplished the remainder of the portage to the Grand River, which they reached about Galt, and descended its difficult and tortuous channel. In fourteen days they reached its mouth and encamped on the northern shore of Lake Erie, which they describe as a "vast sea tossed by tempestuous winds." They built a camp for the winter at or near the mouth of the river and employed their time in hunting game and drying the flesh of the larger animals for subsistence on their journey. To this they added 70 bushels of nuts of various kinds, and apples, plums and grapes (all wild of course.) They spent the winter at this place, and six months afterwards, on March 23rd, 1670, they erected a cross bearing the arms of Louis XIV of France, and took formal possession of the country in the name of that king. Three days afterwards they resumed their voyage to the west, and while encamped upon Long Point a violent gale in the night arose, destroying the contents of one of their canoes. They deplored the loss of their powder and lead, but most of all of their holy chapel, without which the Eucharist could not be celebrated. They proceeded onward, however, through Lake Erie, Detroit river, and Lake Huron even to Sault Ste. Marie, but becoming discouraged returned thence to Montreal by way of the French and Ottawa rivers. An immense distance truly to be paddled in open canoes.

IRON AND STEEL.

A Brief Historic Sketch of their Manufacture and Use.

BY A. T. FREED.

It is customary to speak of the stone, the bronze and the iron ages of the world, as if they were distinctly marked epochs. It is a mistake so to regard them, for, while our fathers undoubtedly abandoned stone weapons and implements for bronze, and bronze for iron, the changes took place at widely remote periods in different countries, and the periods in which the several materials were used in the same country overlapped each other. National intercourse was slow and restricted in the early ages of the world, and one nation would be in possession of an important discovery long before another not distant nation had heard of it. The bronze age had come and gone on the shores of the Mediterranean, and iron was in general use while as yet the Scandinavians and Britons were rudely carving deers' horns with flint knives and destroying their enemies with bludgeons. In the vast host which Xerxes led into Greece were warriors bearing stone weapons, while the great majority were armed with bronze, and a few had advanced to the use of steel. So that to speak of the ages of stone, of bronze, and of iron is as indefinite as if we should divide history into the ages of absolutism, limited monarchy, and republicanism.

The dawn of history found iron in limited use. Chinese historians say that it has been employed in their country for many thousands of years. Pliny the elder, in the early days of our own era, wrote that, "as many kinds of iron as there be, none shall match in goodness the steel that cometh from the Seres, for this commodity also, as hard ware as it is, they send and sell with their soft silks and fine furs. In a second degree of goodness may be placed the Parthian iron." India has made steel of the finest quality from times immemorial, and the method which was in use in prehistoric times is observed there to this day. A small clay crucible is made in which not more than two or three pounds of fine soft iron are inclosed together with charcoal, and covered with leaves of a certain plant, when the whole is subjected to great heat till the iron is melted and the result is a button of very fine and pure steel which they call wootz. When Alexander defeated Porus, the latter gave the conqueror 30 pounds of this steel, which was highly prized by him. Malleable iron was also made in India in large quantities in very early times. There is in the gate of a mosque near Delhi a pillar of soft iron 60 feet high, 16 inches in diameter near the base, and estimated to weigh 17 tons. A Sanscrit inscription is interpreted by some to affirm that this pillar was erected in the tenth century before our era, and by some it is understood to make its date 1400 years later. In the ruins of very ancient Indian temples wrought iron beams have been found, and metallurgists are puzzled to understand how these immense masses could have been handled and wrought by means known to have been in existence in those days. The Chalybians, a people inhabiting the southern shores of the Euxine, were famous among the ancients for their iron and steel. Herodotus speaks of them as "a people of iron workers," and from them steel was named.

Frequent mention is made of iron and steel in the Hebrew scriptures, but it is to be noted that when Solomon would build the temple, a thousand years before our era, he was obliged to send to the King of Tyre for a man skilled to work "in gold and silver, and in brass and in iron." Chaldean inscriptions speak of iron as having been in use from time immemorial. Nebuchadnezzar in an inscription telling of his works of improvement in Babylon says, "With pillars and beams plated with copper and strengthened with iron I built up its gates." His daughter Nitocris built a bridge the stones of which were held together by bands of iron fixed in their places by molten lead. At Nineveh, Layard found numerous relics, including "a perfect helmet of iron, inlaid with copper bands," as well as many other articles of iron. "Two or three baskets were filled with these relics."

In Egypt iron was used in the earliest times. In 1837 a piece of iron was taken from an inner joint of the great pyramid at Gizeh, which is now in the British Museum. The almost universal opinion of the best Egyptologists places the erection of that edifice at about 3,000 years before our era, so that this venerable piece of rusty metal is undoubtedly the oldest piece of manufactured iron of which men have any knowledge. Wilkinson copies an engraving showing the process of smelting iron by the aid of bellows in the shape of leather bags, trodden by a man who exhausts the air from one while with a string he raises the other and permits it to be refilled. Butchers are depicted on monuments wearing steels such as are used to-day. Sickles and other weapons of steel are pictured in great numbers and colored blue to distinguish them from the bronze weapons which are colored red. Belzoni found an iron sickle under the foot of a sphynx at Karnak, and it is now in the British Museum. Kenrick, in "Ancient Egypt under the Pharaohs," copies an account of a military expedition made by Thothmes I., who reigned about 1700 years before our era. From some of the Deltan Kings this monarch received as tribute or presents gold and silver, as well as "bars of wrought metal, and vessels of copper, and of bronze, and of iron." From the region of Memphis he received wine, iron, lead, wrought metal, animals etc. When I read that the same king in a successful foray against "Chadasha" took much booty, including "iron of the mountain, 40 cubes," I was tempted to think that Jerusalem must have been meant; but I believe the Chadasha mentioned is understood to be a city of the Khetæ or Hittites, and not Jerusalem, the Khodesh or sacred city of the Jews and El Khuds of the modern Arabs.

The dawn of history finds iron in use among the Greeks. One legend, and the most probable, says they derived a knowledge of it from the Phœnicians, while another says that the burning of the forests on Mount Ida smelted the iron ore exposed to the flames, and revealed the secret of working in iron. That such could have been the case is next to impossible.

Homer speaks of iron and weapons of iron and steel—rarely in the Iliad, frequently in the Odyssey. I leave the Wolfian and other Homeric scholars to decide whether any particular significance attaches to the fact. Nor will I pretend to say whether or not Homer had historic knowledge enabling him to decide that iron implements and weapons were used during the siege of Troy, say about 1,200 years before our era, or whether he simply supposed conditions similar to those he saw around him to have existed in the days of which he wrote, just as Shakespeare supposed cannon to have been used in the days when the Danes governed England. Homer mentions axes of steel. Gladstone in his Homeric Synchronisms, says: "Iron is, in Homer, exceedingly rare and precious. He mentions nothing massive that is made of this material." Among the prizes offered at the funeral games of Patroclus is "a mass of shapeless iron fresh from the forge," and Achilles says:

> Stand forth, whoever will contend for this;
> And, if broad fields and rich be his, the mass,
> Will last him many years. The man who tends
> His flocks or guides his plow need not be sent
> To town for iron; he will have it here.

We may infer from this that iron was very valuable, for the mass in question was no more than a man might lift; and that it was used in agriculture before it was utilized for the manufacture of arms or armor.

As early as 700 years before Christ the iron ores of Elba were worked by the Greeks, who called the island Ethalia, "from the blazes of the iron works." Strabo says that at the beginning of our era the iron mines of Elba were exhausted. Glaucus of Chios made a silver cup, inlaid with iron about 560 B. C. Sophocles, 400 B. C., speaks of the tempering of iron in water, and it is certain that steel swords were made about the same time. The father of Demosthenes made steel arms. When Xerxes invaded Greece, the Assyrians who accompanied him were armed with clubs "knotted with iron." Daimachus, a Greek writer of Alexander's age, mentions four kinds of steel, the Chalybdic and Synopic, from which ordinary tools were made; the Lacedæmonian, from which were made files, augers, chisels and stone-cutting implements, and the Lydian, which was used in the manufacture of swords, razors, and surgical instruments. Iron sickles and other agricultural implements were common in the time of Alexander.

The Romans were not workers in iron, though they encouraged the industry among the peoples whom they conquered. The mines of Elba, which had successfully been worked by the Phœnicians, the Greeks and the Etrurians, continued their operations under Roman rule; but we do not learn that any improvements in processes of manufacture were introduced. The bellows were substantially the same as the blacksmith's bellows in use in our day, and the first reduction of the ore produced a small loop or bloom of spongy malleable iron, which was beaten on an anvil into the shape most suitable for transportation to market for the blacksmith's use. That iron weapons were in use at an early day is proved by the fact that king Porsenna, 500 years before our era, imposed upon the Romans as a condition of peace that they should use iron for agricultural implements only. The best iron brought to Rome at the beginning of our era came from Noricum, corresponding to parts of Styria and Carinthia, and it is believed that the mines now worked at Erzberg and Huttenberg are the same that were worked twenty centuries ago. The Quadi, who lived north of Noricum in what is now Moravia, were then spoken of as a nation of iron workers; and it was from Moravia that, fifteen centuries later, one of the most valuable discoveries in connection with iron—that of coating it with tin—was derived.

The Spanish iron industry flourished during the Carthaginian occupation, and probably before. The Romans attributed Hannibal's success at Cannæ in part to the fact that his troops were armed with Spanish swords of superior quality. Diodorus Siculus speaks of Spanish two-edged swords "exactly tempered with steel," made from iron which had been buried in the ground "to eat out all weaker particles of the metal, and leave only the strongest and purest." The notion is not yet quite extinct that rust first attacks and destroys the poorer and baser parts of the iron, leaving the finest and the best. The manufacture of Toledo blades, begun in prehistoric times, has continued till our day, attaining its greatest proportions, as the weapons attained their greatest celebrity, in the fifteenth and sixteenth centuries.

When Cæsar invaded Britain, 55 years before our era, he found iron in use there. Most accounts represent that the natives who met the Romans employed chariots armed with iron scythes. I have looked carefully through Cæsar for confirmation of that statement; but, though I find many references to the chariots, I find no account of the iron scythes. It is certain, however, that the Britons had iron. Some writers think that they did not make it, but obtained what they had from the Belgæ, with whom they had considerable intercourse, and who certainly manufactured iron. Others maintain that the Britons themselves made iron. Cæsar says of them: "They use either brass or iron rings, determined at a certain weight, as their money. Tin is produced in the midland regions; in the maritime iron; but the quantity of it is small; they employ brass, which is imported." Cæsar's stay on the island was brief, and his knowledge of it far from extensive or accurate. My own belief is that at the time of Cæsar's visits, iron had been made in Britain for centuries, and in considerable quantities. At various places in England, but chiefly in the Weald of Kent, the Weald of Sussex, and in the Forest of Dean in Gloucestershire, have been found vast beds of cinder or slag, the remains of iron works which existed there in very early times. That these operations were carried on during the Roman occupation or later is evidenced by the fact that Roman coins and pottery have been found in the cinder. But I believe they were also carried on before the arrival of the Romans. The smelting operations were to a large extent conducted in wind bloomaries, without any artificial blast. These bloomaries were built on the tops of hills, with openings in the direction of the prevailing winds. The ore, mined with infinite patience and toil, was carried up to these furnaces on men's backs, and the operation was wasteful of metal as of labor; for so little of it was extracted from the ore that in late years the slag has been remelted in modern furnaces, and the operation found remunerative. Now, the Romans had for centuries been accustomed to the use of the bellows in smelting iron; and if they had introduced the industry into Britain they certainly would have adopted the methods known to them and not have reverted to a ruder, more wasteful and more laborious one. I am therefore compelled to believe that when the Romans invaded Britain they found the wind bloomary in use. The hearths of more modern bloomaries have been found, with Roman coins and remains among the ashes; and these are pretty good evidences that during the Roman occupation, improvements based upon Roman knowledge were introduced. Andrew Yarrantan says that "within a hundred yards of the walls of the city of Worcester there was dug up one of the hearths of the Roman foot blast, it being then firm and in order, and was seven feet deep in the earth, and by the side of the work there was found a pot of Roman coin to the quantity of a peck." Strabo says that in his day iron was exported from Britain. In the year 121 a great Roman military forge or fabrica was established at Bath, the iron used at it being obtained at the Forest of Dean. At the time of the Conquest the same region was noted for its iron industry. Camden says that "in and before the reign of William the Conqueror the chief trade of the city of Gloucester was the forging of iron, and it is mentioned in Doomsday book that there was scarcely any other tribute required from that city by the King, than certain dicars of iron (a dicar containing ten bars and one hundred rods) for the use of the royal navy. In 1112 there were in the Forest of Dean 72 *forgeæ errantes* or movable forges, each of which paid a license of 7s. to the crown. The Scotch at this period made no iron, and had none but that which they imported from the continent or stole in England. We are told that in a predatory expedition which they made in 1317, they found no iron worthy of notice till they came to Furness in Lancashire, where they seized all the manufactured iron they could find and carried it off with the greatest joy, though so heavy of carriage, and preferred it to all other plunder." Soon after the Conquest English iron began to be known abroad, and it was exported even to Spain. It was very dear, however, and highly prized.

Thorold Rodgers says that "no direct information about the seasons is so frequent as that found in the notices which the bailiff gives about the great cost of iron." It was the custom for the farm bailiff to buy the year's supply of iron at the great annual fair and to dole it out as needed, a blacksmith being employed to mend or make the necessary implements. The articles most frequently mentioned are plow shoes, or points to wooden plows, horse shoes and nails. Sheffield was already noted as a seat of the hardware manufacture in Chaucer's time, for of one of his characters the poet says, "a Shefeld thwitel bar he in his hose." Birmingham was famous for its production of swords, tools and nails.

Up to this time no great improvement had been made in the manufacture of iron. The furnace was a small square bloomary furnished with leather bellows, worked by manual power, and the product was a bloom, or loop, or wolf of malleable iron. A few of these furnaces yet remain in Spain and Hungary; and Overman says that they are from 10 to 16 feet high, 2 feet wide at the top and bottom and 5 feet at the widest part. An opening in front, called the breast, was kept open until the furnace was heated, when it was closed with brick, the ore and fuel were put in at the top and the blast was supplied by "two bellows and nozzles, both on the same side." The product was called a salamander of mixed iron and steel weighing from 400 to 700 pounds, which was taken out of the breast and reduced to bars by hammers.

At the close of the 14th century the English blacksmith executed excellent work. Picton says: "Ironwork at this period was of the most elaborate description. The locks and keys, the hinges and bolts, the smith's work in gates and screens, exceed in beauty anything of the kind which has since been produced." The defensive armor made in England was also exquisitely wrought.

We are indebted to Germany for the development of the bloomary into the high furnace by which the product was changed from malleable to cast iron. The old bloomary had been gradually increased in capacity; but a limit was imposed upon that development by the impossibility of creating a strong blast by means of the bellows then in use. The same cause operated to render abortive early attempts in England to substitute mineral fuel for charcoal. Wooden tubs or cylinders in which a piston, operated by water power, expelled the air with considerable force, were invented by Hans Lobsinger in Germany, in 1550. From that time the furnace grew higher and wider, and the blast stronger. At first a portion of the ore was reduced to a bloom of malleable iron, or mixed iron and steel, and a portion flowed to the bottom of the hearth as cast iron. As the furnace grew still larger the ore absorbed more carbon from the fuel till the whole of it was melted. The old furnace was then known in Germany as a stuckofen and the high furnace a blauofen or flussofen, that is a blast furnace, because of the strong blast from the improved bellows, or a flowing furnace because the product was withdrawn in the shape of a stream of molten iron. In England, however, bellows of wood on the old pattern were made of great size and operated by water power, and these supplied a blast strong enough for the conversion of the ore into cast iron.

In Elizabeth's time the iron industry had so reduced the forests by the great consumption of charcoal, that repressive laws were passed; the production of iron was greatly lessened, and the industry continued in a low state till the use of mineral coal was introduced.

Still, during that very period, nearly all the improvements in connection with the iron industry were made in Britain, and it was the ingenuity and originality of her inventors, no less than the enterprise of her business men, which gave to England the preeminence in iron manufacture which she enjoys to-day. A highly important invention was that of rollers for converting blooms into rods, bars, or plates instead of performing that work by the slow and laborious manipulation of the hammer. It is customary to say that Cort invented rolls in 1782; but I found in the library of the Franklin Institute at Philadelphia a copy of a patent granted to John Payne nearly half a century earlier. This patent is dated Nov. 21, 1728. The first part is for the conversion of cast into malleable iron by the application of ashes, salt, etc., to pig or sow iron while in the refinery fire, "which," the patent says, " will render the same into a state of malleability as to bear the stroke of the hammer, to draw it into barrs, or other forms at the pleasure of the workman, and those or other barrs being treated in the said melted ingredients in a long hot arch or cavern, as hereafter described; and those or other barrs are to pass between two large mettall rowlers (which have proper notches or furrows upon their surfass) by the force of my engine hereafter described, or other power, into such shapes and forms as shall be required." In this document we have a faithful description of grooved rolls, and also an account of the decarbonization of cast iron in a reverberatory furnace—that is a process of puddling iron, instead of reducing it to nature by the slow and expensive process of repeated heatings and hammerings, as had theretofore been practiced.

Another candidate for the honor of having invented rolls was Major John Hanbury, who professed to have made the discovery in 1729, a year after Payne's patent was granted. About 1680 Andrew Yarranton was sent into Saxony to learn the art of coating iron with tin. The knowledge of that process is said to have been carried into Saxony from Bohemia by a clergyman, but its origin is lost. Yarranton succeeded in his mission, and brought the art into England, where the manufacture of tinned plates soon assumed considerable proportions, not only for home use, but for export. After the introduction of rolls the English plates were considered superior to those made on the continent, because they were rolled and not hammered, and were consequently of equal thickness throughout.

A great impetus was given to the iron trade in England by the labors of Henry Cort toward the close of the 18th century. He greatly improved the rolls and brought them into general use; and he perfected the process of puddling, bringing it substantially to its present perfection. It will be remembered that the product of the low bloomary was malleable iron. The carbon in the fuel was all burned away by a strong blast of air directed through the tuyeres upon the bloom as it formed. The process was slow and expensive, though it is to be noted that bloomaries only slightly improved are in use to-day and produce high grade malleable iron of first rate quality in competition with modern furnaces. When the high furnace was introduced it made the first production of iron much cheaper, but the iron was cast iron, and the expense of converting it into malleable iron in the finery was tedious and costly. Cort by the puddling furnace made the operation simple and very much cheaper.

Another highly important improvement introduced into England about the middle of the eighteenth century was the substitution of mineral fuel for charcoal. The attempt had been made a centnry earlier by Dud Dudluy, a cousin I believe of the unfortunate husband of Lady Jane Grey, but though he demonstrated the practicability of it, he achieved for himself only ridicule, disappointment and great pecuniary loss. Revived in 1735 by Abraham Darby at Coalbrookdale in Shropshire, it proved immediately successful, and restored to Britain her iron industry, which had fallen into a great decline through want of fuel. The first iron cylinders for supplying a blast to the furnace were constructed by John Smeaton at the Carron Iron Works in Scotland, and steam was first used at the same works to furnish the power through the influence of of Dr. Roebuck.

Since then the only important improvements introduced in the productive iron industry have been the application of the hot blast, first employed by Neilson in Scotland in 1728, and the withdrawal of unconsumed gases from the top of the furnace, and their utilization for the production of heat. I think France is entitled to credit for that discovery.

Iron is of two kinds—cast iron, containing from 3 to 5 per cent of carbon, which is brittle and granular in its construction; and malleable or wrought iron, which is ductile and fibrous, and contains little or no carbon. Between the two lies steel, containing from a quarter of 1 per cent to 2 per cent of carbon. If you ask me for a technical definition of the word steel, I shall tell you frankly that I cannot give it, and I have heard some very expert metallurgists express dislike to be put to the same test. A few years ago you would be told off hand that steel was an article which would forge, temper and weld; but if you demand these qualities to-day you will relegate to the iron heap a great many articles which the world calls steel, including all metal produced by the pneumatic process. I believe the article produced in the Bessemer converter, however, to be a true steel, but it will not weld.*

In former times steel was sometimes obtained as part of the product of the bloomary united in certain proportions with soft iron in the bloom or loop. But when it was desired to produce steel from iron, very fine bar iron was arranged in layers in a fire-brick oven, each layer of iron being overlaid with charcoal. All openings were then carefully closed with clay and the whole oven was heated to redness and kept at that temperature for from seven to ten days.

* Since this paper was read I have learned that improvements in the pneumatic process have resulted in producing steel that will weld, and that Bessemer steel is daily being applied to new uses.

This process is still employed, and the product is variously known as cement or blister steel, or, if the bars are rolled together to secure homogeneity, as shear steel. Reaumur described this process in 1722; and it is not known how long before his time it was employed or where, when or by whom it was introduced. About the middle of last century Benjamin Huntsman, in England introduced the modern method of making crucible cast steel substantially as it is practiced to-day.

Steel was also sometimes made by dipping bars of soft iron into molten cast iron, from which they absorbed a portion of the carbon and were converted into steel; and sometimes malleable and cast iron were fused together in a close chamber producing steel of an inferior quality.

Siemens-Martin steel is made by the decarbonization of cast iron in a reverberatory furnace heated with gas, the flame of which assists the reaction; and the subsequent recarbonization of the bath by the addition at the close of the process of white iron, spiegeleisen, or ferro-manganese. The operation requires from four to eight hours.

The Thomas-Gilchrist process is simply an improvement upon the Bessemer or pneumatic process. A chemical lining is put into the converter, which absorbs phosphorus and other objectionable minerals from the melted metal, and permits the use of a lower grade of iron than is possible in the Bessemer process.

Puddled steel is made in much the same way as wrought iron is made from cast iron. That is, the iron is melted in a reverberatory furnace exposed to a strong draught of atmospheric air, and is kept stirred or puddled until the oxygen of the air unites with the carbon in the iron and burns it out. If steel is desired the metal is withdrawn before all the carbon is consumed; if iron is desired the process is continued till the carbon is consumed, when the metal is brought to a spongy, pasty condition, is rolled into balls or blooms, and is lifted to the squeezer, where the slag and other impurities are squeezed out. Puddled, or open hearth steel, as it is generally called is growing in favor, and in England its production is increasing more rapidly than that of Bessemer or pneumatic steel.

The most important metallurgical discovery of the age was that of making steel from cast iron by the pneumatic process. This was the invention of Sir Henry Bessemer, and was made about 30 years ago. Bessemer's first idea was to produce wrought iron by forcing a strong blast of atmospheric air through the melted iron by which the carbon would be burned away and the iron reduced to nature. His earlier experiments were disastrous failures. The iron produced was so brittle as to be almost worthless, and no steel worthy of the name could be made. At length Mr. Robert Mushet suggested that if manganese were added to the iron good steel could be made. This was done and proved highly successful. Some improvements were also made in the lining of the converters by which the amount of silicon in the iron was reduced. The Bessemer process requires a good quality of pig iron, reasonably free from phosphorus, sulphur and arsenic, and not containing a superabundance of silicon or titanium. This is melted in an ordinary furnace and conveyed to the converter, which somewhat resembles an immense soda water bottle with the neck wrenched to one side. The ordinary converter contains from five to ten tons of molten iron, but is then not more than one fourth filled. A powerful blast of air is now conveyed to the bottom of the converter whence it rises through the iron, uniting with the carbon, producing combustion and intense heat. The blow is usually continued from 15 to 20 minutes, and manganese is added during the process, generally in the shape of spiegeleisen, but sometimes as ferro-manganese. When the operation has continued a sufficient time, which is determined by means of the spectroscope, the blast is stopped, the converter is tipped to one side, the metal flows into moulds, and the ignots so formed are known as Bassemer blooms. Sir Henry Bessemer's royalty amounts to only a shilling a ton, but in 1879 Mr. J. S. Jeans, secretary of the British Iron Association, wrote that he had then received from his patent upward of £1,050,000 sterling.

A description of the first iron works established in Canada will not, I hope, prove uninteresting.

Colbert, the great French financier and Prime Minister to Louis XIV., was strongly impressed with the importance of the Canadian dominions of France, and he carried on a long correspondence with M. Talon, the royal intendant, with a view to the discovery and working of mineral treasures in New France. Many of the letters are now in the Parliamentary Library at Ottawa.

In 1650 Father Drouillettes, a member of that noble band of

Jesuit missionaries who did so much to explore and develop not Canada alone, but the whole country as far as the Mississippi, settled among and converted to Christianity a tribe of Indians, the Attikamegues, living near Three Rivers, at the mouth of the St. Maurice, on the north bank of the St. Lawrence, about midway of Stadacona (Quebec) and Hochelaga (Montreal.) It is probable, though not certain, that Father Drouillettes reported the existence of iron near that point, for in 1666, M. Talon, who had been sent by Colbert to Gaspe to look for silver and had failed, sent the Sieur de la Tesserie to Baie St. Paul, near Trois Rivieres, where he found iron ore which appeared to be rich. M. La Portardiere was sent from Quebec to inspect the mine, but his report was unfavorable, and nothing practical was done for seventy years.

In 1681 the Marquis de Denouville reported to his Majesty's Government that he was convinced a very fine iron mine existed at Trois Rivieres, where a forge could be profitably worked. He said he had sent some of the ore to M. Colbert, who tested it with favorable results. In 1686 the same nobleman reported that he had sent a sample of the ore to France, where the iron workers found it "of good quality and percentage," and desired fifteen or twenty "bariques" of it to give it a thorough trial. In 1672 the Count de Frontenac reported that he had begun to mine the ore and that "there are six piles of ore now lying at Cape Madeleine, which, according to the annexed report of the miner, would last for two castings per day for four months." He strongly urged the establishment of "forges and a foundry."

In 1737 a firm known as Cugnet et Cie., was formed by royal charter, which acquired the mines and a tract of forest land, and at once erected two furnaces, a foundry and dwelling for the operatives. There was a French garrison at Trois Rivieres, and the soldiers were the principal workmen. The operations appear to have been very unprofitable, for in a few years Cugnet et Cie. surrendered their charter to the local Government, and the works were carried on for some time by agents of the Crown. The fuel used was charcoal, and the product of the furnace was pig iron. The greater part of this was cast into stoves, pots, etc., for local use ; but some bar iron was made, though I can find no description of the method employed. It probably was the old method of repeated heatings and hammer ings, as there was a trip hammer operated by water power.

In 1752 M. Bigot, who was at that time Intendant of New France, resident at Quebec, instructed M. Franquet to visit the St. Maurice forges, and his report is of great interest. After describing the locality he says: "The stream that drives the machinery of the establishment is dammed up in three places; the first dam drives the wheel for the furnace, the second and third each a trip hammer. . . . It is supposed that the stream or water power is sufficiently strong to drive two other hammers. . . . On entering the smelting forge I was received with a customary ceremony; the workmen moulded a pig of iron about 15 feet long, for my especial benefit. The process is very simple ; it is done by plunging a large ladle into the liquid boiling ore and emptying the material into a gutter made in the sand. After this ceremony, I was shown the process of stove moulding, which is also a very simple but rather intricate operation.* Each stove is in six pieces, which are separately moulded; they are fitted into each other and form a stove about three feet high. I then visited a shed where the workmen were moulding pots, kettles and other hollow ware. On leaving this part of the forge we were taken to the hammer forge, where bar iron of every kind is hammered out. In each department of the forges the workmen observed the old ceremony of brushing the stranger's boots, and in return they expect some money to buy liquor to drink the visitor's health. The establishment is very extensive, employing upward of 180 men. Nothing is consumed in furnaces but clean coal, which is made in the immediate vicinity of the post. The ore is rich, good and tolerably clean. Formerly it was found on the spot : now the director has to send some little distance for it. . . . This iron is preferred to the Spanish iron, and is sold off in the King's stores in Quebec at the rate of 25 or 31† per hundred pounds weight."

In 1760, Quebec having been taken by Wolfe, Canada was ceded to Great Britain, and among the stipulations in the treaty was one that the papers relating to the forges should remain in the possession of M. Bigot, the intendant, and should be transmitted to France without inspection of the British.

For seven years after the event the works lay idle, but in 1767,

* Intricate simplicity was probably common in those days.

† The editor says "castors."—beaver skins.

Christopher Pelisier formed a company which obtained a concession from Governor Carleton for the working of the forges for 16 years, at an annual rental of "£25 lawful money of our said province of Quebec." An indication of the relations so soon established between the French and English people of Canada is furnished by the names of this company which embraced, Christopher Pelisier, Alexandre Dumas, Thos. Dunn, Benjamin Price, Colin Drummond, Dumas St. Martin, George Alsopp, James Johnston and Brooke Watson. When this lease expired Conrad Gugy took the works at the annual rental of £17 15s. sterling. Various persons conducted the business down to 1801, when another firm took it at £85 sterling, which rental was reduced in 1810 to £50 currency.

In 1815 a visitor wrote: "The foundry itself is replete with convenience for carrying on an extensive concern; furnaces, forges, casting houses, workshops, etc., with the dwelling houses and other buildings, have quite the appearance of a tolerably large village. The articles manufactured consist of stoves of all descriptions that are used throughout the Provinces, large caldrons or kettles, that are used for making potashes, machinery for mills, with cast or wrought iron-work of all dimensions. There are likewise large quantities of pig and bar iron exported. The number of men employed is from 250 to 300.

The ownership remained in the Government till 1846. In the year named the property was sold to Henry Stuart, who seriously embarrassed himself by large and ill advised expenditures. He then rented it, and it subsequently fell into the hands of Andrew Stuart and John Porter, of Quebec, who worked on a limited scale till 1859, when the fires were extinguished.

The only information, later than that in the narrative which I have been able to get is contained in a report to Parliament made in March, 1879, which says: " The St. Maurice Forges.—Owned by F. McDougall & Son, Three Rivers; using a bog ore; making a very fine iron with charcoal fuel. The first furnace was erected in 1737. Still running with same fuel; capacity four tons.

METHODS AND RESULTS OF TORONTO OBSERVATIONS.

BY LIEUT. ANDREW GORDON, R.N., DEPUTY SUPERINTENDENT
METEOROLOGICAL SERVICE OF CANADA.

The Toronto Observatory was one of the five which were established by the Imperial Government with a view to extending the knowledge of magnetic phenomena.

The elements on which the determination of the earth's magnetic force is based are the declination, inclination, and intensity. The declination determines the direction of the force referred to the plane of the meridian (astronomical.) The inclination determines its direction in reference to the horizontal plane. If in addition to these quantities we know the measure of the intensity expressed in some absolute unit, the force will be completely determined. The absolute unit which has been adopted by English observers is for mass, the grain; for space the foot; and for time the second. The idea may be readily grasped from the following. When two south poles, distant one foot from each other, are charged to equal strength, and repel one another with a force which, if continued uniform, would produce in one second a velocity of one foot per second in a mass of one grain, each pole is said to be charged with unit magnetic force.

For the purpose of detecting and examining the more minute changes in the magnetic force a different system of elements is employed, the intensity being resolved into two portions in the plane of the magnetic meridian, one portion horizontal and the other vertical. It is readily seen that these two components may be substituted for the total intensity and the inclination, being connected with them by the relations

$$X = R \cos I; \; Y = R \sin I$$

where X and Y are the horizontal and vertical components of the force, and R and I the intensity and inclination respectively. Variations in R and I are then expressed in terms of the variations in X and Y.

Of these elements the declination was the first to be examined, and I shall now treat briefly of it. The declination called by sailors the variation has been the subject of investigation for hundreds of years. Humboldt awards the distinction of having discovered the changes in declination to Columbus, who on the 13th September, 1492, records the fact that in lat. 28° north and long. 28° west or thereabouts, the direction of the needle changed from east of north to west of north. It appears however, that the heathen Chinee was aware of this fact as early as the twelfth century, for in a treatise by a Chinese philosopher at this date it is distinctly stated that the magnetised needle did not point north and south but always declined to the east of south.

It is the business of a permanent Observatory to watch and record the changes which take place in the elements of magnetic force. These changes are of three kinds, called secular changes, periodic changes, and disturbances.

The secular change is that which takes place from month to month and year to year, and taking the Toronto observations of declination, the change has been from 1° 14'·3 west in 1841 to 3° 51, west at the present time; the annual increase varying in amount from 1'·8 in 1848 to 7'·5 in 1875. The necessity for careful and long continued observations is in this amply exemplified, as it must be remembered that the charts on which ships are navigated have the declination curves laid off on them, and have a fixed amount to be applied as an annual increase or decrease to the declination laid down, but this annual correction is a fluctuating quantity, hence unless corrected from time to time errors would soon accumulate.

The diurnal or first periodic range in declination has at Toronto an amplitude of from eight to ten minutes of arc, the needle moving rapidly from an extreme easterly position about 7 to 9 a.m., to an extreme westerly one at 2 p.m., returning though with a minor curve westwards, and generally remaining to the east of the mean position all night. The other elements have also a regular daily fluctuation.

Disturbances are sudden and irregular fluctuations of the magnet, some of which seem to be camparatively local whilst others are practically universal; changes of a similar character and almost similar amounts occurring at Zika Wei, in China, at Toronto, at Kew, in Great Britain, and at Melbourne, Australia, at almost the same instant of time. Of the causes of these irregular movements, or as they were christened by Baron Humboldt, magnetic storms, little can at present be said that is not conjecture. This much may however, be safely asserted, that all the greater disturbances when their mean effects are taken for a sufficient period of time, have a character of periodicity. This was first suggested by General Sabine in his comments on the observations at the Toronto Observatory for the years 1841, 1842, and further comparisons have elicited the fact that the disturbances (speaking of the declination) are more frequent at the equinoxes than at the solstices, and occur most freqently at night, the proportion of those occurring at night, to those in the day being approximately ::8 : 5 These disturbances have also a regular period approximately eleven years, a maximum occurring between 1848 and 1853, with 1843 and 1856 as the years of minimum disturbance increasing again to a maximum in 1860. Such regular fluctuations in the amount of disturbance preclude the idea that these differences are accidental.

Additional evidence of the existence of this eleven year period may be found in M. Arago's observations taken in the year 1821 to 1830, showing minimum daily range in 1823 and maximum in 1829, 1882-3 is also expected to be year of maximum disturbance, and accordingly we have already had a disturbance far greater than has been observed for many years.

The progressive increase in the range of the diurnal variation concurrently with an increase in the number and values of disturbed observations at places widely apart, suggests the idea that they proceed from some common cause, and though we cannot at present say by what physical agency these disturbances are produced, still, since we find that variations like the regular diurnal variations have also a diurnal law, and since the sun is at least a primary source of all magnetic variations which depend on local time, it is natural to enquire whether the sun has any periodical variation having a coincident epoch.

Now, M. Schwabe's investigations, extending from 1826 onwards, seem to show an affection of the solar atmosphere, whose periods of maxima and minima exactly coincide with those of the magnetic disturances and the extent of the diurnal range of the needle. In Humboldt's Cosmos will be found a table containing the results of M. Schwabe's observations of sun spots from 1826 to 1850, and in Walker's treatise on terrestrial magnetism the same table extended up to 1864, and from this we find that the following are the minima years: 1833, 1843, 1856 and 1866.

Another singular point is on record which adds to the weight of proof that the condition of the sun's outer envelope bears its couterpart in the magnetic condition of the earth. It was witnessed on September 1, 1859, by Mr. Carrington, at Redhill, England, while observing the sun's disc. He was taking observations of the forms and positions of the solar spots, the sun's image being projected on on a plate of glass, coated with distemper of a pale straw color, at a distance, and under a power which presented a picture of about 11 inches in diameter. Suddenly within the area of the largest group there broke out two patches of intensely white light. The outburst after increasing for some seconds rapidly died away, the whole duration of the phenomenon being not more than five minutes. In this interval the two patches had traversed a space of about 35,000 miles. On visiting the Observatory at Kew a few days later he found that at the instant when he had observed the phenomenon the three magnetic elements were simultaneously disturbed, the time of duration of the disturbance being about ten minutes.

The above incident taken with the almost exact coincidence between the periods and turning points in three classes of phenomena so widely different as the magnetic disturbances, the diurnal range and the frequency of the solar spots, leaves, I think, little doubt that the coincidence is not accidental but causal.

Professor Balfour Stewart, of Owen's College, Manchester, has lately been investigating the observations of temperature taken at the Toronto observatory with a view to determining the existence of a thermometric period similar to the sun spot period. His results are published in appendix G to the report of the committee to advise on the methods of carrying on observations in solar physics. I shall now quote from the concluding portion of Professor Stewart's report :

" In the course of this paper I have given evidence which tends to show that there are in all probability solar variations of short period, and that these are connected with variations in the temperature range. Toronto was chosen as a station from which accurate information, with regard to temperature, was to be obtained, and also as one which, being in America, may be supposed to be influenced more directly and immediately by solar changes than an equally good station in Europe."

Similar results have been obtained from a comparison with the temperature ranges at Kew and Utrecht, as well as in the magnetic declination ranges at Kew, Prague and Travendrum.

Evidence has been adduced to show that the phase of a given meteorological inequality is not the same at different stations, but that the maximum or any other salient point reaches Kew about eight days after it has appeared in Toronto, and Utrecht about a day and a half after it has appeared at Kew.

A similar progress from west to east, but only quicker, is suspected in what may be called magnetic weather.

In conclusion Professor Stewart says the evidence tends not only to show that solar variations of short period exist, but to render it possible, if not probable, that they are the cause of temperature range periods of similar length, in such a way that a maximum amount of spots corresponds to a maximum and not a minimum temperature range, or in other words denotes, in all probability, an accession of solar energy and not a diminution thereof.

The fact, then, may be admitted as established that there are fluctuations in the meteorological and magnetic conditions of the earth, which have epochs coincident with disturbances in the solar atmosphere and that the major period is approximately eleven years. It has also been determined that both magnetic and meteorological weather travel from west to east. The magnetic weather (as we may call it) preceding the meteorological, and it remains for continued careful observation and study to develop results which may be of the greatest practical utility, for if the laws which govern the relations between magnetism, solar spots and terrestrial meteorology were once established, the magnetic needle would take its place as one of the instruments to be carefully watched in making weather predictions, extending over comparatively longer periods than we are at present able to attempt.

I shall now endeaver to describe the magnetic instrumental appliances in use at the Toronto Observatory.

Besides the instrument used for making the absolute determinations, we have two sets of differential instruments, one for noting the changes by direct eye observation, and the other recording by aid of photography, the changes which take place in the magnetic elements.

The changes in declination are measured by means of a magnet enclosed in a box and suspended by a thread of unspun silk. The magnet carries a mirror which reflects a finely divided scale fixed some distance off, the scale being read by means of a telescope which is securely fastened to a stone pillar. In this way small changes in azamuth of four or five seconds of arc can be immediately detected.

The changes in the horizontal component of the force are measured by an instrument invented by M. Gauss many years ago. In this instrument the magnet is suspended by two threads separated by an arbitrary interval, the circle to which the upper ends of the threads are attached is then turned until the torsion of the threads compels the magnet to take up a position as nearly as possible at right angles to the magnetic meridian, any increase of force will then pull the marked end of the magnet towards the north ; whilst if the force decrease, the torsion of the threads pulls the marked ends southwards again. As in the declinometer the needle carries a mirror which reflets the fixed scale by means of which the amount of change is measured.

Changes in the vertical component of the force are measured by a magnet suspended by means of knife edges on agate planes and therefore only free to move in the vertical plane, this needle is mechanically balanced so that at the normal force the magnet shall be as nearly as possible horizontal, an increase of force will cause the north end of the magnet to dip, the angle through which it moves being measured by means of micrometers.

The photographic instruments are placed in an underground chamber with a view of exposing them as little as possible to change of temperature. As in the instrument used for direct reading, each instrument has attached to it a small mirror and immediately below a fixed mirror is attached to the slate bed on which the instruments are placed. The light from a gas jet passes through a slit into a collimating tube, the image of the slit passes then through a lense and is thrown on to the two mirrors and by them reflected through a semi-cylindrical lense which focuses the light into two bright points which are projected on cylinders carrying sensitised paper and fed forward by clock work. The spot from the fixed mirror gives a straight or base line, and that from the mirror attached to the magnet exhibiting the direction and amount of the movements of the needle. It is to the continuous record thus obtained by photography that we must look to obtain the information necessary to establish the laws of change in the magnetic elements, and on the occasion of violent magnetic storms they give us the means of comparing the most minute changes as well as the greatest, which on these occasions seem to take place at the same instant of absolute time.

Professor Grylls Adams has in this way investigated the great magnetic storm of the 11th, 12th, 13th and 14th August, 1880. This storm began at 10 hours, 20 min., G. M. T. The traces showing the same instant in Europe, Asia and America in high northern and southern latitudes, and also near the equator at Bombay, and everywhere precisely in the same way. A full report of the examinations of the records of this storm will be found in the report of the British Association for 1881, being a paper on magnetic disturbances and earth currents by Professor W. Grylls Adams, F. R. S.

Professor Adams says in closing his paper on magnetic disturbances . "We know so little as yet of the causes of the changes of the sun, and this connection with terrestrical phenomena that we can hardly do more than ask what possible causes there are that could account for the effects which are observed. Can we suppose that the sun is a very powerful magnet, and that a great alteration in his magnetism accompanies the production of the bright faculœ, and the spots in his atmosphere ? Such a change of magnetism would affect the magnetism of the earth, although the effect would not be large unless the sun is magnetized to an intensity much greater than the earth, even allowing for the difference in the mass of the sun and earth."

As I have already mentioned, Professor Balfour Stewart has pointed out that there are similar periods of short range in the solar spots and in the fluctuations of temperature at Toronto and other stations where results have been worked up.

The conclusion which he drew from these investigations was that the sun emitted more heat at times of maximum number of spots than at minimum. In order to test directly whether this was the case he devised an instrument called an actinometer. One of these instruments of a most improved pattern has been purchased for use at the Toronto observatory.

The instrument itself consists of a large mercurial thermometer, with its bulb in the middle of a cubical chamber of brass, the chamber being so massive that its temperature will remain sensibly constant for some time. This massive chamber is lined outside with felt, and this again surrounded by polished brass plates.

A lense is attached by means of a rod to the cubical chamber, and in taking the observation the sun's rays are focussed by this lense, and projected directly on the bulb of the thermometer. In taking an observation the aperture in the cubical chamber through which the sun's rays are projected is first kept closed, and say that the time of exposure has been selected as two minutes, the thermometer is first read exactly two minutes before exposure begins. It is again read at the expiration of the two minutes, and the exposure at once made by drawing out the slide which covers the aperture. Exactly two minutes after it is again read and the exposure discontinued. Again, at the expiration of another two minutes, the thermometer is read. The comparative heating power of the sun is deducted from the formula

$$R + \frac{r \times r}{2}$$

where R is the amount of heat gained during exposure, and r and r' the difference between the 1st and 2nd, and 3rd and 4th readings respectively, which indicate the heat which the instrument is losing by radiation from itself.

The great difficulty in the way of making these direct observations is the variability of the condition of the earth's atmosphere, which forms a medium of ever varying opacity, through which we are forced to view the sun. This source of uncertainty might be reduced to a minimum, if these observations were made at some great altitude, as on the top of a high mountain where the lower or grosser strata of the atmosphere would be left behind.

In Toronto we have determined to pursue the observations regularly, and endeavor to allow for the effect of the condition of the atmosphere at the time of the observation by careful simultaneous observations of cloud and the hygrometric condition of the atmosphere, etc., etc.

I am strongly of opinion that, when true observations have been taken for a sufficient length of time to determine the effect of the sun's altitude, light cirrus cloud, etc., we shall be able to detect the existence of any variability in the direct heating power of the sun.

One great difficulty which we labor under in the Toronto Observatory is that in connection with the meteorological service, there is such a vast amount of routine and purely clerical work, as correspondence, checking observations, etc., that but little can be done in the way of reducing the observations and endeavoring to deduce results. At present some of our results are being worked up at home by the committee of the Royal Society on Solar Physics, but it would be a great point gained if the Government would so add to the staff that some time might be devoted to the working up of our own results, especially in view of the fact that there is every reason to believe that these results would ultimately prove of great public utility.

DYNAMO-ELECTRIC MACHINES.

BY R. HINCHLIFFE.

The subject chosen for this evening's paper is exciting universal interest throughout the civilized world at the present time. Not only is this the case among specialists, but it has become a question of considerable commercial importance, and has attracted the attention of all classes. Since the beginning of the present century, light and heat, in their effect upon health, and for industrial purposes, have received a large share of the thought of those who have devoted themselves, not only to the solution of problems specially bearing thereon, but to all questions of scientific interest. They are so closely associated with the immense progress made in manufacturing pursuits, as to be inseparable from them. No industry can be carried on without heat and light, and the finer and more delicate the operations to be done, the greater is the demand for the presence of both. They are a matter of necessity in all processes of manipulation, and perhaps there is nothing that would cause greater consternation amongst men whose capital is employed in industrial operations, than to understand they were to be deprived of them. During the last fifty years, when steam has almost driven all other motors out of the field, heat, and the means whereby it can be raised, has become a question of very great importance. No doubt we all remember the consternation that was created a few years ago, by the intelligence that the coal fields of Britain were likely soon to be exhausted. The question was almost immediately taken up by the British Government, which resulted in enquiry showing there was no fear, even with a continually increased annual output, for the next 1000 years at least. Although heat is inseparably connected with all mechanical motion, it is of but secondary importance as compared with light. No operation could possibly be carried on without the aid of light. Light infuses life and vitality into every living organism. It is essential to life. Our very thoughts are dependent upon it, for by its aid through our senses, the brain receives impressions from without, which suggest new ideas and consequently thought. It permeates everything, and the more light that is thrown upon any subject, both figuratively and literally, the more it becomes evident to our senses, and the more easy to comprehend.

Since the general introducton of power in the manufacture of textile fabrics occured, now, about a century ago, artificial light became a necessity. This was owing to two causes; first, because of the extent of such operations, and secondly, because of the increased demand, owing to the lessened cost of production. The decreased cost of production, and the consequent increased demand, necessitated the building of large factories, which in turn required a greater supply of artificial light. This was met by a supply of gas, which had its advent about the beginning of the present century. A great impetus was then given to all industrial operations, as work which was formerly restricted to daylight could then be carried on at night; the imperfect light obtained from the burning of oil lamps, which were then used, limiting such operations. About seventy-five years ago, Davy experimented with batteries of various powers for the production of luminous sparks, and these were continued until he reached the number of 2000 cells when he not only obtained sparks of great length, but a continuous light, by passing the electric current through two pieces of charcoal. The carbons were held horizontally, which caused an arched form to be assumed by the light, and hence the name of arc light. The name is used to-day chiefly to distinguish it from light by incandescence.

The principle of induction upon which Dynamo Electric Machines are based, was discovered by Michael Faraday, to whom the world is largely indebted, for without his discovery, electric generators by power alone, could not to-day be in existence. This discovery was made about 1830, since which time many efforts have made by various scientists to utilize it for practical purposes. Faraday found that by introducing a magnet quickly into the interior of a coil of wire joined at its both ends to a galvanometer, that an electric current was induced in the coil. When the magnet was allowed to remain at rest the galvanometer indicated no current. When it was quickly withdrawn, a current was induced in the opposite direction. Motion was therefore necessary, either in the magnet, or in the coil, to induce a current. The indications of the galvanometer varied with the speed with which the magnet was introduced or withdrawn from the coil. This is the governing principle of the action of all generators, by mechanical means. He also tried an experiment with a coil of thick wire connected with a battery. On introducing this quickly into the interior of a larger and finer coil connected as in the other experiment, to a galvanometer, a current was generated and on withdrawing it a reverse current was observed. He concluded from these two experiments that the cause operating to produce the action on the galvanometer was the same. The differences, if any, indicated by the instrument were due to the difference of magnetic intensity in the coil and magnet, owing to the greater magnetic effect of an intense current passing through the introduced coil, than resulted from the introduction of the permanent magnet. In order to prove the existence of induced currents generally, from magnetic influence, he caused a metallic circle to rotate rapidly before the poles of a magnet, and this apparatus which was one of extreme simplicity, was probably the first Magneto-Electric Machine in existence. It may perhaps be well to explain here what this apparatus was, to show from what a simple beginning the complex machines known as Dynamo Electric-Machines, have sprung. It consisted of a disc of copper revolving between the poles of a horse-shoe magnet fixed horizontally, connected in circuit by one end of the conductor rubbing on the axis, on which the disc rotated, the other rubbing on the periphery, directly above or below the axis. By turning the disc in one direction a positive current was sent through the circuit, and by turning in the opposite direction a reverse current was observed.

One of the first experimenters who tried to turn Faraday's discovery into practical use, was M. Pixii, a maker of mathematical instruments in Paris, who in 1832, only two years after the principle of induction was discovered, made a machine for generating electric currents, which consisted of a horse-shoe electro-magnet suspended from a wooden frame, and a permanent magnet of similar form, the ends of which were turned upward, and were as close as possible, without touching, to the ends of the suspended electro-magnet. On rotating the lower magnet, so that its poles passed rapidly before the poles of the other, a current was generated in the coils of the electro-magnet, from the magnetic influence communicated to them from the revolving magnet. At every revolution the poles of the electro-magnet were changed twice, which induced a corresponding reverse current in the coils. The machine was not on a sufficiently large scale to be of much practical use. Following Pixii were Saxton, Clarke, Nollet, Siemens, Wheatstone, Ruhmkorff, and others, a detailed description of whose experiments and machines would occupy too much space for this paper. All the machines spoken of were magneto-electric, that is, they were machines whose currents were generated by permanent magnets. One only of those was put to public use, that of The Alliance Company, of France, and Holmes of England. Each of these two types of machines were used for light-house purposes. They were very cumbersome and costly, so much so, that they never came into general use.

About the year 1867, Messers Ladd & Wilde introduced the first Dynamo-Electric Machine, or rather a combination of magneto and dynamo, that is, a machine consisting of both permanent and electro-magnets combined. The permanent magnets were used to excite a small current, which traversed the electro magnets, which were of great size, and they in their turn induced a current in the revolving armature. Shortly afterwards, Wilde brought out a self-exciting machine, that is, the current that was generated was sent around the electro magnets, and became thus its own exciter. To this class of machines which is now nearly the only kind in use, Dr. Siemens gave the name of Dynamo-Electric, or self-exciting machines, to distinguish them from Magneto-Electric, or those in which currents were induced by permanent magnets. Some French writers state that the names are not distinctive, because each class is both a Magneto and a Dynamo machine. Each class generates its current through the inductive influence of magnets, the first from permanent, the other from electro or temporary magnets—and each is driven or may be driven by the same kind of motor. Viewed in this way each type can be called by either name. The object of Dr. Siemens, however, was to distinguish one class of machines, which converted mechanical force into electricity, and were self-exciting, from the other class, which converted force into electricity, by the inductive action of permanent magnets only. Paccinotti, an Italian-Frenchman, or a French-Italian, was one of the first in the field with a Dynamo machine. And it is in some measure to him that M. Gramme is indebted for the type of machine that bears his name. There are but two distinctive types of continuous current machines, although there are many modifications of each. That of Gramme has its armature wound round the outside and through the inside. It is in fact a broad ring composed of many turns of iron wire bent flatways in cylindrical form with the turns of the many coils, of which it is composed, wound around and around it. The Maxim, Fuller, and Brush in America are more or less modified types of the Gramme. The other distinctive type is the Siemens, differing only from the Gramme, in the winding of its armature, which, instead of being a ring, is a cylinder with the wire wound lengthwise on the outside, altogether. The wire begins at one end of the cylinder, is passed lengthwise along the face, crosses over the end, and is bent aside to clear the axis or shaft. It is carried in the opposite direction to the other end of the cylinder, which it crosses in the same manner, and is so wound until the section is completed. The types of this machine made on this continent, are the Edison, Weston, and some others. The Wallace-Farmer machine is a modification of Wilde's bobbin machine, and is composed of a number of bobbins (in form like the segment of a circle with rounded ends) each having a separate and distinct core, all of which are attached to the disc. Two discs, with bobbins so attached, are placed side by side on the same shaft, so that they are in reality two machines in one. There is another class of machines called alternate current machines, which have a number of north and south poles, alternating with each other, and which give rise to as many currents alternating in direction; that is, a momentary current is sent through the conductor, say, in a positive direction, and on the passage of the bobbin giving birth to this current before a pole of opposite magnetism, a negative current is sent through the circuit and so on all around the machine. There will be, consequently, as many currents in alternate directions in one revolution of the armature, as there are poles. These machines were first brought out, it is said, by both Gramme and Siemens. The Jablochkoff candle, which you have heard spoken of so often, in connection with the lighting of the streets at Paris, and the first attempts at lighting the streets of London with electricity, had the currents supplied to them by machines of this kind. Alternate current machines have been very little used on this continent, and they are giving way to those with continuous currents in Europe. The light they furnish per H. P. absorbed, is much less than that given by continuous current machines. They are somewhat simpler in construction, as the commutator, composed of many pieces, in the continuous current class, is replaced in the alternate current, by two plain discs, upon each one of which the brushes rub. For this among other reasons, they are said to be more durable. With the exception of the winding of the armature and the arrangements of the magnets, the Siemens is almost identical with the Gramme. The Weston is identical with the Siemens outwardly, the only difference being in the material of the magnets, the former being of cast iron, and the latter of wrought iron, and the arrangements of the bearings for the armature. There is no doubt but that all machines in use are exact copies of either the Gramme or Siemens in principle, modified more or less in detail only. The system of winding the armature and of attaching to commutator, the construction of commutator, and the method of collecting the electricity as generated by brushes, was wrought out entirely by Gramme. Every type of machine has copied this. In the early history of the Siemens they attempted to use rollers for this purpose, but failed, owing to the impossibility of making good contacts with a solid piece of metal, as is done by brushes made of thin sheets of copper or a number of fine wires, and the rollers had to be abandoned. All the successful machines at present in use are more or less copies of the two classes mentioned. The closer the copies to one or the other, the more satisfactory have been the results. All have not been equally successful. Some of the features of the Brush are objectionable, although it has been one of the most successful before the public. The Weston machine is very highly spoken of, and is a very close imitiation of Siemens. The Edison has the Siemens method of winding the armature, but a totally different arrangement of field magnets. European makers have endeavored to have as little dead weight in motion to absorb the energy of the motor as possible, whilst Edison seems to have gone to the other extreme, and increased the dead weight of the moving parts beyond everything that is necessary. Both Siemens and Gramme have constructed machines for 250 lamps of 20 candle power, far lighter than those of Edison. The Gordon dynamo will light 8600 lamps of twenty candle power, and weighs eighteen tons. This will give a lighting capacity of about 500 lamps, or 1000 half lamps, of ten candle power per ton. The Edison machines built here for 500 half lamps of 7 candle power, weigh about four tons each, which would only be an average of 125 lamps per ton of 7 candle power as compared with the Gordon of 1000 half lamps of ten candle power per ton. A difference of 8 to 1 in favor of the Gordon machine, with regard to the number of lamps, and of eleven and six-tenths to one per ton in lighting power.

The greatest novelty, however, in dynamos, is one that has just been tried in England, called the Ferranti-Thompson Machine, the joint invention of an Italian, Mr. S. Ziani de Ferranti, and Sir Wm. Thompson, who is so well known in the world of electrical science. This machine weighs only 1200 lbs., and at its trial in London, recently, lighted 320 Swan lamps, of 20 candle power, with an intensity of light equal to 15 or 17 candles actually. The number of half lamps per ton to this machine would be 1060. The most remarkable feature about this remarkable machine is its armature, which, independent of the shaft and pulley which drive it, weighs only 18 lbs. The armature alone of the Edison 500 half lamp machine, weighs in the neighborhood of 1000 lbs , which would give a weight of two lbs. per lamp, as compared with the weight of one lb. to seventeen five tenth lamps, of the Feranti-Thompson, or as 35 to one in favor of the latter. Its armature is totally different in construction from anything that has been made, being a single strip of copper half an inch wide, one twelfth of an inch thick, and 1020 ft. long. It is wound as if on a gear-tooth-shaped wheel, and has another wheel with internal teeth pressed over it, so that its shape around its periphery is like a toothed wheel. Each turn of the coil is insulated from the other by a layer of tape.

Having thus given a faint outline of the history of dynamo machines, it will be proper to refer more particularly to their general construction and explain the principles of their action. There are in the construction of dynamos some essential considerations, which are necessary to insure success. The first is the choice of materials for magnets and conductors. The second is the intensity of the magnetic field, which depends upon the material used and the arrangements of the magnets. The third is the quantity or length of useful conductor passing through the field. There are other considerations, such as the number of coils, the length of conductor in each coil, their insulation, the method of winding, their connection to the commutator, and, in general, the whole distribution of the various parts, which, when put together constitute a machine.

As magnetic intensity varies inversely as the square of the distance, it is essential that the field should be as condensed as possible. The closer the field magnets are to each other the greater and stronger the number of lines, or rays of magnetic force, passing between them. It must not be understood from this, that the sizes of machines are limited. On the contrary the larger the machine, if constructed under right conditions, the greater the amount of electric energy developed and the more economic, commercially, it becomes. The revolving wheel of the Gordon machine, mentioned above, is nearly nine feet in diameter, and weighs about eight tons. That machine however is of the alternate current class, in which there seems to be greater latitude for large dimensions than in those of the continuous current kind. Gramme has made some large and powerful machines of the continuous current class. Brush, also, has made some machines that are claimed to be of 80,000 candle power, and will light 40 lamps, of 2000 candle power each. The conductor should move as near to the magnet as possible; one eighth of an inch is the usual space allowed in good machines. Even in that small space there is a great loss of magnetic effect. From what has been said of the ratios of magnetic intensity, if the wire conductor was one-eighth of an inch diameter, the outside layer would only be affected to one-fourth the extent, that it would be, if it could be made to run in the clearance space between it and the field magnets. There is a consequent limit to the number of superimposed layers of conductor wire covering an armature. You will understand, that if a space equal to the thickness of the wire, exists between the outside layer and the magnet, that the magnetic effect upon that layer is only one-fourth what it would be if it was possible to run it without clearance. That the effect on the second layer is in the ratio of nine to four, on the third layer, sixteen to four, and on the fourth layer, twenty to four. The amount of current generated in each layer, twenty is proportional to the magnetic effect. The inner layers or those nearest the armature, have thus a retarding effect on the current generated in the outer ones. This could be carried to the extent of one being entirely neutralized by the other, so that the whole of the current generated in a machine might be spent in producing heat only, in the conductor covering the armature. The iron forming the interior of the armature, that is, the portion next to the wire conductor, comes to the assistance of the inner layers, because, as it is magnetized by induction, with opposite polarity to the field magnet, it in turn helps the generation of currents in those turns of wire next it, but not so strongly as the outer layers, because of its magnetism being feebler, as in no mechanical action can the part acted upon be as strongly affected as the part which performs the action. This action and reaction continues so long as the armature is in motion. The operation is continued, but in a contrary sense, when the armature passes from one pole to another. The quantity of iron that may be contained in the armature is limited, because the larger the mass, the greater the time required to magnetize and demagnetize it. Not only is the quantity limited, but it is better to make it up of a number of turns of small iron wire, or a number of thin sheets of iron side by side. It has been found that small bodies of iron receive magnetism and part with it very readily; much more so than large masses. This readiness to change its polarity, on the part of an armature composed of wire, or thin sheets of iron, possesses two very great advantages, which are sometimes lost sight of. One is, that, as it absorbs magnetism very readily, it consequently absorbs it to a greater degree, and the other is, that as it both absorbs and parts with its magnetism readily, it becomes less heated than it otherwise would do. These properties enable the machine to be run much faster than it could be otherwise. And as the work done by a machine is greater than the ratio of the square of its speed, you see how advantageous it is to construct machines that can be run, not only at a high rate of speed, but which will absorb as little power as possible.

Although machines of the continuous current class may be constructed of very large dimensions, machines of moderate size have, up to the present, given the most satisfactory results. Both Gramme and Siemens five arc lamp machines have given the most light per H. P. of any other sizes, for feeding more than one lamp. This may be owing to their having given more attention to the working out the various details in those sizes than in the others. Both makers have constructed machines of very much larger dimensions than those named, which have given excellent results. One type of machine that Gramme has built seems almost unlimited in the dimensions to which it might be carried. He constructed one with two commutators, one on each side of the armature ring. The coils wound upon the rings were joined to each commutator alternately. One to a section at the right side and the next to a section at the left, and so on alternately, until the whole was joined. He thus obtained as it were, two distinct machines in one. The currents collected by the brushes could be joined in intensity, or quantity, as might be desired. To further increase the power, he constructed four magnets of two coils each, around the machine, the outside of which formed a polygon, and it had two sets, or four brush collectors to each commutator. By this arrangement the power of the machine was again nearly doubled. The result of such combinations was very nearly to quadruple the effect that he could have obtained from one machine of slightly less dimensions.

The magnetic field, as the space in which the armature revolves is called, is dependent largely upon the arrangement of the electro-magnets to each other, and upon the manner of winding. The magnetic effect produced by a current passing through a coil is, firstly, in the ratio of the length of the conductor, or the number of turns, and secondly, in the ratio of the square of the current. If the number of turns of wire of which the coil of an electro-magnet is composed be increased, the magnetic effect is increased in a like ratio. That is to say, if the number of turns be doubled the magnetic effect is doubled also. Again if the strength of the current is increased, the magnetic effect is increased in the ratio of the square of such increase up to the point of magnetic saturation. That is to say, that if the current is doubled, the magnetic effect is quadrupled. It has been found also, that the magnetism of an electro-magnet, for a constant current, is in the ratio of the square of the cross-section of such magnet. In other words, if the electro-magnet is round, its magnetic effect is in the ratio of the square of its diameter, for a constant current and the same number of tnrns of wire. If the same number of turns of a coil are spread over a great length there will be the same magnetic effect generally, but it will not be so concentrated as if the turns were closer together, or coiled in layers one over the other. By increasing the sectional area of the electro-magnet there is greater magnetic effect, but the magnetism will not be so intense; there will be more uniformity of field however. And this is what Edison seems to have done in his machine. He uses very long bobbins, ending in large masses of iron, which produce a more uniform field. This is undoubtedly better, owing to the sensitiveness of the lamps. When incandescent lamps are heated to nearly the maximum, it is important that the dynamo feeding them, should supply as uniform a current as possible. There is a medium length for electro-magnet coils, which practice only can give. If the coil be too long the magnetism is diffused over length. If it be too short, there will be a loss of magnetic effect of the current from the great distance of the outer turns from the iron. A long coil may be useful for some purposes where a short one with the same number of turns would not answer. The length of the coil is somewhat dependent upon the position the magnet will occupy in the machine. It is an essential feature, however, in all dynamo-electric machines that the magnets should be as close together as possible. Having arranged the electro-magnets to form the field, the next consideration is the winding of the armature. The various methods by which this can be done are almost endless. There is one general direction, however, in which the wire must be placed, as it moves in the field, to induce a current. If the motion of the wire is parallel with its length there will be very little current generated, because it will cut very few lines of force. If the wire moves in a direction parallel to the lines of force, there will be no current generated, because in that case, it would not cut any lines of force. It is therefore essential that the wire encircling an armature should be so wound as to cut as many lines of force as possible. To do this, the armature should be placed so that its axis would be in the centre of the field, and the field should be so formed that its lines of force would be like radii, or arms projecting radially from the axis and the wire be wound so that its motion throught the field will be perpendicular to the lines of force, and parallel to the axis. The electro motive force, as well as the intensity of the current, will depend upon the length of the conductor and the nnmber of lines of force cut in a unit of time. With a uniform field, that is one in which the magnetism remains constant, this varies simply as to the speed. As magneto-electric machines always create a uniform field, the electro motive force in such machines varies directly as the speed.

Having thus endeavored to explain the principles governing the production of currents in dynamos, their action may be stated as follows:—First, it will be understood that all metals capable of being magnetized always possess previous to being acted upon, and always retain afterwards, a certain amount of magnetism. It is immaterial whether this varies with different metals, or not. This is called residual magnetism, and by electricians is stated to be due to the influence of the earth, which by them is considered a great magnet, with its two poles north and south. Secondly: the brushes or collectors, which collect the electricity from the commutator, are usually joined, the positive to one of the terminals of a pair of coils, if the electro-magnets are double, and to one, if single, after traversing the conductor, of which these may be formed, and thence to the lamps for lighting purposes, or the electro-chemical baths if for plating purposes, or to other dynamos if for the transmission of power. The current is then returned through the negative conductor to the terminals of the remaining electro-magnet coils, and thence is connected to the negative collector. When the armature is set in motion, the residual or permanent magnetism of the field magnets generates a feeble current, which passes out by the commutator around through the first coils, and the whole of the circuit back through the other coils, and so to the other brush, and in its passage increases the magnetic action of those magnets, which in turn generates an increased current in the armature wire, which in its turn causes increased energy in the electro-magnets, and so acts and reacts until it attains its maximum. This requires but a very short period of time. The time is so short that it cannot be measured by seconds, but by fractions of a second. The plan spoken of, of sending the current through one-half of the coils forming the electro magnets, and thence to perform whatever duty is required of it, before passing through the remainder, is not absolutely necessary, as it may traverse the whole of the coils before performing any other duty. It has been found, however, that when the machine is thus working that the current is more regular and not subject to the irregularities arising from varying resistance, as it would be if the whole current traversed the magnet coils first. Unlike magneto-electric machines, whose power increases simply as the increase of speed, dynamos, in a perfect type of machine, increase in a geometrical ratio. Magnetic intensity of the field magnets varies with all the varying circumstances surrounding it. If the speed is decreased the current is decreased, and as the intensity of the field depends upon the current by decreasing it, the intensity of the field is diminished also. As the speed of the armature is increased the intensity and electro motive force of the current is increased in the same ratio. This reacts upon the electro magnets, increasing the intensity of the field, and so increasing both the electro motive force and the intensity of the current, so that if it was possible to construct a perfect machine, and what is understood by that is one in which there was no loss either from friction, or sparks, or varying resistance, or any other cause, the resultant effect of an increase of speed would be in the ratio of the cube of such increase. In other words, its power would be in the ratio of the cube of its speed. It was found by actual measurement that a Gramme machine of the normal type, running at eight hundred revolutions per minute, gave nearly double the light when increased to a speed of 1000. Now the ratio of the cubes of those numbers are to each other as 512 is to 1000, so that the light produced was nearly equal to the ratio of the cubes of the speeds. The actual amount of light, at 800 revolutions, was 730 becs, at 1000 revolutions it was 1292 becs, their ratio is 1.77. The ratio of 512 to 1000 is 1.95 so that the rate of increase of light as compared to the cube of the increased speed, was in the ratio of 1.77 to 1.95. It must be born in mind, however, that the passive resistances of the machine, at the different speeds, were very nearly the same. The resistance of the machine itself, the conductor to and from the lamps, and the lamps themselves, were the same. There was an increase of resistance at the commutator, due to increased friction, and an increased loss due to an increased sparking. You see what a great difference there is in the dynamo over the magneto-electric, and what a great addition was made to the science of electric lighting by the invention of self-exciting machines. It will be seen from this why dynamo, or electro-magnetic machines, are employed, in preference to magneto-electric ones. It may be stated here, that the first machines of Wilde were a combination of both, to which their author gave the name of electro-magneto-dynamo-electric machines. If there is anything in a name the length of this ought to have been productive of good results.

Magneto-electric machines possess some advantages over their rivals. The intensity of the field is always uniform, whatever the varying resistance of the circuit. There is no other resistance to be considered beyond that of the armature. The whole of the current generated, therefore, can be applied to useful work. A magnetic field of uniform intensity is of very great importance in some operations, amongst which is light by incandescence. It became an object, the attainment of which received considerable attention from electricians, to devise a method of winding the magnet coils of dynamos to secure this, if possible. They have succeeded in a great measure, some machines having been recently built, the currents from which did not vary in intensity, whilst changing from 300 to 3 or 4 lamps, or the reverse. Edison claims to have accomplished this also. Dynamos are almost exclusively used for industrial purposes. De Merritten's is almost the only magneto-electric machine, which claims a place side by side with the others. The uniformity of intensity and freedom from undulation of the current produced by his machine, have contributed largely to its introduction and its extended use.

All currents generated by dynamos undulate. That is to say they traverse the conductor in a series of wave-like motions. This motion varies considerably, being least in the Gramme and Siemens types and reaching a maximum in the Brush, the current of which is more a succession of rapid sledge-hammer-like blows than of gentle undulation. The reason is that Brush, having few coils on his armature, is compelled to form them of a great number of turns. A coil so formed is forced to bottle up, as it were, its energy, until it finds an outlet through the commutator brush. It then rushes out with such tremendous energy as to fly off to a great extent in the form of sparks. The first machines of Siemens were constructed with eight and twelve coils respectively, which gave rise to considerable sparkling. They are now wound with a greatly increased number. It has been found the greater the number of coils on a ring, and consequently of sections, in a commutator, the more even is the flow of the current; because, by increasing the number of coils the outlets are correspondingly increased, the current is not bottled up, and is therefore more uniform and regular.

Machines of both classes vary in constructive detail, dependent upon their uses. One that is suitable for giving a single large light, is not suitable for giving several smaller ones, and a machine, on the other hand, constructed for several lights is not suitable for the production of a single large light.

The writer when first attempting to build a machine used wire on the armature altogether too fine for the purpose intended. The armature ring, too, was of solid iron. The two causes combined, produced so much heat that it would very soon have destroyed itself. Several alterations have since been made, the results of which are highly satisfactory. The machine, although small, will generate ample current with sufficient electro-motive force for three arc lamps of 2000 candle power. Its weight is about 400 lbs.

Much coarser wire is used both for armature and magnet coils, in a machine for a single light, than in one for several, the requirements being largely intensity, or quantity of current, with little electro motive force. The first thing to be considered, in designing a machine, is the purpose to which it will be applied. If the work to be done is only of moderate resistance, comparatively coarse wire can be used. If the work opposes great resistance, much finer wire will be necessary. If the machine is designed for lighting, the number of lamps to be fed by it should be previously known. It is to be understood that in all cases the resistances to be overcome, whether of a number of lamps, of conductor, or of feeding another machine at a distance, can only be overcome by a machine constructed with special reference thereto. Some machines have a very small internal resistance, as notably those used for electro-chemical purposes, and for a single arc light. The resistance to be overcome outside, in the circuit, in both cases, are small, and machines are made for those purposes opposing resistances as low as one quarter ohm. Others again, have a very high internal resistance, such as those of Brush, which for 16 lights will probably average 10 or more ohms. Experiment has shown that the total resistance, including machine, 16 lamps and conductor, was 83.51 ohms. The electro-motive force in Volts was equal to 839, which divided by the total resistance, gave a current of 10 and a fraction amperès. The total resistance was found by adding that of the machine to the 16 lamps, which were a little over 4½ ohms each, and that of the conductor from the machine to the lamps, together. The very high electro-motive force developed by such a machine makes it very dangerous to handle. It is necessary to run the machine at a very high rate of speed to obtain this. While European makers run at velocities varying from 350 revolutions for large machines, to 1500 for the smallest size, few if any of the Brush machines run at a less velocity than 1400 revolutions. In addition to the destructive effect resulting from so high a speed there is another, and perhaps more serious one still, in the great amount of sparkling which is constantly visible, while the machines are running, at the commutators. This is in part owing to the high electro-motive force and to the high speed, but chiefly to the construction of the ring and his mode of collection. The Brush armature, as you are probably aware, is made up of coils varying from eight to sixteen in number. Each coil is connected at the inner end to the one diametrically opposite, and the outer end to the commutator, which consists of but two pieces, with an intervening space between each. He has, therefore, one commutator for each pair of coils. There will be consequently, as many commutators as there are pairs of coils on the ring. A very irregular current is the result. If the action of each commutator is analyzed it will be found that at one portion of the revolution there is a very feeble current which increases to a maximum, which again diminishes becoming feeble as at first, and finally for a portion of the revolution, disappears altogether. The result of these variations is a continuous adjustment of itself between the commutators, a portion from one at the maximum being absorbed by another, which is only supplying a minimum of current. That portion of the commutator which is cut off from the generating coils twice in each revolution, positively stops all current. You will therefore understand, that these variations in intensity, from zero up to 2000 volts, several times in each revolution, multiplied by 1400, in in each minute of time, must have a very destructive effect upon the machine. Niaudet, a French writer who seems to have treated the subject exhaustively, is of the opinion that Brush's machine is faulty in construction and that the ring used is very old, being the one used by Paccinotti, who was the first to construct a machine of a type from which the Gramme has descended. Brush has made some changes in the details of his machine, but they are not considered to be of much advantage. Although there are some faults of a serious nature in the Brush, he is credited with being the first to solve the problem of lighting a number of arc lamps in series, with one machine, with but one conductor leading from it. He has built machines, as already stated, capable of supplying 60 lamps, which have probably the highest electro-motive force in existence, although it is claimed that a machine made in Germany, a modification of the Gramme, has a higher still. The 40 light machine must have an electro motive force of 2000 volts, which is sufficiently high to kill a regiment instantaneously, if they were joined hand to hand with their hands moistened with acidulated water, and the first and last man were connected to such a machine

The type of machine made by Gramme, with eight magnets arranged in four pairs and four sets of brush collectors, already referred to, has a very high electro-motive force and was designed by him for the transmission of power to a distance. The arrangement adopted in this machine enables it to be used either in quantity or tension. The ring being wound double, as it were, and having two commutators, with two pairs of brushes to each, gives rise to four separate and distinct currents, which may be utilized in various ways as may be desirable. One set of collectors are usually employed to furnish the current for the electro-magnets, which may be afterwards added to the other three in quantity. The four currents may thus be joined together, and used as a current of quantity, or may be joined two and two, or may be all united in series, having an intensity of one, with the electro motive force of the four. This last arrangement would enable the machine to transmit power to a great distance. The problem of the transmission of power to a distance is occupying the attention of Frenchmen very much at present. At the recent electrical exhibition at Munich, M. Deprez, who is the inventor of an absolute galvanometer, which will be described further on, was enabled by a machine of special construction to transmit a half-horse power, merely as an illustration, from a machine situated at Meisbach, 36 miles distant, and which worked a small pump for supplying water to a cascade in the exhibition building. This attracted so much attention, that he was requested by the technical committee of the exhibition, to make further trials with machines of a new type, which he promised to do as soon as they were constructed. The trials which are to follow are expected to be very interesting and will be carried on with machines that will supply at least 12 H. P., and will be transmitted, as in the first experiment, by ordinary telegraph wires.

The new dynamo-electric machine of M. Deprez presents this special characteristic, that it is self-regulating under very wide limits, working at a constant electro-motive force, no matter what the work to be done may be, and preserving the same ratio between the power absorbed and that utilized. His theory is that, whatever the distance, the duty performed by the machine will be the same. If this is true, it would make very little difference to such a machine whether the power to be transmitted was great or small or to a long or short distance, provided the work to be done was within the limits of the machine.

The above principle is of very great interest in all application of dynamos, no matter to what purpose it may be applied. When used for giving light with arc-lamps, to enable one or more to be used at pleasure, and to prevent accidents to the lamps themselves it is usual to construct them with an independent equal resistance attached and a self-regulating shunting arrangement, whereby the current is automatically shunted through such resistance if anything goes wrong. In addition to this, provision is made, where a number of arc-lamps are used, say, in different parts of a building or premises, where it may be desirable to cut off a floor or any other portion of a system by introducing resistances convenient to be got at, corresponding to the number of lamps to be thrown out, so that the electro-motive force of the machine may remain constant. This system leads to a considerable waste of power, where the number of lamps fed by one machine is large, and any considerable portion of them is thrown out of circuit. Because, if the machine is not feeding lamps, the current is passing through a corresponding resistance, and is consequently absorbing the same power from the motor whether the number of lamps in use be a part, or the whole to be fed. To obviate this difficulty, it has been customary to supply moderate sized machines to feed 3, 4, 5 or 6 lamps, and to put in more than one machine where a greater number of lamps is required, when a portion of the whole is likely to be disused.

In cases of dynamos for transmitting power, where the power used varies, it is an obvious advantage if machines could be constructed to be self-regulating, and would simply absorb power from the motor which would bear a constant ratio to the work done. This would also apply to machines for electro-chemical purposes. In an establishment containing a number of baths, for depositing one metal, or for depositing several kinds, it would be a great advantage if the machine was self-adjusting, so as to preserve the same electromotive force, no matter whether one or twenty baths were in use at one time.

It may be well to say a few words on the modifications necessary in the construction of machines, to suit the varying conditions under which they are to be applied. In their application to electro-metallurgy, the resistance of the bath is so small, that the question of the electro-motive force required is scarcely necessary to be considered. It is different however with regard to quantity. A machine might be capable of depositing the same quantity of metal distributed amongst several baths, that it could deposit in one only. But the same machine would not answer for depositing a larger quantity amongst several baths, than the amount it was designed to deposit, without the risk of being destroyed. All machines however, are capable of varying the work to be done, but only within the limits of the maximum amount for which they were designed. If it was desired to deposit as much metal in each of several baths as it was intended to be deposited in one only by a machine, a larger one would be necessary. A large machine will electro-plate a few articles as well as a great number, but with nearly the same expenditure of power. The conditions then of construction of dynamos for electro-chemical purposes, are generally those of quantity only, and not of varying electro-motive force and quantity of current together, as is necessary in those used for most other purposes.

In dynamos for the transmission of power, the circumstance of use to which they may be applied, varies greatly. This not so much, perhaps, where the machine to be driven is a long distance from the driver, as where they are used for doing work very irregular in quantity. When the distance is great a considerable portion of the power will always be absorbed in overcoming the resistance of the conductor. In that case, the work to be done in overcoming distance will perhaps form a very great portion of the whole. In the case mentioned of Deprez's machine, in use at the exhibition at Munich, where it worked a small rotary pump, the power given out after traversing 36 miles, was estimated as low as 25 and as high as 37 per cent. of that sent through the dynamo at Meisbach. On the other hand, where the work to be done is not far from the machine supplying the current, there may be a demand for the maximum at one moment, and at the next it may be reduced to a minimum. Perhaps no conditions in this case would vary so much as those in which a dynamo is used for hoisting purposes, either in ordinary hoists, or lifting weights with a crane. The weight to be lifted, under either circumstance, if it was as great as possible, would absorb the whole of the power supplied whilst suspended. When the load was delivered and the crane or hoist was descending empty, the minimum only of which the machine was capable would be absorbed. So with any other purpose to which the machines might be applied. On some of the sugar farms in France, dynamos have been largely used successfully, in ploughing and otherwise preparing the land for the cultivation of beet. Four men, two dynamo machines, identical in construction, with an expenditure of 25 H. P., plough an average of 2½ acres per hour, turning a fallow of ten inches in depth. The average distance of the dynamos which do the ploughing from those which supply the current to them, is about 950 yards. The work accomplished under these circumstances is very nearly uniform. There would be very little waste of energy in consequence.

When dynamos are used for electric lighting purposes, the extremes vary between 1 lamp and 60 the highest number of arc lamps yet lighted by one machine. If all lamps were the same resistance, the work done in every case would be in the ratio of the number employed. No makers, however, have produced lamps that do not vary in resistance and they vary as much as 3 to 1. The work done then, in any one case, will be found by multiplying the resistance of one lamp by the whole number, in such installation. Lamps also vary in resistance nearly in the inverse ratio of the maximum amount of light they are designed to furnish. A single lamp shedding a light of 10,000 candles, may, perhaps, for that reason, only oppose one tenth of the resistance to the passage of a current, that might be offered if the same quantity of light was distributed by 5 lamps. In incandescent lighting, usually employed, the resistance of one lamp is all that has to be considered. The lamps being connected in multiple arc, there is no more force required to overcome the resistance than that opposed by one of them. Arc lamps can be connected in the same manner, but are not, generally. The work done by a machine supplying light by incandescence is also measured by the number of lights. There is this important difference, however, between the two, that, whereas, the resistance to be overcome in the one case is measured by the sum of the resistances of all the lamps in circuit, that in the other simply by rhe resistance of one, no matter how many may be employed. The power in the first case is expended chiefly in producing electro-motive force, in the latter current. These remarks will give you some idea of the variations in the work to be accomplished, and also how desirable it is to construct machines that, under all varying conditions, will preserve a constant electro-motive force, or a constant current.

This paper is long, but before closing, it may be profitable to glance at the means usually adopted to overcome the opposing forces to be met with, in the different purposes to which dynamo machines can be applied. These considerations will also show you the necessity of the knowledge of the work to be done by makers of these machines, before they can determine the particular manner of construction. Very high electro-motive force is obtained by winding the armature with fine wire, and a high rate of speed. There is a limit in this direction, owing to the resistance of the wire itself, which cannot be exceeded. To obtain a large amount of current the opposite is necessary, and the armature is wound with coarse wire. It may be said here, that machines used for electro-chemical purposes can scarcely be wound with wire that is too coarse, owing to the low electro-motive force required. The electro magnets require to be wound in a corresponding manner. Between the extremes of fine and coarse wire, are to be found the sizes best adapted for the work to be done.

The means employed for knowing the capacity of a machine, as well as for the measure of work it can accomplish, and, also, the measure of the work it has to overcome, is an instrument, usually small enough to be carried in the pocket, but sometimes of very large dimensions. They are made to measure very feeble currents of such small electro-motive as the one millionth part of a volt, or higher than the currents generated by a Brush machine. Such instruments, as you are probably aware, are called galvanometers. They are sometimes called, when used as a measure of quantity of the electric generators under discussion, current meters. Some of them are very complex, and require a knowledge of the higher mathematics to understand the principles upon which they are based, while others are so simple as to require no more than a knowledge of simple ratios. Of the latter class is that known as Deprez's galvanometer, a very crude sample of which has been brought here. This instrument is based upon the ratio of two opposing magnetic forces, one of which is obtained from a permanent magnet, which is a part of the instrument, and the other is created by the current to to be measured. In form, it consists of a horse-shoe magnet, made up of five layers of flat steel, bent in the form of the letter U, and fastened to a board which serves as a base. In the strongest part of the field, between the poles, is fastened a rectangular box, which just fills the space between the limbs of the magnet, around which is wound, for the measurement of currents of intensity, a very few turns of coarse wire, or a single band of sheet copper. In the inside of the box, upon two V shaped pieces of brass, one of which is fastened to each end, rests a small thin bar of iron with its two ends V shaped, cut along each edge like the teeth of a very coarse comb to deduce friction, and wide enough just to clear the inside of the box. At the end of this bar next to the binding posts, is inserted an upright piece of brass wire, whose movements, to right or left, are indicated and measured upon a quadrant, placed just behind it, and arching the ends of the magnet. Two binding posts, with screws, standing in front of the quadrant, to which are attached the ends of the wire encircling the box, complete the machine.

This instrument has been given the name of absolute galvanometer, from its power of measuring the intensity and electro-motive force of a current. Its action is as follows:—The permanent magnetism, contained in the magnet, induces opposite magnetism in the ends of the needle, attracting them, so that they lie in a horizontal plane, with their ends toward either pole of the magnet. Their position causes the brass pointer before mentioned, to take up a vertical position, opposite a zero mark, on the quadrant. To test the current of any machine, the conductors are attached to the binding posts. On the armature being set in motion, the passage of the current around the box sets up a magnetic whirl, which causes the needles to take up a new position, dependent upon its intensity, which is indicated by the pointer on the quadrant, which is the measure of the intensity of the current. Its present arrangement is intended as a measure of intensity, or quantity only. To measure electro-motive force, it is only necessary to substitute for the present box, one wound with many turns of fine wire, offering a resistence of 300 or 400 ohms. The needle will then indicate, as before, the electro-motive force of the current, It is necessary, before using the instrument, to compare it with some well known standard of resistance, in order to be able to measure the intensity or electro-motive force of any current.

SUPERFICIAL GEOLOGY OF DUNDAS VALLEY AND WESTERN ANCASTER.

BY WM. KENNEDY.

In 1879, Mr. J. F Carll, of the second Geological Survey of Pennsylvania, presented a report on the pre-glacial and post-glacial drainage of the Lake Erie country, in which it was shown that a great number of the streams of the northern part of Pennsylvania, in pre-glacial times, flowed into Lake Erie.*

The great difficulty with Mr. Carll's deductions was the finding a necessary outlet for Lake Erie.

On 18th March, 1881, Professor Spencer, of King's College, Windsor, Nova Scotia, read a paper on "The discovery of the pre-glacial outlet of the basin of Lake Erie into Lake Ontario," before the American Philosophical Society, and on the 8th December last, Professor Spencer read a paper on the same subject, before the Hamilton Association. On the formation of the Geological Section of this Association, it was understood that the Geology of the dis-

* Report Second Geological Survey of Pennsylvania, III. page 330 *et Seq.*

trict, and indeed the whole of Wentworth County, should be worked out by the Section and the report presented to a full meeting of the Association.

The following pages are intended to form a part of this report, when the Geological Section has completed its work. The question primarily discussed, is the Superficial Geology of that part of the country lying in Dundas Valley and the parts of Ancaster Township around the head of the valley.

Dundas Valley lies at the western end of Lake Ontario, in the form of a rude triangle, having for its base the beach, spanning the mouth of Burlington Bay, and for its two sides the Niagara escarpment. The valley may be divided into three parts. First, the lower portion, occupied by Burlington Bay, a deep body of water, bordered by a low sandy shore, much broken by inlets on the southern side, and a shore rising almost precipitously to the plain above, on the northern side. (This north shore consists of sand and other drift materials.) The bay is enclosed from Lake Ontario by a low semicircular beach of sand and gravel, and is separated from the second or middle third, by Burlington Heights, an old beach containing fossils of the Hudson River period. Second, the middle division, or lower portion of the valley proper, extending from Burlington Heights to within the vicinity of the town of Dundas. And the third or upper portion of the valley, comprising all that broken and hilly region at the head of the valley, and extending from Dundas to the village of Copetown, where the valley proper ends.

In this present paper, I shall not take into consideration the first or lower division, containing Burlington Bay, but confine myself to the two upper divisions of the valley. The division containing Burlington Bay had other and later causes at work in its formation, than those concerned in the construction of the upper two divisions of the valley.

Beginning at Burlington Heights, we have then a narrow canyon shaped channel, lying in a position about N. 70, E., and a little more than eight miles long, cut out between the two walls of rock forming the escarpments. This channel is about four miles wide at the lower end, and gradually narrowing until at Binkley's Corner, on the Hamilton and Ancaster road, the valley is three miles wide, a width it maintains for more than two miles, or until after passing Dundas, when the more westerly escarpments turns slightly east, to the village of Copetown, where it approaches within a mile and a quarter of the eastern side of the valley. From Copetown this western escarpment turns in a westerly direction and disappears. These measurements are from a map made by Mr. T. C. Keefer, in 1859. This map is on a scale of two inches to the mile.

Where, or at what elevation, these escarpments join each other, has not yet been determined. Sir William Logan in his Geology of Canada, published in 1863, says, " It is not, however, certain where it (the Niagara Formation) folds over the Dundas anticlinal, there being no exposures whatever upon the axis. The most western appearance of the upper part of the formation, on the south side of the anticlinal occurs in the vicinity of Ancaster; the most western on the opposite side, about two miles north of Ancaster, on the third lot of the first range of Flamboro' West. It may be inferred from the trend of the formation on each side, and from the general shape of the country, that its summit would fold over the axis of the anticlinal on the line between the townships of Ancaster and Beverly, at about the thirty-fourth lot.

The portion of the valley from Burlington Heights to the town of Dundas, is to a considerable extent, occupied by Dundas Marsh. Between the marsh and the detritus at the foot of the escarpment on both sides, there is a tract of raised level country lying at a general elevation of about eighty feet above the level of the lake on the eastern side, and, a perhaps somewhat higher elevation on the western side. The level plain on the eastern side is here and there cut through to the blue Erie clay, by streams of recent origin. On the western side, the country rises by broad successive steps to the foot of the escarpment. The western side is also peculiar in the absence of streams of any size, and also their fewness in number. The composition of this level plain appears to be chiefly beds of clay and silt in alternate layers, with patches of conglomerate in places.

The division from Dundas to Copetown, lies on a much higher plain, rising by steps to the summit of the valley.

Passing up the valley we come to the second elevation about a quarter of a mile beyond Binkley's Corner, on the Hamilton and Ancaster road. This elevation, which is about twenty feet higher than the general level of the second division, stretches in a semicircular form with its concave side looking down the valley, from the Hamilton or eastern side, crossing the public road, passing through Mr. Hatt's farm and coming to an end in the heavy clay beds near Dundas. This level is very much cut up by deep ravines ; showing on their sides in many places, gravel terraces or levels of resting places of the waters of the lake in former places. From this point to the upper end of the valley the district rises in quick stages. This district towards the head of the valley, is much cut up by streams, and showing a generally broken surface. The hills between the streams lie in positions so that their long axis points in the direction of the long axis of the valley. Several, and indeed most of these hills, show distinct traces of two or more terraces or old beaches, and being in every case rounded on the top. Some of the hills are cone shaped, and this the more so, the nearer the head of the valley is approached. In composition, these hills, are for the most part clay of a whitish yellow color, lying upon beds of a stiff blue clay, or bluish sand. The yellow clay shows little or no signs of stratification, in any manner. The cone, or rounded hills, near the head of the valley, consist to a great extent, of drift sand or silt, and some few being of fine gravel mixed with reddish colored silt. Many of them have all the characteristics of sand dunes, the sand being apparently blown sand. A number of these hills in this division contain beds of conglomerate

The height of land closing the head of the valley proper, and separating the drainage system of Dundas valley, from that of Fairchild's Creek, and the Grand River, is composed largely of coarse, washed or beach sand, with broken shales in some parts. On the road leading from Ancaster to Jerseyville, on the farm of Mr. J. Crysler, there is a fine exposure of these gravel or sand beds. Here, the sand is distinctly stratified, lying at a high angle and dipping eastward, or down the valley. The angle of beds, to the west, or towards the head of the ridge, being the highest (about 40 degrees). Passing east, the beds gradually assume a more horizontal position until they merge into the general level. Again, on the line of the next concession road to the north, and about a mile and a half, or two miles, further west, there is an exposure of beds of the same material dipping at a low angle to the west. This second exposure is on the southern border of a large swamp. On the northern border of this swamp, and still on the western side of the height of land the ridge is composed chiefly of dark colored broken shale, having, where noticeable, a western dip. This broken shale can be traced for nearly a mile along the road leading into the village of Copetown. That these two exposures (the one at Crysler's and the one at the swamp) are on the opposite sides of the height of land is obvious, both from the dip of the beds of sand and shale, as well as from the course of the different streams having their rise in the district—all the streams on the western side running in a southwestern direction to the Grand River or Fairchild's Creek, while the eastern side sends all its streams down the valley to the Dundas Marsh. This swamp lies on the top of the ridge, and its outlet (if outlet it can be called) is through the gravel to the southwest.* The depth of this swamp has never been properly ascertained, but it is generally estimated to be somewhere between fifty and sixty feet. From a series of measurements made by aneroid, I made this swamp 520 feet above the level of Lake Ontario. The hills around the swamp rise to a considerable height above it. This ancient beach, for it is without doubt an old beach, is flanked on both sides by high, long shaped and rounded hills, of reddish sand, heaped up apparently by glacier or water action, and showing no signs of stratification, beyond that here and there the underlying sand assumes a bluish tint.

The belt of sand to the west of this ridge is much broader and is less broken than that on the eastern side. On the west, the hills as a general rule are long rolls stretching first in a southwesterly direction, but to the westward, gradually assuming a more northerly and southerly position. The margin of this sand belt beginning to the west of Jerseyville, passes easterly in a semicircular form around the height of land, and borders a large district of stratified clay, On the eastern side the hills are in a great measure cone shaped and broken, passing into clay mounds within a short distance down the valley. In many places I have noticed these cone shaped hills to contain conglomerate. In continuation of this ridge a broad belt of sand and silt, more or less broken and rolling, passes towards the southeast to the line between the townships of Ancaster and Glanford,

* This outlet can only be of any effect when the swamp is swollen by the heavy rains of Fall or Spring.

where it thins outs and is replaced by stratified beds of stiff clay containing inter-stratified beds of quicksand. These beds of clay gradually deepen to the banks of the Grand River. At Middleport on the Grand River, the clay beds are between ten and fifteen feet above the surface of the river, and at Onondago, a few miles further up the river, the beds are about thirty feet higher. At both places, there are inter-stratified beds of sands, containing shells of recent species. At Onondago the drift is 78 feet thick, and the river flows through it about 35 feet above the rock bed.

In addition to the large swamp already mentioned as lying on the top of the height of land, there are numerous small cup-shaped swamps lying among the sand hills on the eastern side of the ridge. On Fairchilds Creek, at Mud Run, I found shells of recent species in a small bed of sand enclosed in heavy beds of clay. The sand occupies a position between the white colored and bluish clays. The white is twelve feet thick, and the blue four feet before reaching the water level. * There is, therefore, twelve feet of clay above this six inches of sand. This clay and sand is apparently the bottom of an old lake. In the bottom of Lakes Superior and Huron, beds of clay and sand, containing shells of recent species, are being formed. †

WALLS OF THE VALLEY.

The escarpment forming the walls of the valley, is composed principally of Medina shales (250 feet, according to Professor Spencer)§. These are succeeded by thin beds of the Clinton formation, and the whole surmounted by the beds of the Niagara formation. Sections of the escarpment near Hamilton, Ancaster and at West Flamboro, are given in Logan's "Geology of Canada."|| The eastern escarpment presents in many ways, an aspect considerably different from the western. From Hamilton to Ancaster, this escarpment shews a clear face of hard Niagara limestone, and Niagara shales, lying upon the shale beds of the Clinton and Medina formations, and surmounted for the greater part of the distance, by a thick

* These measurements were madé in December after a long season of heavy rains.

† See LYELL's Principles, pages 254 and 758 ; and DR. BIGSBY Jour of Science, No XXXVII, pages 262 and 263.

§ Ancient River by Prof. Spencer : page 2.

|| Geology of Canada, pages 313 and 325.

band of broken material containing considerable quantities of chert.* The talus, of which there is only a moderate quantity, is largely composed of pieces of this broken band, and can be seen in the ravine. or channel, formed by every brook flowing over the escarpment, The section given by Sir Wm. Logan, in his Geology of Canada, ‡ places the Niagara beds in the vicinity of Hamilton, at fifty-eight feet, three inches in thickness. This section, beginning at the pentamerus bed, gives five beds ; three of limestone, aud two of shale. The other twenty feet of this section will be found, I think, back on the limestone ridge, near the town-line between Barton and Glanford. This upper escarpment can be traced through Barton Township into Ancaster Township, and to within a short distance of the lower escarpment at Tiffany Falls, on the farm of Mr. Robb, within one mile of Ancaster village·

Over the escarpment, between Hamilton and Ancaster, a number of streams flow into the valley beneath. These streams mostly flow in channels cut at right angles, or nearly so, to the face of the escarpment. Amongst the largest, is the stream at Chedoke. This stream has cut for itself a channel about two hundred yards wide at the mouth, and back into the face of the escarpment, nearly five hundred yards. The walls show a clear section of the broken upper band, and in places the heavy bed of limestone on which the broken band rests. This limestone is from six to eight feet thick, and the broken material, eighteen or twenty feet. The lower beds, apparently red and bluish colored shales, are hidden by the debris falling from the sides of the ravine, and brought down by the stream. At the head of the ravine the water has cut through the broken material to the solid rock, and falls over a face of fifty feet into a pool excavated in the underlying shales. In Nicholl's quarry on the right hand side looking up, and close to the mouth of the ravine, within thirty feet of the level of the bed of the stream, there are exposed the blue and red shales and sandstones of the Clinton group. From the horizon of these shales, I do not doubt but that they are a continuation of the same beds as are to be found at Dundas, with an elevation of one hundred and twenty feet above the

* In this band of chert several species of fossil sponges have been discovered by Lieut-Col. Grant.

‡ Geology of Canada, page 323.

lake level. There are exposed in the cutting of this stream, several fractures crossing the ravine at various angles ; all nearly right angles ; and one of these fractures nearly half way up the stream, on the right hand side looking up shows an opening of from eighteen inches to two feet, passing down through the broken band to the heavy limestone bed. Here the fracture seems to have divided, and passes down through this limestone bed in the shape of two close jointed fractures, with a distance of twelve feet between the joints or lines of fracture. This fracture if continued westward, should come out on the face of the escarpment a little further up the valley. I have not yet seen the outcome of it. It may, however, in its course, have met other fractures running in the other direction, or passing back into the country. This would be no uncommon occurrence, as this eastern escarpment is full of fractures running from the face back. Indeed, I am inclined to think from the curved and broken appearance of the Chedoke ravine, that that stream has in its course followed the lines of several such fractures. Such a course would enable the stream to cut out the channel it has done at a much more rapid rate than it could otherwise do. Several other streams further west have also succeeded in cutting for themselves channels, and forming ravines quite as large, and have their courses filled with drift in much the same manner as Chedoke. The stream near Ancaster forming Tiffany's Falls flows through a ravine not so wide nor as long as Chedoke, but when the gravel hills lying close to its edges are taken into account a great many feet deeper. Tiffany's Falls flow over a sheer precipice of over eighty feet. The cliff is broken into two divisions by a heavy four or five feet band of limestone. This band is underlaid by blue shales containing in many places, patches of an earthy iron ore. The shales overlying the thick band are Niagara shales. Some distance up (about one hundred yards) the stream flows over a smaller fall, or linn, of sixteen or eighteen feet in height, entirely composed of thin shales containing patches of chert. This second fall is the continuation of the second escarpment, seen at Guest's lime-kiln, the overlying beds of the Barton Lime Ridge and Guest's quarry being exposed a few yards further inland. Between the falls and the linn, the stream has hollowed out the shales so as to give them the appearance of being set on edge. There are other smaller streams, dry in summer, but foaming torrents in Fall and Spring, and most of them have formed considerably sized channels for themselves through the broken band forming the top of the escarpment and drift material filling the bottom of the valley, but have not as yet, succeeded in doing much towards forming a channel through the harder beds in the face of the escarpment. The channels of the streams crossing the lower, or second escarpment, near Ancaster, also form large ravines of the same general form as those in the upper ridge.

The lower escarpment crosses the Ancaster and Hamilton road about a mile to the northeast of the village of Ancaster, at an elevation of three hundred and seventy feet above Lake Ontario, and passing along in a westerly direction, crossing the road from Ancaster to Dundas at the Red Mills, and coming to a general level at Mr. Leith's gate, near the Sulphur Springs road. The lower escarpment is probably joined by the upper in Mr. Leith's farm ; and at Mr. Leith's gate both form a single escarpment about three hundred and sixty feet above Lake Ontario. Of this, however, I am not at all satisfied, as I have not be able to trace the upper escarpment any further than into the farm of Mr. William Farmer, where it is completely hidden by gravel hills. However, from the nature of the rock, trend, and elevation, I would not be surprised to find it on Mr. Leith's farm. So far as I have examined it, the rock bedding, both at Leith's and Chapman's, have the characteristics of the lower escarpment. On Mr. Forbes' farm, the lower escarpment is comparatively covered up by a large quantity of debris of the same material as the escarpment, and which has apparently been thrown down from the face of the cliff by the action of the weather, or some other agency undermining the softer beds lying underneath—from the texture of the escarpment here seen, I should think, by the action of water. This lower escarpment is composed chiefly of shale rock. Sections of it can be seen in the channels of any of the streams flowing over into the valley. This escarpment is lost in the drift on Lot 38, of the first concession of Ancaster.

The upper escarpment comes to the road at Guest's lime-kilns From the lime-kilns it follows the road to the village of Ancaster, where it rises to an elevation of about five hnndred feet above Lake Ontario, and turning in a westerly direction, it passes along the southern end of Mr. Egleston's farm, and round behind the village until it meets the lower escarpment near Mr. Leith's gate. The upper escarpment is, in this vicinity, considerably broken. There is an old channel at the northern end of the village of considerable depth, but of no great width or length. This break or channel is filled with clay and sand drift with large flag shaped boulders of limestone and sandstone, tilted at high angles, some of them being set on edge. The upper bed is of limestone, weathered into pits or honeycombed, and corresponds to Number Six of the section given by Sir William Logan, in his geology of Canada.* The head of this ravine behind the village, is crossed by the honeycombed rock which the stream has cut through, and is now passing over the underlying shales which the water has worn off into small steps. This stream has worn a large channel in the shales of the lower escarpment at the Red Mills, on the road leading from Ancaster to Dundas. The head of this channel is five hundred and ten feet above Lake Ontario. Passing along the northern end of the village this escarpment shows a bold face looking north, a short distance, when it is again broken by a stream having a channel of considerable width, but of no great depth. Here, the upper beds of the escarpment are very much broken by fissures of considerable width, and in many places present a series of steps. At other places the drift completely covers the escarpment only allowing the rock to appear here and there on the side of the stream. After crossing this stream the upper escarpment passes into the sandhills of the neighborhood and disappears. The honeycomb bed can be seen on the surface west of the village, and also on the farms of of Messrs. George Farmer and A. Book, a distance of something like four miles to the south of the village of Ancaster. From these exposures, we might be inclined to infer that the upper escarpment turned south from Ancaster village, leaving a basin to the west between it and the Onondago group. The beds of the upper escarpment are made into lime by Messrs Guest, and also quarried for building purposes, on both sides of the stream at Ancaster. The top bed at Guest's lime-kiln runs out before reaching the quarry on the adjoining farm.

Between the top of the lower escarpment and the foot of the upper, there is a considerable tract of level rocky floor covered with

*Geology of Canada, page 324.

drift of considerable depth. A well bored by Mr. Guest, to a depth of thirty-five feet, passes through sandy loam the whole way and finishes in quicksand. This well is only within a few hundred yards of the upper or lime ridge.

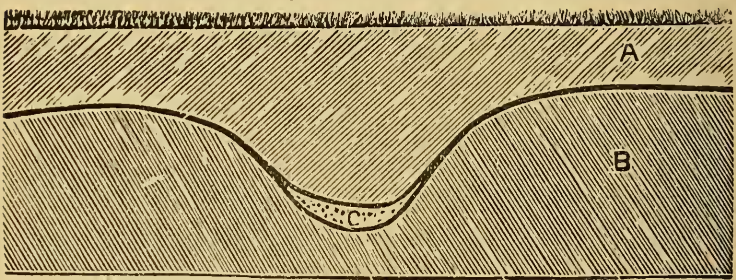
The Drift covering this rocky floor is heaped up into long shaped hills on the outside, leaving a valley between them and the talus of the upper escarpment. Through this valley, the stream from the northern end of the village passes and shows in its banks beds of gravel and boulders in patches. The hills are mostly of clay, with pebbles and streaks of sand, and where cut by streams show no signs of being stratified. This cutting away of the upper beds, I would refer to ice action, as, on a sheet of rock exposed where the lower escarpment crosses the road, there are striae running in a direction of N. 60, E. It is interesting to note that on the road, at the lime-kilns, there is an exposure showing the black shales of the Niagara formation, with several contorted beds of thin shales lying immediately above them. These contorted beds are surmounted by other beds of a uniform level with the black shales underneath.

The quarry close to the Woollen Mill, belonging to the Egleston estate, and lying on the other side of the ravine, shows several large perpendicular fractures passing from the surface down through the several beds in the face of the quarry so far as exposed. At one place, two of these fractures run parallel to each other at a distance of three feet apart, and giving the enclosed rock the appearance of a dyke. That it is not a dyke, however, can be seen from the enclosed material being of the same texture, and having the same bedding in uniformity with the rest of the quarry.

At Guest's lime kiln, just above the exposure of the black shales, the top beds, where not quarried, show a cut-away edge, somewhat as if a mighty agency had passed along and bevelled them off. This cutting away has the appearance of being due to the action of the waves, whether it was only done by the ice and the markings afterwards obliterated by the action of the water, I cannot say. It is, however, probable that such is the case, as the upper beds are not of such a nature as to retain any but very deep marks. In no place in this vicinity have I seen ice-markings on this upper escarpment.

The escarpment on the more westerly, or West Flamboro' side of the valley, differs in some respects from the Hamilton side. There are fewer streams on the west, there being only three or four large brooks, contrasted with the numerous small streams on the other side. The quantity of talus or detritus is much greater on the West Flamboro' side of the valley, than on the Hamilton. So extensive is this detritus in some places, that it completely covers the rocky escarpment.

Section of clay beds near Copetown showing old channel in the blue clay.



A. Yellowish clay.
B. Blue clay.
C. Gravel.

This section is contorted to show more clearly the position of the gravel.

The division from Copetown to Dundas is to a great extent, covered by heavy clay drift, the rock bedding only breaking through here and there, and showing mostly the upper strata of the Niagara group. In this division the drift is composed of two heavy unstratified clay beds. The clay of the upper bed is of a light color, and lies unconformably upon the blue clay of the lower division. The light-colored clay is very thick, in some places showing an exposure of between eighteen and twenty feet.

"Colour is of little value in determining the division of clays into beds, as many of the dark brown and blue clays when exposed to the air and dry, assume light tints." In this district, however, the blue and light clays are separated by a strongly marked line of a broken or waving form. The shape of the dividing line looks as if the upper surface of the blue beds had been exposed for some length of time, and had been subjected to the action of running water before the upper bed of light clay was laid down.

In some places there are considerable quantities of gravel and small boulders mixed with the clay; in others, both the beds are comparatively free from stones of any description. The gravel is mostly found at the junction of the two beds, and particularly where the blue bed is cut into stream-like hollows or gulches. In the upper bed, on the sides of these depressions, I have found fragments of rock, rounded and water worn, and containing fossils of the Hudson River period.

Mr. Weir's quarry, on the first lot of the first Range of Flamboro' West, is overlaid by ten feet of the light colored clay, containing angular blocks. The blue clay is absent, but in one place, a small patch of red till appears, lying close to the rock. The top stratum is of a hard, light-colored limestone. This bed looks extremely like as if there had been part of it cut away before the ice action set in. It has only been quarried in places; and the parts untouched, where exposed, present an edge smoothed and rounded off, and showing the glacial grooves in a beautiful condition and running in a perfect parallelism with this part of the escarpment. In the quarry I found no shells, but a few specimens of the coral favosites gothlandica, and several crystals of galèna, from an inch to two inches in diameter.

The band of broken material capping the Hamilton escarpment, is wanting in Mr. Weir's quarry. The precipice at West Flamboro,' according to the Geological Survey, is capped by blue and grey limestone, including bands of white buff and grey chert, and thickly studded with chert nodules, to a thickness of twenty feet.*

Last year an attempt was made to bore an Artesian well at Dundas, and through the kindness of Mr. Bertram, I am enabled to present here, a section of this boring. The mouth of the well is in the talus of the mountain, and one hundred and fifty feet above lake level.

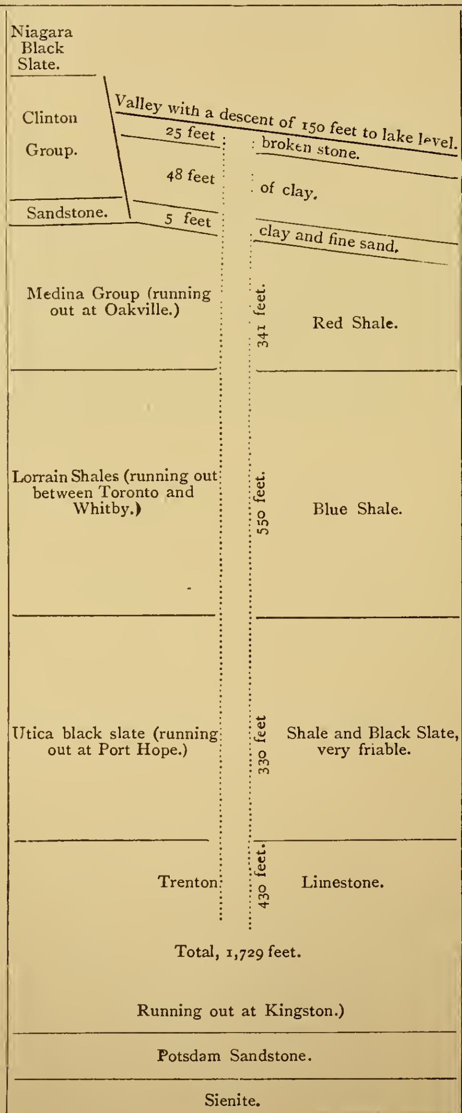
Section of Dundas Artesian well:

1	Broken Stone	25	feet
2	Clay	48	"
3	Clay and Fine Sand	5	"
4	Medina Group (Red Shale)	341	"
5	Lorrain Shales (Blue Shale)	550	"
6	Utica Black Shales (Shale and black slate very friable)	330	"
7	Trenton Limestone to bottom of well	430	"
	Total	1,729	feet

* Geology of Canada, page 327

DUNDAS ARTESIAN WELL, SHOWING UNDERLYING STRATA.

The right hand column gives the Contractor's record and classification. The left hand column is from a section by Mr. Bell The dip of the beds is about thirty feet to the mile.



The well did not pierce the Trenton to its base. Below the Trenton we have the Potsdam and Sienite, and above the mouth of the well the Clinton and Niagara Groups. This section is drawn from N. E. to S. W. The beds dip at about 30 feet to the mile. The Medina Group runs out at Oakville. The strike of this group being in an E. and W. direction, it appears, in the section of the Eastern Escarpment from Niagara to Ancaster, on the same horizon, or 120 feet above the level of the lake. From this section the Medina Group appears to be only 367 feet thick at Dundas, 120 feet of which is above the lake level thus leaving 247 feet under that level. The clay beds in the same neighborhood have, however, been pierced to a depth of 60 feet below the level of Lake Ontario, thus showing the absense of the Medina Group to that depth.||

On the Sydenham road, on the 16th and 17th lots of the first range of Flamboro' West, the Clinton Group is 100 feet 11 inches thick. This is overlaid by 127 feet thickness of beds of the Niagara Group.†

The rocks of the section in the neighborhood of Dundas, form two separate and distinct terraces. The lower and more marked escarpment presents the strata beneath the band of chert and lime stone, which caps the precipice at Flamboro' West.

The upper escarpment, composed of the dark colored bituminous and magnesian limestones, and their accompanying beds, rise more gradually in a succession of steps, terminating at the summit in a wide extent of Table land.

The elevation of the top of the escarpment at Dundas, is 520 feet above lake level.

OLD BEACHES.

Dr. Robert Chambers, in his Ancient Sea Margins, in speaking of the region of the great American Lakes, says: "This district presents some memorials of ancient sea levels which are not, perhaps, exceeded in interest in any part of the globe. To the north of the lowest lake, Ontario, which is 232 feet above the ocean level, the gentle slope, composed of a deep bed of clay enclosing scratched boulders, is traversed lengthways by a series of ridges, nine in number, at a rising series of levels."

||Geology of Canada, page 903.
†Geology of Canada, page 326.

Sir Charles Lyell says: "With the exception of the parallel roads or slopes in Glen Roy and some of the neighboring glens in the Western Highlands of Scotland, I never saw so remarkable an example of banks, terraces and accumulations of stratified gravel, sand and clay maintaining over wide areas so perfect a horizontality as in this district of Ontario." *

Sir Charles Lyell regards them as referable to some ancient beaches and lines of cliff formed on the margins of channels of the sea; others, including some of the loftiest of the ridges, as having originated in banks and bars of sand, formed not at the extreme edge of a body of water, but at some distance from the shore, in proportion as the water attained a certain degree of shallowness from the upheaval of the land."

The height of these ridges above the sea have been given by Mr. Roy, in a paper presented to the Geological Society of London, in 1837, as: ‡

A	342	feet.
B	441	"
C	514	"
D	542	"
E	576	"
F	634	"
G	654	"
H	734	"
I	790	"
J	858	"
K	914	"
O	996	"

To these Dr. Chambers adds two others at §

	242–7	"
	392	"

Between Lake Ontario and the head of Dundas valley proper, there are indications of at least five of these ancient sea beaches. Two of these, Burlington Beach and Burlington Heights are clearly defined. The one at the head of the valley, although the evidence

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* Ancient Sea Margins.

‡ Geology of Canada, page 915.

§ Ancient Sea Margin,, Appendix, Table I.

in support of it is pretty well decided, is not so easily traced. Of the other two the evidence is not so clear, as only parts of them are to be found. These beaches so far as can be traced are all rudely parallel to each other, crossing the valley in a circular form and having their convex sides looking north east towards the lake.

Taking these beaches in serial order, we have first, Burlington Beach, a low sandy and gravelly bar about five miles long, varying from a hundred yards to half a mile in width, and in no part elevated more than a few feet above the level of the lake.

This, I would assume from its positon and elevation to be the most recent of the series of beaches to be found in the valley. Its elevation corresponds pretty nearly with the lowest beach given by Dr. Chambers, or about 242 feet above sea level.

Second, Burlington Heights. This is a beach of much older origin than Burlington Beach. It forms the barrier between Burlington Bay and Dundas valley proper. This beach with its broken strata of sand, gravel and conglomerate, begins close to the escarpment on the south of Hamilton, about the end of Catharine street, and can be traced through the city of Hamilton along the road leading to Burlington village. It is separated from the raised level country lying along the escarpment at the northern end by a deep channel, at one time the mouth of the old canal and outlet of the waters flowing through the marsh into Burlington Bay.

A very fine section of this beach can be seen on the line of the G. W. Railway, from Dundurn grounds to where the line passes around it at the old mouth of the canal.

From levels kindly supplied to me Mr Haskins, the city engineer, I am enabled to give here the heights of this old sea margin at various points in its course through the city.

	FEET.	INCHES.
Reservoir, at commencement	272	
Catherine Street	187	6
John Street	117	4
James Street	110	9
McNab Street	110	6
Park Street	108	
Bay Street	113	4
Caroline Street	115	7

	FEET.	INCHES.
Hess Street	116	
Queen Street	114	
York Street, Cor. of Dundurn	102	6
Kent's [Paradise]Park	109	
Desjardins Canal	109	
Old Mouth of Canal	109	

Leaving out of our calculation the elevations at Catherine and John streets, we might give this beach an average elevation of 110 feet. This added to the elevation of Lake Ontario, 232 feet would give an average elevation about sea level of 342 feet, thereby making Burlington Heights a Beach equivalent to A in Mr. Roy's table.

A section of Burlington Heights shows a series of strata consisting of fine, coarse sand, gravel and pebbles, in alternate order. The beds are much broken and give several angles and directions of dip.

A section of an outlying spur of this beach in Beasley's Hollow on measurement last Fall, gave a section in descending order of

	FEET.	INCHES.
1. Soil	3	
2. Clay	14	
4. Coarse Conglomerate	3	
4. Sand, fine		3
5. Stratified Coarse Sand	1	4
6. Stratified fine Sand	4	6 (dips 1 deg.)
7. Silt	6	
8. Clay		8
9. Silt	6	
10. Clay		8 (dips 4 deg,)
11. Sand partially concealed		

The dip of the beds in this section is to the west, or towards the marsh. Bed No. 5. dips at an angle of one degree and No. 9 has a dip of four degrees.

At the time of my making the measurement the face of the pit shewed four bands of carbonate of lime running through it ; three, in a vertical position and the fourth, running in the direction of the dip but not parallel to the beds, but in a broken line crossing and recrossing two or three of the beds. The three vertical bands were from the three fourths of an inch to one inch in thickness ; the broken band being only about one-half inch in thickness and in places fretted.

These bands apparently had their source in an overlying mass of the same material.

Another section of the same spur gave underneath the brick clay :

1. Sand, with broken top...........	$4\frac{1}{2}$ inches.
2. Clay, 18 inches, thinning out to.	8 or $5\frac{1}{2}$ inches.
3. Sand, course......................	10 inches.
4. Sand, fine..................	2 inches.
5. Conglomerate..................	2 feet 6 inches.

The beds beneath the conglomerate are concealed here.

The dip of this section is also in a western directions.

The section of the Heights at the present mouth of the canal gives :

1. Soil, 2. Fine Sand, 3. Gravel, 4. Coarse Sand, 5. Gravel.	Horizontal.
6. Coarse Sand, 7. Gravel, 8. Coarse Sand, 9. Gravel, 10. Coarse Sand, 11. Coarse Gravel, 12. Sand and fine gravel, 13. Coarse Gravel, 14. Coarse Sand, 15. Silt	Some beds wedge-shaped across the Heights and all dipping slightly towards the old mouth of the canal.
16. Stratified Sand.	
17. Beds of alternately fine and coarse sand.	

These beds are underlaid by the Erie clay lying upon the Medina formation. In this section the underlying beds are mostly dipping towards the North-East with horizontal beds overlying them. These beds are not as a rule, of uniform thickness throughout, many of them being wedge-shaped, particularly those immediately underlying the horizontal beds. The underlying strata are concealed at the canal and are rarely visible at any part of the Heights.

The pebbles contained in the gravel composing these beaches, (Burlington Beach and Burlington Heights) are mostly from the rocks of the Hudson River formation, granites and other crystalline rocks and the Niagara limestones.

Although Burlington Beach and Burlington Heights are usually denominated beaches, the evidence they offer can hardly warrant them being properly so called. Beaches, strictly speaking, are the margins of the land, and an examination of these two will show that they can hardly ever have been in that position. They might, more properly, be considered as banks, ridges or shoals, derived from the debris of the old shores of the lake, when the water level was at least 120 feet higher than at present.

The position, composition and shape of Burlington Beach, points out conclusively that it never was a beach, but since its formation has continued to be what it is at present a low sand bar.*

Of Burlington Heights, the disposition of the materials composing it, answers the question of its origin. Different parts of the heights dip in different directions. It has already been shown that in Beasley's and to the south-east, the beds dip in a western direction or away from the lake, while at the canal the dip is to the east or towards the lake, some of the beds also having a slight inclination towards the old mouth of the canal.

Had the Heights been a beach, with the terrace closing up behind, I do not see how the beds could have been given this western slope. After studying this phenomenon, only two very likely causes can be offered for the formation. These are, first, that Burlington Heights are the remains of a morraine of the last glacial period, afterwards stratified by the action of the lake. This I do not think tenable, as a morraine, even although of a second period and derived in a great measure from the relics of the first, could hardly escape having some large angular blocks; but here the stones are small, rounded and water-worn, and corresponding specimens can be found in patches in different parts of of the valley.

The second cause for the formation of the Heights, appears to be much more reasonable and in accordance with the observed facts.

At the time when the lake stood 120 feet or so higher than at

*See paper by Mr. P. S. Vanwagner for further information concerning Burlington Beach.

present, the waters would be washing away the clay and gravel beds in the neighborhood of Dundas. The softer materials, such as silt and clay, forming these beds, would be carried down to the lake, while the pebbles and gravel, being heavier, and requiring a greater force to move, would be gradually rolled down towards the mouth of the valley, afterwards to be heaped up into the position they now occupy, by the storms affecting the lower and less sheltered waters of what, at that time, would be Lake Ontario.

The western slope of the beds is accounted for, by the water washing over the top af the ridge and gradually moving the materials over to the western side. This may also account for the wedge-shape of the beds formed here and there through the ridge.

The abrupt termination of the beds at the northern end of the ridge, would lead the observer to conclude that the current down the valley at the time the ridge was being laid down, set in close to the eastern and southern shores of the valley, and gradually worked its way over to the position it now holds at present, throwing the ridge and other materials close to the eastern shore, filling up the old bed with materials derived from the new.

Another proof of this beach or ridge being laid down in comparatively deep water, is the conglomerate composing the beds and also found underlying the clay, in different parts of the valley.

This conglomerate is formed by the infiltration of the beds of gravel and sand with carbonate of lime, and as the carbonate could hardly pierce the heavy clays, lying in some places above the conglomerate, without leaving some traces of its having done so, it may reasonably be inferred that the waters charged with the lime, were flowing through the valley and depositing their charge before the upper clay beds were formed.

The carbonate of lime was derived, without doubt, from the continued washing of the waves against the limestones of the escarpment, some streams of the present day being so highly charged with this material, as to act upon the mosses and other vegetable matter, growing within reach of their spray. It could, therefore, only be after the action of the waves upon the cliffs had ceased that the heavy clay deposits lying upon the conglomerate throughout the valley were laid down.

As no conglomerate has been found beneath the blue clay, it can also be reasonably inferred that the conglomerate beds, with the overlying silts and clays are the results of a period succeeding the glacial period, in which the blue clay was laid down

These beds may be, and are in all probability the results of a closing up of the mouth of the stream flowing down the valley, and a general flooding of the district for a great number of years.

The breaking of the bank closing up the mouth of this stream, after the lowering of the waters of the lake, would drain the valley to the extent we now find it, and also leave the channel occupied, as we now find it, by the marsh. When we consider the great depth of the old mouth of the canal, this seems all the more probable.

The question how is it that the beds are alternately coarse gravel, mud pebbles and sand, of various degrees of fineness, naturally comes up to the observer's mind.

This variation, accepting the foregoing theory as correct, would lead to the conclusion that then as now, the waters of the lake were subject to periods of storm and calm. In fine weather, when the waters of the lake were at rest, they would have less force of action, and as a consequencc would only be able to move the finer materials, but at times of storms the force of water breaking over the shoal, would carry the pebbles high up on it and deposit them where we now find them.

Mr. Sanford Fleming, in the Canadian Journal, New Series, Vol. VI, page 257, describes another such ridge, known as the Davenport Ridge, in the Township of York. He says "the gravel deposit can be traced over a considerable area, but unlike the terrace in its windings into the interior, the gravel is found only in a uniform straight direction, and that generally parallel to Lake Ontario.

"The gravel is not deposited in horizontal beds as is generally the case with subaqueous formations, nor is it laid in thin beds dipping southerly or from the shore towards the water, as if they had been thrown up one over another on the inclined plane of the bench by the storms of the former lake. On the countrary we find the gravel invariably deposited in the the opposite direction, that is to say, dipping away from the lake and in some instances, nearly at right angles to what may have been the plane of the beach."

Mr. Fleming's theory as to the formation of the Davenport Ridge is, that the gravel was washed out of the terrace into the position it now occupies, and that being at one time under and at another time above the water, the waves washing over it caused a gradual changing of the materials, and the formation of the beds of gravel and sand dipping away from the lake. He also refers to the spit or island lying in front of Toronto harbor. Davenport Ridge like Burlington Heights is underlaid by clay.

The Beach at the head of the valley has already been referred to, and it is therefore unnecessary to again refer to it beyond that its elevation being about 560 feet above Lake Ontario, or 792 feet above sea level, a height corresponding within a few feet of 790 of Mr. Roy's table.

From what has already been said concerning this beach, or ridge, it might be inferred that this was the line of division between the two lakes at some past period of the geography of the district, as at present it is the watershed of the two drainage systems of Lake Erie and Lake Ontario.

Concerning the other old beaches in the valley, little can be said. Remains of two can, I think, be shown to exist in parts only. I have not yet traced either of them sufficiently to be able to describe them.

The Geological survey * gives us information of two old water margins in the vicinity of Dundas, thus: "to the west of the town of Dundas is an old water margin at an elevation which seems to coincide with the Burlington Heights, while on the north side of the town another ridge of gravel and sand attaining a height of 318 above the lake, occurs just under the escarpment of the Niagara formation. In its eastward extension it recedes from the cliff and diminishing in height disappears at the end of a mile. It approaches the face of the escarpment on the east side of Spencer's ravine, on the other side of which a still higher bank of sand and gravel connects the escarpment and was probably at one time connected with the gravel ridge, which would thus have formed a bar between the former outlet of Flamboro' Creek and the waters which then filled the Dundas valley."

This gravel ridge is, I think, the end of the one found running across the valley and forming the beach dividing the lower portion of the valley proper from the upper one, on the Hamilton and Ancaster road. At the road it is about 120 feet above lake level.

* Geology of Canada, page 914.

GLACIAL MARKINGS.

Had the glacial period anything to do with the formation of the valley ?

Professor Spencer says " that Dundas Valley is not of glacial origin is almost too apparent for consideration. The surface of the adjacent country is often covered with ice markings, but the striae are not parallel to the axis of the valley." This is Professor Spencer's view, while on the other hand Mr. George J. Hinde, in an article in the *Canadian Journal*, vol. xv, page 407, asserts that Dundas valley is altogether of glacial origin. He says, after speaking of the old channel at St. David's : "Valleys of a similar character are to be met with in other places in this escarpment of Niagara dolomite; for instance the one at the western extremity of the lake in which the town of Dundas, Ont., is situated; another one occurs at Owen Sound; in all these cases there is no evidence of streams having been the means of forming these wide-mouthed valleys, whilst both near Dundas and Owen Sound there are plain traces of glaciers having passed up them. The fact of the existence of ancient stream beds leading from the south-west end of Lake Erie, in the direction of the Mississippi valley, and showing that the pre-glacial drainage of that area followed that direction, militates against the theory of a Niagara Falls existing of pre-glacial or inter-glacial date, to which this old valley has given rise." *

The axis of the valley is about N 70 E, and from the following table we see that on the two sides of the valley the striae are in different directions. In the township of West Flamboro', of the four sets of grooves, one of them, S 69 W, is within one degree of the axis of the valley. In the same place, two other sets cross in the direction of S 74 W and also S 24 W. In the upper part of the same township the striae S 49 E largely diverge from the axis of the valley. In the Township of Ancaster, two sets of striae, one S 71 W, and the other S 59 S W, have been recorded. The striae S 59 W passes along the top of the lower escarpment and apparently was a prime agent in forming this escarpment. These Townships lie on the two sides of the valley, and the direction of these markings would make them converge further up towards the head.

In the Township of Beverley six sets of striae varying from S 46

* Glacial and inter-glacial strata of Scarboro' Heights.

E to S 79 E are given. These two directions are the outside markings of a series, and would apparently show a divergence of a considerable amount.

In a list of ice markings given on page 891 of the Geology of Canada, we find the following directions of striae in the neighborhood of Dundas valley :—

LOCALITY.	LATITUDE.	LONGITUDE.	DIRECTION.
Brant..................	44.12	81.13	S 10 W
Syndenham.............	44.35	80.52	S 12 W
"	44.32	80.55	S 23 W
Beverley................	43.19	80.14	S 46 E
" near Sheffield.....	43.20	80.13	S 72 E
" near Troy........	43.15	80.12	S 76 E
"	43.18	80.13	S 59 E
"	43.19	80.10	S 79 E
West Flamboro..........	43.21	80. 2	S 49 E
do. (other grooves S. 69 W.).........	43.16	80. 1	S 74 W
do.	43.16	80. 1	S 24 W
Ancaster...............	43.15	79.56	S 71 W
"	43.15	76.59	S 59 W
Barton..................	....	....	....
York, Grand River.......	43.02	43 02	S 68 E

Comparing the several directions of these striae, one would be inclined to draw the inference that the ice coming from the North-East passed into the valley in currents, met near the narrow part of the valley, forced itself through the gorge into the Township of Beverley and the western part of Ancaster Township, and spread over the country on its way to the South-West.

What effect the glaciers leaving these marks had upon the formation of the valley, is not so apparent. The question might naturally be asked, are these ice markings the result of a first or second glacial period ? That is a question that I cannot very well answer, as some of these markings I have not seen. Some of them I would unhesitatingly ascribe to the one period and some to another ; whether these periods were first, or second, or third, or fourth, I do not know.

If we take the Township of West Flamboro' as an instance, we have, in one place, no less than three sets of markings, running in as many different directions. These are S 74 W., S 69 W., and S 24 West. From the generally level appearance of this situation, it could hardly be inferred that it was the centre of a local glacier, radiating in these directions. We have, therefore, little option in the matter, but must ascribe these directions to two periods of glacial action, which we may call first and second. This will be more readily understood when we come to look at the drift filling the valley and covering the escarpment in many places.

Ice, according to Mr. Carll, moves at different rates of speed at different depths and on meeting any serious obstacle to its progress would turn aside and pursue a course in the line of least resistance.* This may account for the direction of the striae in the valley being in different directions from those from those found on the top of the escarpment. It is clear that the ice coming from the north-east would impinge on the eastern escarpment, which would effectually bar any further progress of the lower strata or stream in that direction. It is also self-evident that on account of the pressure exerted from behind by the whole weight of the moving glacier, the line of least resistance would be along the face of the cliff to the westward, and this course would be the direction pursued by the lower ice current, while the upper division would pass over the top of the escarpment. To this action I would ascribe the two lines of cliff, the upper and lower, and the broken material found on the top of this lower east ern escarpment, and which is wanting in most parts of the western or West Flamboro' wall of the valley.

In the stream near Ancaster, blocks of sandstone belonging to the Medina formation have been found embedded in the sands and clays filling the old ravine. This would seem to bear out the theory of the movements of the lower ice. It would thus appear that this stream is of pre-glacial date, or at least existed at a time before the glacier tearing up these blocks covered the district.

The position of Dundas Valley, however, in respect to the rock bedding of the district, is peculiar. The valley lies on the top of the anticlinal and must at one time have had an elevation of 520 feet above lake level. At the time the bedding of the escarpment formed the anticlinal, the escarpment would also be complete in the channel of the present Niagara river, as far down as Queenstown Heights.

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* Report III. Second Geological Survey of Pennsylvania, page 330 et seq.

This elevation would, therefore, have to be compared with the elevation of the old channel at St. David's and at Queenstown.

This may form an objection to the theory that Dundas valley is an old river channel. From the nature of the Niagara beds in this district, and from the frequency and extent of the fractures throughout these beds, it may be that at the folding over of the anticlinal, a fracture of considerable dimensions occurred and thus opened a direct passage to the streams of the district and enabled them to operate upon the softer shales lying underneath the limestones forming the surface. This theory receives some color from a large fracture extending from the ravine at Albion Mills back into the country for some miles. The fissure thus opened will gradually be enlarged by the action of the water, the frosts in winter and other atmospheric changes. At the opening of the first Glacial period this gorge would present a natural pathway to the ice, and by the grinding of the glacier along its sides would be enlarged to form an opening of considerable extent. On the retiring of the glacier, the stream would resume its sway until the return of the ice would still further widen the gorge and on retiring close up the avenue completely and leave the country to the action of the lake, when the upper beds would be gradually re-arranged into the form we now find them.

DRIFT FILLING UP THE VALLEY.

Through the agency of the sections seen in the streams running through the valley, we have a general knowledge of the upper beds of the drift, while the records of well-borings give us a pretty fair idea of what is to be found further down.

What is the floor of the valley, and at what rate of inclination does it go up the valley? I think these questions can be answered in a partially accurate manner.

In Hamilton the hard rock of the Hudson river formation has been reached at a depth of 227 feet below lake level, and near the centre of the valley, on Lot 40, of the first concession of Ancaster, at an elevation of 232 feet above lake level, a well 30 feet deep came the sandstones of the Clinton formation. This rock would therefore be 202 feet above lake level. These elevations would give a general inclination of about 434 feet in seven miles, or about 62 feet to the mile.

Although this is the approximate rate of inclination it cannot be the true level of the old floor. This inclination would, at Dundas, five miles up the valley, give the Clinton formation an elevation of about 80 feet above lake level. The clays in the same neighborhood have, however, been pierced to a depth of 60 feet below lake level, without touching rock. Now, by adding these two—80 feet above, and 60 feet below lake level—we may arrive at the conclusion that between the place where the rock has been found ar 202 feet above the lake and Dundas a break of 140 feet occurs. Professor Spencer estimates the depth of Burlington Bay, from water level to rock, to be 70 fathoms, or 83 feet below the bottom of the boring in Hamilton. This 83 feet would therefore have to be added to the break of 140 feet we have seen to be above Dundas, making a total break of 223 feet. Niagara Falls are 160 feet, and if these measurements are of any value, the pre-glacial age of Dundas valley witnessed a fall of 63 feet higher than the present age has the pleasure of beholding.

The streams running through the valley have cut channels at various depths, many of them piercing the underlying blue clay. The sections of many of these channels, show the clays banded with alternate layers of red and blue clays.

A section has already been given of the stream in Beasley's Hollow. Further up in the cutting, near Robinson street, the section is :—

	FEET.	INCHES
Red clay, visible	1	6
Blue clay (almost hard as slate)	1	
Red clay	4	
Blue clay (almost hard as slate)	1	3
Red clay	5	
Total	12	9

This is overlaid with reddish yellow clay, covered by a thin layer of gravelly soil. The clays of some parts of the north eastern side of the valley have the same banded appearance.

On the stream near the Red Mills, on the Ancaster and Dundas road, the blue clay, comparatively free from stones, is visible several feet above the stream bed, and is surmounted by heavy beds of a whitish clay. Further up the valley this stream runs upon the top of the blue clay, between high banks of this whitish clay.

The white clay in this neighborhood shows no stones in the sections, although occasional fragments containing Hudson river fossils and small boulders of granite are found on the surface and in the beds of the streams. These granite boulders are for the most part small and rounded. A stream running parallel to this on the other side of the line of terraced clay hills, and cuts occasionally into clumps or knolls ot blue clay.

On the line of the Hamilton and Dundas Street Railway, near Ainslie's Woods, a stream has cut through the brown clay beds to the blue clay and in some places into it for a few feet. The blue clay seems to have the property of forming ifself into a slaty material on its exposure to the air.

In this stream near Ainslie's Woods, the water has worn it off into a step-like form, giving to an observer, at a casual glance, the appearance o: blue slaty beds.*

On the line of the same road, where it begins to to descend to the level of the marsh, there is exposed in the cutting a section of stratified whitish clay and silt, in very thin beds, none of them exceeding three inches in thickness, the surface soil being about two feet thick, but this is evidently brought about by the breaking up and mixing of several of the beds by cultivation, or the vegetation on the surface.

Again, after passing through a small corner of the marsh, and near where the road crosses Morden's creek, there is another section of the same kind exposed to view. Throughout the cutting on the H. & D. S. R., on Mr. Buttram's farm, a band of faint brown clay can be detected between the beds of whitish yellow clay.

On the top of the second escarpment, at Ancaster, this stratification is altogether wanting. The streams show in their sides, clay mixed with gravel and sand, in no regularity, but in patches.

A hill on the farm of Mr. R. Guest has already been described as being composed of blue clay enclosing peebles and patches of fine building sand. These patches of sand tempted Mr. Guest to open a pit, but it proved a failure on account of the uncertain distribution of the sand. On the same farm, a well near the upper ridge passed through 35 feet of sandy loam.

* The red and blue elays in this stream may, upon closer examination and tracing, prove t be shales of the Medina.

The records of the well borings which I have been able to obtain, show the state of affairs further down.

A well on the brick field of Mr. Henry New, gives a section of 50 feet :

Brick clay	8 feet.
Blue clay, filled with limestone fragments.	6 feet.
Gravel and sand	32 feet.
Quicksand, or silt	4 feet.
Total	50 feet.

At Bamberger's there are two wells, each twenty feet deep, passing through clay and ending in sand.

Mr. J. Buttram's well is 38 feet deep and gives a section of :

Clay	27 feet.	
Gravel	6 feet.	
Hardpan, (conglomerate)		3 inches.
Beach shingle	5 feet.	
Total	38 feet,	3 inches.

These wells are on a general elevation of about 80 feet above the lake. Farther up the valley, and within a hundred and fifty yards of the Hamilton escarpment, a well dug by Mr. Hamilton Arthur passed through 27 feet of gravel before reaching the blue clay. This well is on the edge of a stream filled with pieces of limestone and cannot be much more than eighty feet above the lake. Toward the head of the valley, and in the narrow part of the gorge, three well-borings have been obtained.

The first, on Lot 40, of the first concession of Ancaster, has already been referred to, as being 232 feet above lake level. The surface is clay loam, with a sub-soil of blue clay containing boulders and fragments of limestone. This well is 30 feet deep and ends at the sand-rock of the Clinton formation. The second well, on Lot No. 40 of the same concession, passes through the blue clay 38 feet 6 inches.

On another part of the same Lot 40, a well 42 feet deep passes through red clay into quicksand.

At this place it may be worthy of note that beds of limestone and sandstone appear nearer the centre of the valley than the last mentioned well.

A little to the west of Ancaster, wells to the depths varying from 30 to 90 feet have been dug through sand, gravel and hardpan, and in one place clay. One well near the top of the ridge was bored about 190 feet through sands, gravels and clays.

The gravel beds covering the end or the upper escarpment in this district are about 200 feet in thickness.

In the village of Ancaster, although the rock appears upon the surface in places, there is a ridge of sand more than 40 feet in thickness. It has been pierced to that depth without touching rock.

Passing over the height of land, and toward the west, we have seen that outside of the belt of sand and gravel surmounting this Height of land, there are large beds of clay interstratified with the beds of silt. Generally these beds have a stratified appearance. In many places the beds present regular strata or whitish yellow and reddish clays, in layers of from half an inch to one inch in thickness. This arrangement is particularly marked on the banks overlooking the Grand river between Middleport and Onondago. These clays lie at a lower level than the sand ridge. At the village of Alberton they are about 465 feet above Lake Ontario, and at a mile or so to the east they have an elevation of about 480 feet.

I regret I am not able to say accurately what the elevation of Middleport or Onondaga is, but from the general elevation and run of the streams I would estimate these places to be nearly 400 feet above Lake Ontario. They may be a few feet less, but not enough to make any material difference in our present calculations.

The records of deep wells bored in this district are very scant. Although there are numerous wells dug, they generally do not exceed 12 or 15 feet, some few being from 30 to 50 feet in depth.

One at Onondaga, 78 feet ; one on Lot 32 of the sixth concession of Ancaster, over a hundred feet ; and one on Lot 31 of the fourth concession of the same township, 110 feet.

In Onondaga Township, a well bored 50 feet was stopped by reaching rock. Placing these wells in a tabulated form, we see at a glance what the general features of the underground portion of this district are.

TABLE SHOWING THE PARTICULARS OF WELL-BORINGS IN DISTRICT LYING TO THE WEST OF THE HEIGHT OF LAND.

LOCALITY.	DEPTH.	SURFACE.	UNDERLYING STRATA.	BOTTOM.	NATURE OF WATER.	REMARKS.
Lot 39, IV. Con. Ancaster..	30	Whitish Clay, mud with sand	Whitish clay and sand....	Quicksand..	Fresh ..	
Lot 39, V. Con. Ancaster....	50	do	Whitish clay and sand; beds of quicksand at 30 feet....	Quicksand..	Sulphur	
Lot 31, IV. Con. Ancaster..	110	Whitish brown clay loam ..	Beds of clay and quicksand; rock at 55 feet.	Limestone 55 feet in rock.	Fresh ..	The water coming out of the rock was highly chg'd with sulphur and the boring had eventually to be plugged.
Lot 34, III. Con. Ancaster..	52	Sandy loam..	Sandy loam...	Quicksand..	Salt....	
Lot 33, III. Con. Ancaster..	35	Sandy loam..	Sandy loam..	Quicksand..	Fresh ..	
Lot 32, III. Con. Ancaster...	12	Clayey Loam..	Clayey oam..	Quicksand..	Fresh ..	The sand in this well rises so fast that it has frequently to be taken out to prevent the pumps choking.
Lot I. Con Onon. three miles S. W. Alberton....	41	Clay.........	Clay with sand	Rock......		
Alberton.........	61	Clay and sand.	Clay........	Quicksand..		
Lot 33, VI. Con. Ancaster...	100	Clay.........	Clay and sand	Rock at 85 feet.....		
Lot 22, I. Con. Onondaga..	50	Clay.........	Quicksand at 16 feet......	Rock	Fresh ..	
Lot 21, I. Con. Onondaga..	22	Clay.........	Clay, blue clay at 40 feet ..	Quicksand..	Fresh ..	
Lot 21, I Con. Onondaga..	35	Clay.........	Clay and sand	Sand.......	Fresh ..	
Onondaga..........	78	Clay.........	Clay and sand	Rock	No wat'r	The bottom of this well is 25 feet below the bed of the river.

In this table it will be seen that rock has been reached in five places, viz. :

	Elevation of Rock above Lake Ont.
Three miles S. W. of Alberton, at 41 feet	389 feet.
Onondaga Village at 78 feet	322 "
Lot 31, IV. Concession of Ancaster at 55 feet	432 "
Lot 22, I. Concession of Onondaga, at 50 feet	350 " ?
Lot 43, VI. Concession of Ancaster, at 85 feet	400 " ?

These elevations tend to show the general uniformity of the rock bedding underlying the district ; and also, I think, to show that in case, as Professor Spencer says, the Grand River at one time ran into the Dundas Valley, it must have come up in a channel situated to the west. This channel, most probably, was that now occupied by Fairchild's Creek. In this district we find quicksand, or silt, at the depths of 12, 16, 20, 30, 35, 50 and 60 feet. It is, however, probable that the beds at 12 and 16 feet, and at 30 and 35 feet, are the same beds pierced twice. This would reduce the number of these sands to five distinct beds, or strata.

It has already been noticed that the sand in the section shown at Mud Run, on Fairchild's Creek, contain several species of recent fresh-water shells. At Middleport and Onondaga, the inter-stratified beds of sand also contain specimens of recent shells, most of which, however, are of different genera from those at Fairchild's creek. Only one class seems to be common to the two places.

The present lakes, notably Lake Superior and Huron, are laying down deposits corresponding with what we see covering this district. The maps of the U. S. Coast Survey also describe the bottom of Lake Erie as mud and clay. Mr. Geikie, in his "Great Ice Age," in describing several districts of Scotland as old lake bottoms, gives sections nearly corresponding to the beds of clay and sand covering the tract west of the Height of Land, at the head of the valley. Some of his sections are so near a parallel that they might be substituated for what is found here.

Looking at the deposits of clays and sands in this district, there seems to be little doubt but that it is the bed of a lake of post-glacial date, the Height of Land forming the barrier between it and Dundas valley. Mr. Geikie, in referring to these old lakes, says such filled up lakes are probably far more numerous than we have any idea of—for it is always difficult to prove that a wide flat of alluvial ground marks the site of an ancient lake. The barriers that formerly held the waters become obliterated, either by being swept away or buried deeply under recent deposits. Such is the case with not a few rock basins, where the lower lip of rock is often concealed below silt, sand or gravel, and it is only by boring that this fact can be demonstrated.

In this district, fortunately for the theory of its being an ancient lake bed, the barriers are not wanting. The Height of Land, we can easily see, formed the border of this lake on the north and eastern sides. In all probability the western border will be found in the upper beds of the Onondaga group, while the southern side would be partially left open for the connection with Lake Erie by the Grand river, to which, we have already seen, all the streams in the district are tributaries,

The deposits forming the upper beds of drift in the valley proper correspond very nearly to those in the region which we have just shown to be the bed of the post-glacial lake. The sands and clays, brown and blue, are present in many places in regular order, thus showing in a pretty conclusive manner that the operations concerned in the formation of the one were also actively engaged in the construction of the other.

This district has also its bounds shown—the three sides, the escarpment, and the fourth we have already assumed to be Burlington Heights partially, or it may have been occasioned by the retiring glacier damming up the waters in the valley and forming a lake.

The valley proper has, however, several features altogether wanting in the district to the west. In the western district just described, I have not in any instanee seen any boulders or fragments of native rocks. Boulders of any kind are not very plentiful and those generally found are altogether rounded and water-worn granites.

Well-diggers and the farmers of the district assure me that the underlying clays whenever pierced are absolutely free from stones. Of course, in a wide district like this and the small holes usually made by the diggers, it would be a strong assumption to say there were no stones to be found in the clays. On every farm there is at least one well, and on some farms two or three, many or most of which have entered the blue clay. When these numerous diggings fail to show stone, we may assume that stones are by no means of frequent occurrence in the district. Beds of gravel are also reported as being absent.

Now, the condition of the underlying blue clays of the valley is altogether different.

The borings in many places report the underlying clays to be literally packed with stone, and limestone fragments in nearly every case.

Beneath the upper bed of the blue clay, gravel and shingle are of frequent occurrence. These again in some places are underlaid by a lower bed of blue clay. The blue clays in the head of the valley lie upon the rock, while the beds of the same material towards the mouth of the valley are underlaid in most places by beds of shingle gravel and silt.

Another feature of the upper blue beds is their want of uniformity throughout the valley. In Mr. New's boring we find it within eight feet of the surface, while in the boring at Mr. Burtram's, about a mile and a half further south west, its place is supplied by beds of brownish clay, inter-stratified with fine sand or silt.

Again, at Mr. Arthur's the blue clay underlies a bed of gravel 27 feet thick, and at Dundas the blue clay under the gravel beds is more than 90 feet.

The positions of these underlying beds of clay, sands, gravels and shingle correspond in many particulars to instances given by Mr. Geikie, in his " Great Ice Age."

The position and formation of the beds of gravel and shingle underneath the blue clay can only be accounted for by assuming them to have been in that position before the blue clay was laid down.

Several reasons may be adduced in favor of the theory of these beds being already in the positions they are now found in prior to the deposition of the glacial bed :

First—If Dundas valley was an arm of a pre-glacial sea, then, from the shape of the valley, there would be a tendency of gravel, sand and other material to gather within its bounds, but in that case these beds of gravel and sand would stretch across the valley in a semi-circular form. Many of the gravel beds appear to lie in this position.

Second—If Dundas Valley is the gorge or canyon of a pre-glacial river, then these gravel beds would be ranged on one side or both sides of the old river bed. In the case of modern rivers running through gravelly soil, all gravel or sand bars usually stretch down and across the stream from one side or the other. If this rule be applied to the gravels underlying the clay beds in Dundas valley, we would be warranted in ascribing these beds to an existing pre-glacial river. These gravels, if belonging to a pre-glacial age when the valley was an arm of the sea, would not only be placed in a position across the valley, but would be likely to contain fossil shells of the species living in the waters of that time. None, however, have been obtained from any of the beds. They would also have a stratified appearance, the strata lying at a low angle and sloping down the bay towards the lake in the same manner as the gravel beds of the upper deposits. From all that is at present known concerning these beds, it is not very safe to say how they may slope, or how far their stratification may be depended on.

Third—That these gravel beds were laid down prior to the glacier period is also borne out by the position of the clay beds found on Lot 40, or on top of what must at one time have been a fall in the course of the stream passing through the valley. At the place where sandstone was struck in boring, clay containing fragments of limestone was found resting upon the rock, while in different places of the same lot this clay was underlaid by sand. The same thing occurs in the course of the Niagara, and we may assume that this place in which the clay was found resting upon the rock was subject to a strong current which prevented the sand from gathering in its course, while the comparative quiet at the banks of the river allowed accumulation of beds of sand and gravel to be formed. Near the Height of Land, at the head of the valley, these underlying sands and gravels are found in dositions leaving the observer to infer that, previous to the depositon of the last beds of clay at least, a stream of considerable magnitude passed down toward the valley and over the rock bedding on Lot 40.

DRAINAGE SYSTEMS.

This district appears to have two systems of drainage, an upper and lower. In the valley, both systems are draining in one direction. In the district, around the head of the valley, the superficial system carries the water to the Grand river, while the underground or deep-seated system apparently carries its water towards the Dundas valley.

I am aware that the evidence to be adduced in support of this theory is very meagre and consists chiefly in the nature of the waters shown in the different wells and springs throughout the region.

Numerous sulphur springs are found, stretching from the Onondaga group, at Paris, down toward the head of the valley.

One peculiarity of these springs is, that they are only found in certain band-like tracts, and are always more or less deeply seated springs.

The superficial waters on the margin of this band are perfectly fresh and apparently bear no relation whatever to the waters underneath.

Nor is this band lying in a straight line between the two formations—that is, between the Onondaga and Niagara—but, from what can be gathered from the position of the wells of sulphur water, they follow a line along the Grand river from Paris to Onondaga, and then branch around toward the head of Dundas valley.

These wells are found on Lots 30, 31 and 39 of the IV. Concession of Ancaster, and again at the Sulphur Springs, about two miles west of Ancaster. The analysis of this water made in 1858, by Dr. Wilson, gives :—

Chloride of Sodium	3,5476
Chloride of Potassium	.0052
Chloride of Calcium	1.3528
Chloride of Magnesium	.4190
Sulphate of Lime	.6500
Carbonate of Lime	.2035
Carbonate of Magnesia	.0160
Carbonate of Iron	.0274
Silica	.0097
Organic matters, Phosphoric Acid, Alumina and Iodine	Traces.
Total	6.2312

The carbonates are bi-carbonates. The sulphuretted hydrogen 5.6 inches to 100 inches of water. The spring is slightly thermal.

In addition to these Sulphur springs, there are also saline springs running in a direction nearly parallel to the sulphur. On lot 34 of the III. Concession of Ancaster, a well gives brackish or salt water, and on Lot No. 39 of the I. Concession of the same Township a salt well is found. This well was considered of sufficient strength to warrant an attempt to make salt being made. Again, in the valley, a well charged with salt is reported. There is also a saline well in a brook near Dundas.

Sulphur springs are by no means rare in districts overlaid by the Niagara group, but the peculiar positions of these springs in this district seem worthy of remark.

No spring would rise from the rock unless there were fractures or fissures in the rock enabling them to reach the surface. May not these fractures be the sides of the canyon through which an ancient stream passed, on its way from the present course of the Grand river to the outlet through the valley.

The evidence of the saline springs appears to me to show that there is a gradual underground drainage from the higher beds of the Salina or Onondaga group toward Lake Ontario, or in the direction of the lowest level.

Of the present surface drainage enough has already been said to show that, with the exception of one or two streams at the most, the present system is altogether of recent origin.

The only stream which I have observed that can really be ascribed to be of pre-glacial or inter-glacial origin is the one at Ancaster. From the drift filling its old channel, and from the position in which it enters the valley, it can easily be inferred that this stream existed at a time before the ice action set in, and that it entered the the valley, when a current was flowing through the valley towards Lake Ontario.

The question of the origin of Dundas valley is one of considerable imporance, and if properly solved would prove valuable as a key towards the solving of many of the problems connected with Canadian Geology.

We have already seen that two theories have been put forth— one is that of glacial origin, and the other that it is due solely to fluviatile and ærial erosion.

The supporters of both theories bring forward evidence to prove their assertions.

To briefly recapitulate the evidence supporting these theories will require little space. Mr. George J. Hinde asserts that it is only of glacier origin and points, in support of his theory, to the ice markings found throughout the whole district, and also to the beds of blue glacial drift, or till, lying in the bed of the valley. He also points out the form of Lake Ontario and the direction of the glacial striae found at both ends of the lake. Another proof of the glacial origin of the valley is the evidence of pre-glacial outlets from the south-west end of Lake Erie towards the Mississippi valley and the absence of any outlet for the waters of Lake Ontario towards the north-east by the St. Lawrence in pre-glacial times.

The fluviatile theory is supposed by Mr. J. F. Carll, of the Geological Survey of Pennsylvania, and Professor Spencer, of King's College Windsor, N. S. Mr. Carll has shown by numerous measurements of borings that the whole, or at least the greater part of the pre-glacial drainage of the northern division of the State of Pennsylvania, was into Lake Erie, and from the directions in which these streams entered Lake Erie that their course must have been down the lake towards the northeast.

Prof. Claypole, in a paper on the origin of Lake Erie, also supports Mr. Carll, by stating that the basin of Lake Erie must have existed before the advent of the glacial period. He says "If Lake Erie had been excavated in this manner (that is, by glacial action) there would have been evidence of the beds of drift around the south end of the lake" He ascribes the formation of Lake Erie to the action of an ancient river flowing through the region in pre-glacial times. Lakes Erie and Ontario would then be broad, open valleys worn out where the rocks were soft, and connected by deep channel, where they were hard.

Professor Spencer, in his paper, assumes this theory as correct and points out that the deep channel connecting the two lakes, Erie and Ontario, would in all probability be through Dundas valley.

The evidence gathered by personal inspection and given in the foregoing pages, all tend towards the confirmation of the theory laid down by Professor Spencer, that Dundas valley formed in preglacial times the connecting link between Lake Erie and Lake Ontario.

One objection to this theory might, however, be raised. There does not appear to be any outlet for the water of this river after reaching Lake Ontario. Professor Spencer has, after examining the district to the south of the lake been unable to find a position for an outlet. I am unacquainted with this region, but from a study of the maps of the United States Coast survey, and the frequency of rock bottom, would favor the opinion that some local elevation has had the effect of closing up the old channel, and by damming up the waters has formed Lake Ontario and forced the water to find a new channel through the St. Lawrence. Of this, however, I have no evidence to offer, and can only feel that if the evidence I have here produced has any effect towards settling the question of the origin of Dundas valley my object has been attained.

THE FORMATION OF BURLINGTON BEACH.

BY P. S. VANWAGNER.

When the grand and distinct changes which mark the different epochs in the earth's geological history had ceased, and left its surface in comparative repose, we may conjecture from certain indications observable a few miles east of Hamilton, that a large stream receiving the waters shed by that portion of country now drained by the Grand river, flowed through the passage which, at present, is in part occupied by Big creek. The channel of this ancient river can be traced for some distance upward from the Albion mills. Down this incline towards the close of its career, it hurried with increasing velocity to the smooth level rock at the foot of the Lover's Leap. From this rock it leaped in a broad sheet with a fall of fifty feet, and entered the wild gorge below. Seething and foaming with mad fury it rushes between the high frowning walls, and emerging into the light on the lower level, flows swiftly onward through a crooked channel. Less than a mile south of the railway embankment on the Big creek, we see on the west side of the old river bed, unmistakable indications of the river having worn away the perpendicular walls of shelly red rocks. From this point it flowed slowly onward, carrying with it the drift from the cutting above; and discharged its waters into the lake through a wide mouth, now known as Lottridge's pond.

Through the sinking of the ocean beds (these depressions being compensated by upheavals in other portions of the earth's crust), the waters had already retired to nearly their present level, leaving Lake Ontario as the lowest basin in the chain of broad lakes. The westerly limit of this great water was Burlington Heights, besides which, as we have been recently informed by a scientific writer, flowed at a still more remote period, a great river. Having premised the foregoing, we will now consider the probable manner in which the Burlington Beach was formed. I am not aware that this subject has been treated by any previous writer, but, if so, I wish it to be understood that I do not desire to oppose another's theory, or to disturb the learned, nor those deeply versed in geologic lore.

Violent easterly storms, would, as they continue to do, wear away the southerly shore of the lake, and drive forward before them the small stones, gravel and sand, washed from the banks, and deposit them and also the drift from the Niagara beyond a cape or projection in the shore immediately east of the present mouth of the Stony Creek. The clay and other fine material would be held in solution by the motion of the water, and during a change of wind or a succeeding calm, be precipitated as silt on the bottom of the lake. This will account for the deposit, whenever there is a beach, being made up of clean hard material.

As the stones, gravel and sand could not by any possibility be returned by the comparatively feeble action of the north or north-west seas, they must have continued to accumulate, filling first the mouth of the lagoon directly behind the shore projection just mentioned, thence onward along the mainland the deposit continued until it met the current at the mouth of the old Grand River, at present Lottridge's pond. Here a struggle began between the accumulating sands and the flow of the river ; but the sands prevail, and the river's mouth is pressed aside westerly, until it reaches the spot where the water-pipe leaves the south filtering basin. This old channel through which the river flowed into the lake, has been recently obliterated by being filled up to afford the nearest roadway. This passage would be ultimately closed by heavy blows filling it with sand, and the waters thrown back a short time ; and again they burst through with great force spewing the sand out to the left, forming a long and broad beach touching the mainland. This warfare continues for a lengthened period, or until, on the occasion of an unusual dry season, the river contained a small quantity of water, and a succession of east storms taking place, threw up such a mass of sand and gravel as to seal up the mouth of the river at this place for ever. On an increase of its waters, the river breaks through the lighter and weaker accumulation next the mainland, and forms a new mouth in the open bay. This much narrowed channel is now spanned by the Black bridge, which unites at this point the mainland and the Beach.

The contention between the perpetually increasing sand deposit and the stream was less violent for a considerable space of time, and the beach continued to lengthen, until another strand was made at what is now called Dynes point, where we find a slip of sand running sonthwesterly into the bay, between which and the beach proper there is deep water, and evidently the former bed or mouth of the river, through continually becoming more shallow through the action of the waves of the bay, heaving this tongue of sand into it. Here we have the last trace of, and must bid farewell to the old Grand River. It had warred for centuries with the driving sands and had performed its part through deposits and otherwise, in the formation of the beach. Previous to its waters being withdrawn an island had formed north of its mouth, the point mentioned being the remaining south portion thereof.

As a positive proof of the sand and stones moving westerly and northerly along the shore of the lake, I may say from actual observation, that, heavy field stones used for filling cribs at the foot of the Stony creek road, have, within twenty years (now that the cribs are broken up), travelled a quarter of a mile northwesterly; and as one proof of the constantly increasing sand deposit on the shore, I may also add, that the wreck of the schooner Alvord came ashore near the Beach school-house, in May, 1868; that the bottom with the stern post attached became firmly imbedded in the sand forming an immovable land mark, and that the average water level is fully ten yards from the wreck; although the stern post had been, when first imbedded, at the water's edge.

Any obstruction on the shore gathers sand on the seaward side.

That this ancient river ceased to discharge its waters into the lower basin, may be accounted for either by a gradual upheaval of the upper level, through which it flowed disturbing its course, or by an extraordinary freshet cutting a new bed, by which it took a more southerly direction and following the deeper indentations of the surface at length formed a third, or last mouth, in the upper basin of Lake Erie.

On the southerely side of the bay the water is, and was, shallow, with principally a clay bottom with some alluvial deposit and fine sand. On this coarser sand and gravel continued to be deposited; and the beach grew broader and extended northward until a sort of estuary was formed, into which the heavy easterly waves rolled but to recoil from the calm deep water inside. The bottom of estuary having been the bed of the great river before mentioned. The sand and the gravel being held in a balance by the undertow, the foundation of a bar was laid, between the great surbank on the south and the mainland on the north, which had already pushed forward a spur made up of the drift from the north shore of the lake. The bar rose slowly in the deep water, and at length reached the surface. Additions to it, now on the side only ; caused it to widen and increase rapidly, and the connection between the north and south shores was completed.

Birds brought grass seed and grape stones, and acorns to the new formation ; and the waves wafted to it twigs of the balm, the poplar and the willow, which took root and grew. The small birds sang cheerily, the monarch eagle shrieked his approval, the fishes sported and the amphibia bellowed their praises ; henceforth the new bay became a nursery and a paradise for fish and amphibious animals and water fowl.

As a result of the lengthened labors of these natural forces we behold to-day our ever increasing and pleasant summer resort, Burlington Beach.

NOTE.—Since writing the above I fortunately met with a reliable old resident who told me that his father had been informed, in his youth, by old Indians that their fathers remembered a wide passage from the marsh (Lottridge's pond) into the big water—Lake Ontario. This would appear to indicate that the pent up waters of Burlington Bay sometimes forced a passage at the south end of the Beach, whenever there was a greater accumulation of sand at the north end. True, the banks at the south are higher than those at the north end ; this has been brought about recently by the force of the easterly waves ; whereas at the north end of the Beach the heavy rise of the waves was and is disturbed by the rebounding pressure from the north shore of the lake. Or, as appears somewhat probable, had those Indian fathers a tradition that the old Grand River flowed into the lake at this point at a remote period ? All considered, I am disposed to believe the whole Beach formation to be more recent than is generally accepted.

FOOD AND FEEDING.

BY DR. REYNOLDS.

This paper formed one of a series of papers on sanitary matters, that were read before the Association. It began by referring to the necessity of more education as to the importance of food, for in proper food there is stored up the potential energy, which in the body is manifested as heat, constructive power, nervo-muscular action, mechanical motion and the like; while it also supplies the materials necessary for the development and maintenance of the body. But on the other hand, defective food produces many diseases, which may be owing to defects in either quality or quantity, and in the matter of quantity, there may be errors in either extreme. Moreover, besides special diseases that may result from improper food, the use of it is liable to produce a condition of the system in which there is a great tendency to contract disease. And lastly, errors in the method of treating the food, that is in feeding, no matter how excellent the properties of the food, will produce disorders of, the system.

The composition of Food was first gone into, and as the phenomena of life are maintained by the use of proper food, since it preserves the proper structure of the body, the composition of the body from a chemical point of view was considered, before that of the food. The various elements and compounds entering into the structure of the body were referred to, the most important especially so, an account of their functions being given. The derivation of food from its ultimate elements was alluded to, showing how they are converted into vegetable and animal tissue. Then an account was given of the process of digestion, so as to show how the food is adapted for the purposes of building up the human frame, and maintaining the functions of the body. A description was given of the process in different animals from the amœba, at the foot of the scale of creation, to man at the head. Especial attention was then drawn to the various steps of the process seen in the several organs of the human system. The paper next took up the composition of foods, both microscopically and chemically; the action of the digestive ferments on the different elements of the food being shown, and also that of heat, the artificial means used by all nations to render food more digestible. The different classes of foods were then named and their identity shown with the several classes of proximate principles found in the animal body. It was also pointed out here, that, "The design of the food is seen to be the maintenance of the structure of the body, by means of the albuminoid constitutents more particularly, and the production of heat and motion, more especially by means of the amyloids and fats." Reference was also made to the necessity for a mixed diet, viz. : one consisting of members of all classes of foods, a fact proved by experiment. While it had also been ascertained, that the various compounds found in the body must be introduced into it, in a state of combination produced by the agency of living beings, in the form of the various food stuffs, with the exception of water and common salt which are taken in their inorganic form. The fact of people being able to thrive on one class of food, was shown to be due to the mixture contained in it, of elements of the different classes, good examples being shown by the two staple articles of diet, milk and bread. Food was next considered from a sanitary point of view, the first point considered being the various disorders due to errors in food and diet, especial attention being given to those found amongst children, such as the various affections of the stomach and bowels, so especially prevalent in summer when the heat is an additional predisposing cause, convulsions, ricketts, and the various scrofulous and tuberculous affections so common among those whose constitutions have been lowered by improper diet, also local diseases of the mouth, &c. Amongst the diseases of adult life, attention was called to the various epidemics due to unsanitary conditions, but especially defects in food, both in quantity and quality, the Irish famine fevers being examples in this particular, and also teaching the necessity of mixed diet, for the people suffered so much when deprived of potatoes their sole staple article of diet.

The diseases seen among the wealthier classes also were noticed, particularly gout, happily not so prevalent now that greater abstinence is practised. Indigestion in its various forms of local inflammations, also having been alluded to, the various constitutional derangements were taken up, especially anæmia, so prevalent amongst young girls and others whimsical about their diet. After speaking of the disposition to disease, brought on both by want of food and also by over-indulgence, the last division was referred to, namely erroneous feeding. The course of the disorders under this head was traced through the various stages of the digestive process, it being shown how people by disobeying physiological rules from the very beginning of the process, do themselves great harm. Another great source of evil was shown in the defective manner in which food is prepared, too much attention being given to the appearance of food, and to the *art* of cookery and not the *science.* This is especially the case it was pointed out, among the wealthier classes, while the poor pay little attention to either. Attention was also drawn to the errors committed in the purchase of food. The affluent buys in excess, very often unfit food, for which he may have acquired a taste, which his cook panders to. The poor man knows that he has to be careful, but in making a sacrifice, lets it take place in the matter of quality. The advantage of cooking meat properly was shown in the saving effected, and also the danger avoided of incurring the liability to the development of parasites, which are killed by the action of heat such as would be made use of in proper cooking. In conclusion, after speaking of the advantages of good food as seen in hale old people who have always been careful of their diet, also of the improvement in health amongst the sick poor, when admitted to institutions where the diet though plain, is nevertheless good, the paper spoke of the remedies for the evils described. The remedies given were, "first, always look out for quality before striving for quantity." Especial attention was called to the necessity of this rule for children, so as to avoid weakening their systems, at the start in life, and advice was given on the subject of milk as being the best food. Regularity in feeding infants was also insisted upon, and the practice of allowing children the run of the table, condemned. For the community at large, moderation was advised. In selecting the quality of food, it was shown that the digestibility of the various foods must be studied, and variety also was shown to be necessary. The question of quality and quantity having been settled, the value of education in cookery was alluded to, and also the necessity for instruction in the science of cookery, as thus the food could be so prepared as to be more easily assimilated while there would be less waste and destitution. Lastly, attention was drawn to the value of instruction in the physiology of digestion, and the observance of its rules was strongly exhorted, especially those for gastric digestion.

THE ENGLISH LANGUAGE.

BY REV. C. H. MOCKRIDGE, D. D.

The following is a plan of the essay:

I. The phenomenal character of speech in general was dwelt upon. The earliest records of our race give us no clue to its origin.

It is the natural gift to man as an attendant upon thought, which would be of little use without it.

II. A study of the English language shews that it is a tongue which has been carefully improved and enriched by time. Alfred the Great and Queen Elizabeth could not have understood one another, and Queen Victoria would find great difficulty in conversing with Elizabeth.

III. After some illustrations drawn from comparative philology in favor of all languages having had a common origin, a hasty sketch of the English language was given, beginning with the Celtic which was the most ancient element. Then came the Roman period. The disadvantages of the Latin language were clearly pointed out. Then the Saxon reigned supreme, and much of its beautiful simplicity was described. A slight influence came from the Danes,—and a great change from the Norman conquest when Norman-French became the language of the upper class while Saxon was spoken by the conquered and enslaved people to whom it belonged.

IV. This gradually led to a new tongue which might be called Norman-English, which grew steadily in the direction of simplicity in structure and grammar.

V. The clumsiness of inflection first began to give way, the only instance of which now exists is our possessive case.

VI. A specimen of English by William Caxton was given, showing the progress made up to his time, A.D., 1470, the time of the invention of printing. From this the language gradually took the form of grandeur found in Shakespere and Milton.

VII. The future of the English language was painted in bright colors, hopes for its final triumphs being founded on its extreme simplicity of structure, its absolute freedom in the way of grammer from all difficulties and its known power in absorbing other tongues into itself. It may be said that there are no difficulties in the language except the spelling. Simplify this and the pronunciation becomes easier, and the language beautiful and practical alike, fit for what will undoubtedly last and become a universal tongue.

The following papers read through the year, will appear in the next report.

1. "Commercial Transactions in Prehistoric Times." By Wm. Kennedy.

2. "Hon. T. D. McGee." By G. W. Fields, M. A.

4. "Meteorological Cycles." By Geo. Dickson, M. A.

Treasurer's Account

FOR YEAR TO 1st MAY, 1884.

RECEIPTS.

Balance on hand at 1st May, 1883		$10.73
Subscriptions		87.80
		$98.53

EXPENDITURE.

Printing	$34.65	
Attendance	5.00	
Specimens purchased	15.00	
Carriage of Books from England	15.10	
Tables for Hall	15.00	
Repairs	75	
Secretary's expenses	4.50	
		$90.00
Balance on hand		$ 8.53

RICHARD BULL,
Treasurer.

Audited W. H. Ballard, A. T. Neil.

GEOLOGICAL SECTION

—OF THE—

Hamilton Association.

OFFICERS—1883-1884 :

Geo. Dickson, M. A., *Chairman.*

A. T. Neil, *Secretary.*

Wm. Kennedy, }
Wm. Turnbull, } *Executive Committee.*

Thirty meetings of the section have been held since its formation in January 21st, 1882, of these twenty-four were held in the Collegiate Institute, and the remaining six in the rooms of the Association in the Alexandra Arcade building. The members employed themselves at these meetings chiefly in examining, labelling and arranging specimens. The section is greatly indebted to Lieut-Col. C. Coote Grant for the donation of several hundred fossils from the formation that occurs near Hamilton. Among the specimens are sponges from the Niagara chert beds* and Graptolites, also a large number of fossils from foreign localities. Specimens of buildlng stone were obtained from the quarries worked in the neighborhood for the purpose of forwarding them to the Geological Museum at Ottawa, but being less than the required size, they have been detained by the Association. Arrangements have been made with the owners of these quarries to furnish samples of building stone of the required size.

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* Lieut.-Col. Grant has placed specimens of these sponges in the hands of Professor Solus, of Bristol, for examination. Professor Solus has already determined and named several species.

List of Fossil Specimens (determined) presented by Lieut.-Col. Coote Grant to the Geological Section of the Hamilton Association:

SPECIMEN.	FORMATION	LOCALITY.	PROV.
Leptaena sericea	Hudson River boulder	B. Beach and neighborhood	Ont.
Rhynchonella plura............	"	"	"
Strophomena rhomboidalis......	"	"	"
Cyrtolites onatus.............	"	"	"
Modiolopsis modiolanus	"	Hamilton	"
Murchisonia gracilis...........	"	"	"
Ambonychia radiata...........	"	"	"
Pterinea demissa..............	"	"	"
Leperditia..................	"	"	"
Murchisonia..	Medina	"	"
2 Cordlike algae.............	"	"	"
1 Palæophycus..	"	"	"
1 Ptetenomia................	"	"	"
2 Athyris....................	"	"	"
1 Zaphrentis bilateralis........	"	"	"
Bryozoa, many specimens......	Clinton	"	"
Annelida, " "	"	"	"
Fucoid " "	"	"	"
Lingula Oblata, (several)	"	"	"
Lingula colored "	"	"	"
Orthis Circulus, internal and external casts..............	"	"	"
Orthis Testudinaria	"	"	"
Atrypa hemispherica	"	"	"
2 Buccanella tulobala.........	"	"	"
6 Streptorhynchus tenuis, several	"	"	"
Streptorhynchus...............	"	"	"
Strophomena, Several..........	"	"	"
Stricklandia Canadensis........	Clinton	Hamilton	Ont.
Tentaculites ornatus (slab)......	"	"	"
Posidonia alata (Hall).........	"	"	"
Posidonia rhomboidalis........	"	"	"
Athyris umbonato.............	"	"	"
Leptaena transverslis..........	"	"	"

Specimen.	Formation.	Locality.	Prov.
Lingula oblonga..............	Clinton	Hamilton	Ont.
Rhynchonella neglecta.........	"	"	"
Arthrophycus Harlani..........	"	Grimsby	"
Zaphrentis bilateralis, showing orifice, from the lowerbeds of	"	"	"
Calymene Bluemenbachii, fragment	"	Hamilton	"
Calymene tuberculosa....	"	"	"
Rhinopora tuberculosa.........	"	"	"
5 Specimens marsh plants not determined.....	"	"	"
1 Bryozoon (colored)..........	"	"	"
2 Shell impression (colored)....	"	"	"
2 Specimens of fossils showing root termination of marsh plants...................	"	"	"
3 Stromatopora................	"	"	"
3 Favosites Niagarensis	"	"	"
1 Colored shell (fossil).........	"	"	"
1 Buthotrephis gracilis.........	"	"	"
1 Strophomena from the grey band	"	"	"
1 Hemapionites paradides or streptorhynchus tenuis of Hall..	"	"	"
1 Ptelenomia.................	"	"	"
2 Species of algae from the upper green band hitherto said to be unfossiliferous....	"	"	"
Fossil sponges and sections, many not yet named............	Niagara, Barton beds	Barton T.P.	Ont.
Fenestella, many not determined	"	"	"
Rhynchonella allied to Tennesseensis	"	"	"
Spirifera Crispa.	"	"	"
Atrypa reticularis	"	"	"
Athyris subtilita	Niagara B Beds	Barton T.P.	Ont.
Rhynchonella Indiannaensis....	"	"	"
Calymene Blumenbachii, fragment	"	"	"
Sphærexochus Romingeri	"	"	"

Specimen.	Formation.	Locality.	Prov.
Stromatopora...............	Niagara B Beds	Barton T.P.	Ont.
Avicula.....................	"	"	"
Lingula Lamellata............	"	"	"
3 Caryocrinus ornatus	"	"	"
1 Stephanocrinus angulatus.....	"	"	"
1 Caryocrinus ornatus (plate)...	"	"	"
1 Spirifera radiata.............	"	"	"
1 Retzia....................	"	"	"
1 Sticklandia Canadensis.......	"	"	"
1 Pentamerus Canadensis	"	"	"
1 Strophomena striata..........	"	"	"
2 Posidonia alata.............	"	"	"
1 Posidonia (new species)......	"	"	"
2 Platyostosra niagarensis.......	"	"	"
Several Orthis testudinaria......	"	"	"
1 Cronia....................	"	"	"
1 Spirifera Crispa	"	"	"
1 Rhychonella, allied to Tennesseensis	"	"	"
1 Rhynchonella pisa...........	"	"	"
1 Athyris noviformis	"	"	"
1 Leptæna *transversalis*........	"	"	"
1 Atrypa reticularis...........	"	"	"
1 Orthis elegantula...........	"	"	"
1 Stephanocrinus angulata.....	"	"	"
Rhynchonella Pisa............	B. Beds	"	"
Rhynchonelia *Niagarensis*......	"	"	"
Strophomena rhomboidalis.....	" ...	"	"
Strophomena pecten..........	up chert	"	"
Discina fibrosa	"	"	"
Discina tenuis lamellata.......	"	"	"
Orthoceras undulata, many......	"	"	"
Dalmanites limuliurus (*frag*).......	Niagara up chert	Hamilton,	Ont.
Dalmania vigilans.............	"	"	"
Cladopora fibrosa.............	"	"	"
Cladopora, many not det.......	"	"	"
Encrinurus punctata...........	"	"	"

Specimen.	Formation.	Locality.	Prov.
Caryocrinus ornatus, showing portion of stem attached....	Niagara up chert	Hamilton	Ont.
1 Crinoid root................	"	"	"
1 Coscinium proavium, new variety	"	"	"
1 Phylodictya..................	"	"	"
1 Conularia niagarensis, new variety..................	"	"	"
1 Dendrograptus	"	"	"
Inocaulis, several specimens, not determined.............	"	"	"
1 Inocaulis..................	"	"	"
1 Sphonoxurus angulata.........	"	"	"
1 Buthotrephis (Hall).........	"	"	"
1 Algae	"	"	"
1 Cephalic shield of Calymene	"	"	"
Blumenbachii............	"	"	"
2 Rhynchonella Tennesseensis.. .	"	"	"
1 Modiolopsis	B Beds	"	"
1 Retzia evax (Hall)...........	"	Waldion	Indiana
Dendrograptus Ramosus.	"	Hamilton	Ont.
Dendrograptus pendosus.......	"	"	"
Callograptus magorensis........	"	"	"
Callograptus Granti............	"	"	"
Callograptus multicaulis........	"	"	"
Callograptus minutus..........	"	"	"
Dictyonema Expansum	"	"	"
Dictyonema giracile	"	"	"
Holopea Guelphensis..........	"	"	"
Murchisonia longispira.	"	"	"
2 Murchisonia, not determined..	"	"	"
Pentamerus occidentalis........	"	"	"
Pentamerus oblongus..........	"	"	"
2 Pentamerus, not determined..	"	"	"
1 Tremella accumunota........	"	"	"
Eatonia peculiaris, Hall........	Oriskany sandstone	Schoharie	N. Y.
Meristella lata "	"	"	"
Leptocelia flabelleta "	"	Cobelshill	"

Specimen.	Formation.	Locality.	Prov.
Atrypa reticularis.............	Corniferous	Stratford	Ont.
Spirifera Vanuxemi ....,..	L'r Helderberg	Schohaie	N. Y.
Pentamerus galeatus	Pentamerus Limestone.	"	"
Rhynchonella congesta........	"	Binghampton	"
Nucula oblonga..............	Hamilton group	Earlsville	"
Lingula Punctata	"	"	"
Nucula bellatella..............	"	"	"
Muculutus trigutra............	"	"	"
Rhynchonella prolifica.........	"	"	"
Fenestella Lyelli...............	Lower Carboniferous	"	Nova Scotia
Aicula pecten, Lyell...........	"		"
Actinocrinus rotundus...........	"	Burlington	Iowa
Pentremites..................	"	Chester Falls	
Grammysia	"		Nova Scotia
1 Terebratula Congesta	Lower Green sand	Farringdon	Berkshire Eng.
2 Belemnites.................	"	"	"
1 Seyphia (sponge)............	"	"	"
1 Pustulopora spiropirales......	"	"	"
Bryozoa, several specimens..	"	"	"
1 Thornnosta................	Coral Rag	Stamford	Berkshire Eng.
1 Toastea	"	"	"
1 Toastea, variety.	"	"	"
1 Lima coevas arla............	"	"	"
1 Lima rigida	"	Whealley	Oxford Eng.
1 Thecosimitia annularis	"	Stamford	Berkshire Eng
1 Cardium dissimite...........	Portland Oolite	Shotover	Oxford Eng.
1 Pecten	Kinmeridgeclay	Oxford	England
1 Throcia depressa............	"	"	"
1 Rhynchonella plicata..........	"	"	"
1 Pustulipora, a bryozoon attached to former specimen........	"	"	"
1 Exogyra cornea and a specimen of Bryozoon attached......	"	"	"
Allirisma Sedgewickii..........	Upper coal measures	Kansas city	Missouri
Athyris Subtilita	"	"	"
Muskella stuata costata........	"	"	"
Bellerophon..................	"	"	"

Specimen.	Formation.	Locality.	Prov.
Pleubratula bovoides..........	Upper coal measures	Kansas city	Missouri
Productus cona...............	"	"	"
Necopterus..................	"	"	"
Conularia....................	"	"	"
Pecopleris Arboresens.........	"	Mazon Cr'k	Illinois
Ostrea quadruplicatus.........	Cretacious	Dennison	Texas
Buccanum undatum...........	Post Tertiary	Montreal	Que.

List of specimens presented to the Geological section of the Hamilton Association by Andrew T. Niell, Esq.:

SPECIMEN.	FORMATION	LOCALITY.	PROV.
2 Pleurotomaria umbilicata......	Trenton	Collingwood	Ont.
1 Murchisonia fusispira subusiformis..................	"	"	"
1 Murchisonia belicincta.......	"	"	"
2 Chaetetes petripolitona.......	"	"	"
2 Strophomena attenuata.......	"	Craigleith	"
2 Lingula Collingensis.........	"	Collingwood	"
1 Lingula custa................	"	Craigleith	"
1 Lingula obtusa (Hall)........	Utica	Craigleith	Ont
1 Asophus Canadensis, caudal shield..................	"	"	"
1 Leptaena sericea............	"	"	"
1 Orthoceras..................	"	"	"
1 Rhynchonella...............	"	"	"
2 Modilopsis modilaris free.......	Hudson River	Burlington Beach	Ont
1 Cyrtodonta.................	"	"	"
3 Orthis.....................	"	"	"
5 Orthis testudinaria	"	"	"
1 Pterinea demissa............	"	"	"
1 Ambonychia radiata.........	"	"	"
2 Pentamerus occidentalis......	Guelph boulder	Arthur	Ont
Several Spirifera Arenosa (Conrad)	Oriskany Sandstone	Hagersville	Ont
Several Rensselæria ovoides.—Hall	"	"	"
1 Strophomena ampla..........	"	"	"
5 Spirifera perrinea.—Hall......	"	"	"
Spirifera mucronatus..........	Corniferous	St Marys	Ont

Specimen.	Formation.	Locality.	Prov.
Strophomena rhonboidalis......	Corniferous	St. Marys	Ont.
Pentameerus oblonga..........	"	"	"
Strophomena demissa..........	"	"	"
Pentamerus lena.	"	"	"
3 Athyris.....................	"	"	"
Dictyonema retiforme..........	"	"	"
Rhizograptus bulbosus.........	"	"	"
Acanthograptus Granti	"	"	"
Inocaulis ramulosus...........	"	"	"
Atrypa reticularis	"	Township of Downie.	Ont
Atrypa reticularis.............	"	"	"
Rhynchonella thalia.	"	"	"
Spirifera mucronatus	"	"	"
Lucina proavia................	"	"	"
Lucina proavia, variety.........	"	"	"
Conocardium trigonalis........	"	near Hagersville	"
Phacops buffo (cephalic shield)..	"	"	"
Strophomena demissa..........	"	St Marys	"
Pentamerus lena..............	"	"	"
Spirifera mucronatus, variety....	Hamilton	Thedford	"
5 Spirifera mucronatus.........	"	"	"
3 Cyrtia Hamiltonensis	"	"	"

List of specimens presented by John McLean, Dundas:

SPECIMEN.	FORMATION.	LOCALITY.	PROV.
3 Specimens of Lucina provia...	Corniferous	Tp. Tuckersmith	Ont.
2 Atrypa reticularis............	"	"	"
2 Athyris chloe................	"	"	"

Presented by Walter Hunter, B. A.:

SPECIMEN.	FORMATION	LOCALITY.	PROV.
1 Atrypa reticularis...........	Niagara up chert	Hamilton	Ont.

By G. E. Hemming Esq., Hamilton:

SPECIMEN.	FORMATION.	LOCALITY.	PROV.
Lime Concretion	Niagara	Georgian Bay	Ont

Presented by William Turnbull, Esq.:

	SPECIMEN.	FORMATION.	LOCALITY.	PROV.
2	Ambonychia radiata.........	Hudson River	Hamilton and Burlington Beach	Ont.
1	Modiolopsis modiolaris	"	"	"
3	" " free....	"	"	"
1	" curta.	"	"	"
2	Pterinea demissa.............	"	"	"
1	Cyrtolites ornatus.	"	"	"
2	Murchisonia gracilis.........	"	"	"
1	Strophomena alternata	"	"	"
2	Orthis occidentalis...........	"	"	"
1	Orthonata parallella.	"	"	"
2	Modiolopsis concentrica......	"	"	"
1	Orthodisma curvata	"	"	"
1	Strophomena Niteus	"	"	"
1	Spirifera varicosa............	Oriskany sandstone	Hagersville	Ont.
1	Spirifera Arenosa...........	"	"	"

Presented by Alex Gaviller, Esq.:

Specimens of Lead, Iron and Copper Ore, mingled with Fluor, spar, Carbonate of Lime &c., from Derbyshire-England.

" " Carboniferous sulphate Barytes from Derbyshire, England.

" " Fossil Echinus etc., from Chalk Cliffs Devonshire, England.

" " Fossil Fish.

" " Sea Urchin.—*Modern.*

" " Ammonites &c., from England.

" " Fossil wood from Australia.

" " Flint Arrow Heads (Canada.)

" " Vegetable Ivory, Bean, etc.

" " Sandstone from Isle of Wight.

" " Coral.

" " Star Fish.—*Modern.*

" " Plumbago.

" " Coquina or Shell Stone from St. Augustine, Florida.

List of specimens purchased by the Hamilton Association from Mr. DeCew of DeCewsville:

SPECIMEN.	FORMATION.	LOCALITY.	PROV.
1 Diphyphyllum aurundinacum...	Corniferous	Hagersville and vicinity	Ont.
3 Favosites gothlandica........	Limestone	"	"
3 Fragment showing diaphrams..	"	"	"
2 Michelina convexa	"	"	"
1 Michelina favosoidea	"	"	"
2 Favosites turbinata..........	"	"	"
2 " basaltica..........	"	"	"
3 Calisiophyleum Oneidense....	"	"	"
1 Blothrophyllum decorticatum .	"	"	"
3 Species hellopyllum Colligatum	"	"	"
1 Fistulipora Canadensis.	"	"	"
1 Haimeophyllum ordinatum ...	"	"	"
1 Zaphrentis gigantea..........	"	"	"
3 Zaphrentis prolifica..........	"	"	"
2 Diphyphyllum stramineum....	"	"	"
1 Cystiphyllum aggregatum.	"	"	"
2 Eridophyllum Simcoensis.	"	"	"
1 Michelina convexa	"	"	"
2 New and undetermined specimens	"	"	"
2 Eridophyllum verneuilanum...	"	"	"
2 Favosites, undetermined......	"	"	"
2 Syringopora perelegans.......	"	"	"
1 Syringopora laxata...........	"	"	"
2 Syringapora Maclurii.........	"	"	"
1 Diphyphyllum stramineum	"	"	"
1 Favosites Cervicornis	"	"	"
1 Syringopora Hisingeri........	"	"	"
1 Aulopora Umbellifera	"	"	"
1 Aulopora, not determined	"	"	"
3 Stromatopora...............	"	"	"
1 Cystiphyllum grande.........	Corniferous.	Hagersville,	Ont.
3 Cystiphyllum Senecaenisis	"	"	"
2 Cystiphyllun sulcatum........	"	"	"

Specimen.	Formation.	Locality.	Prov.
1 slab containing Heliophyllum ..	Corniferous	Hagarsville	Ont
2 Polymorpha	"	"	"
Alveolites	"	"	"
Aulopora umbelifera	"	"	"
2 Corunta Diphyphyllum.	"	"	"
1 Conophyllum magnificum.....	"	"	"
6 Favosites polymorpha	"	"	"
6 Alveolites..	"	"	"
1 Aulopora Cornuta	"	"	"
1 Zaphrentis, undetermined. ...	"	"	"
3 Heliophyllum Eriense	"	"	"
3 Heliophyllum Cayugaense	"	"	"
3 Heliophyllum Canadense	"	"	"
20 species of small corals	"	"	"
1 Syringopora nobilis.	"	"	"
1 Phillipsastrea verneuilanum ...	"	"	"
2 Species bryozoa	"	"	"
2 Cyrtoceras Ammon	"	"	"
4 Encrinites, (fragments)	"	"	"
3 Calymene Blumunbachii (matrix)	"	"	"
1 Phacops Calisphalis	"	"	"
6 Proteus pygidium and other fragments	"	"	"
3 Strophomena Ampla	"	"	"
4 Strophomena rhomboidalis	"	"	"
1 Strophomena Patersoni	"	"	"
4 Strophomena demissa	"	"	"
3 Strophomena inequistriata	"	"	"
2 Strophomena perplana	"	"	"
2 Strophomena, undetermined ..	"	"	"
12 Chonetes, 4 species	"	"	"
2 Heliophyllum (sections	"	"	"
2 Vanuxemia	"	"	"
2 Stroporallis	"	"	"
2 Conocardium trigonolis	"	"	"
2 Stricklandinia elongata	"	"	"
3 Spiriferia gregaria	"	"	"

Specimen.	Formation.	Locality.	Prov.
4 Spirifera raricosta	Corniferous	Hagersville	Ont
4 Spirifera fimbriata	"	"	"
1 Spirifera duodenaria	"	"	"
1 Spirifera Accuminata	"	"	"
4 Orthis Livia	"	"	"
4 Pentamerus aratis	"	"	"
1 Loxonema Catterani	"	"	"
3 Orthoceras (fragments)	"	"	"
5 Athyris Clara, 1 with coil	"	"	"
2 Athyris Scitula	"	"	"
1 Athyris uniplicata	"	"	"
6 Atrypa reticularis	"	"	"
2 Atrypa undetermined	"	"	"
10 Species of gastropods	"	"	"
2 Leptocælia	"	"	"
2 Rhynchonella tethys	"	"	"
2 Rhynchonella thalia	"	"	"
2 Charionella	"	"	"
2 Retzia Eugenia	"	"	"
2 Centronella	"	"	"
2 Undetermined specimens	"	"	"
1 Phillipsastrea gigas	"	"	"
1 Favosites hemispherica	"	"	"
Polyzoa, *several specimens*	"	"	"
A remarkable specimen of Eridophyllun	"	"	"
1 Base of the formation	Oriskany sandstone	Hagersville and vicinity.	Ont.
1 Favosites Gothlandica	"	"	"
1 Favosites hemispherica	"	"	"
1 Favosites basaltica	"	"	"
1 Favosites Polymorphia	"	"	"
1 Cystiphyllum Senecaense	"	"	"
1 Zaphrentis spatiosa	"	"	"
1 Zaphrentis prolifica	"	"	"
1 Michelina Convexa	"	"	"
1 Heliophyllum exiguum	"	"	"
2 Trilobite fragments	"	"	"

Specimen.	Formation.	Locality.	Prov.
1 Fenestella	Oriskany sandstone	Hagersville and vicinity	Ont
1 Eridophyllum Simcoense.	"	"	"
1 Heliophyllum....	"	"	"
1 Spirifera Arenosa (small ex coil)	"	"	"
1 Athyris Clara	"	"	"
1 Fish plate and spine	"	"	"
1 Spirifera Arata.	"	"	"
1 Strophomena magnifica	"	"	"
1 Atripa reticularis	"	"	"
1 Avicula	"	"	"
1 Strophomena Ampla.	"	"	"
1 Strophomena perplana.......	"	"	"
1 Strophomena demissa..	"	"	"
1 Chonetes	"	"	"
1 Rensselæria ovalis...........	"	"	"
1 Rensselæria ovoides..........	"	"	"
1 Orthis hippariangse..........	"	"	"
1 Pentamerus Aratus..........	"	"	"
1 Platyostoma ventricosa.......	"	"	"
9 other Gastropods............	"	"	"

Presented by the Geological and Natural History Survey of Canada :

Carbon

1 Bituminous coal "cretaceon" Union mine, Comox, B. C.
2 Albertite..................Albert mines, Albert Co. N. B.,
3 Graphite..................Buckingham, Que.
4 do (dissiminated) ..... " "

Baryta and Strontia.

5 Barite........ ....Hull, Que.
6 Celestite..................Lansdowne, Ont.

Lime and Magnesia.

7 Gypsum............... ....Cape Breton, N. S.
8 " (selenite) ....Oxford, N. S.
9 " (fibrous)...........Nova Scotia, N. S.
10 Calcite....... ....Lachine, Que.
11 " ....Orford, Que.

12 Calcite with mica..........Grand Calumet, Que.
13 " fetid................Chatham, Que.
14 Apatite..................Templeton, Que.
15 " crystals.............Lake Clear, Ont.
16 " ....Templeton, Que.
17 Fluorite..................Ross. Ont.

Alumina.

18 Cryolite.................Greenland

Silica.

19 Quartz.................Chatham, Que.
20 Agate...................Partridge Island, N. S.
21 Amethyst ....Amethyst Harbor, L. Superior, Ont.

Hydrous Silicates of Magnesia.

22 Steatite ....Potton Que.
23 Potstone ....Bolton Que.
24 Serpentine ....Calumet Portage, Calumet Isd., Que.
25 " .... " " " " Que.
26 " (chrysolite) ....Shipton, Que.
27 " foliated.........Shipton, Que.

Anhydrous Silicates of Lime and Magnesia.

28 Wollastonite.............Grenville, Que.
29 Pyroxene, with Graphite...Grenville, Que.
30 " in Calcite......Calumet Portage, Calumet Isd., Que.
31 " Crystals........Calumet Island. Que.
32 Hornblende ....Hornblende Isd., nr. Parry Sd., Ont.
33 " ....Calumet Portage, Calumet Isd, Que.
34 " Tremolite .....Ross, Ont.
35 " Asbestus......Burgess, Ont.

Hydrous Compound with Silica.

36 Chloritoid ....Leeds, Que.

Zeolite Family.

37 Stilbite ....Cape D' Or, N. S.
38 Natrolite ....Cape Split, N. S.

Anhydrous Silicates Alumina.

39 Feldspar.................Bathurst, Ont.
40 Labradorite ....St. Jerome, Que.

41 Albite (Peristerite) .... Bathurst, Ont.
42 Scapolite .... Calumet Portage, Calument Isd,Que.
43 Chrome Garnet .... Orford, Que.
44 Idocrase with Mica .... Burgess, Ont.
45 Epidote .... Handkerchief, Mt. Megantic Co. Qne
46 Phlogopite .... Burgess, Ont.
47 " in Crystals ...... Templeton, Que.
48 " in Calcite .... Calumet Portage, Calumet Isd. Que.
49 Biotite (?) .... Ross, Ont.
50 Tourmaline .... Calumet Portage, Calumet Isd., Que.

Molybdenum and Titanium

51 Molybdenite .... Ross, Ont.
52 Titanite with Graphite ..... Grenville, Que.
53 " Crystals .... Renfrew, Ont.

Antimony.

54 Stibnite.. .... South Ham., Que.

Iron.

55 Pyrite .... Elizabethtown, Ont.
56 Arsenopyrite .... Marmora, Ont.
57 Specular Iron Ore .... Chatte Lake, Bristol, Ont.
58 Micaceous Iron Ore .... East River, Pictou Co., N. S.
59 Hematite .... McNab, Ont.
60 Ilmenite .... Baie Ste. Paul, Que.
61 Magnetite .... South Crosby, Que.
62 Titanic and Magnetic Iron
Sand .... Moisie River, Que.
63 Chromite .... South Ham. Que.
64 Limonite .... Nova Scotia.
65 Bog Iron Ore .... Vaudrieul, Que.
66 Clay Iron Stone .... Saskatchewan, N. W. T.

Lead

67 Galenite .... Lake Superior, Ont.

Copper.

68 Chalcocite .... Alma, N. B.
69 Bornite .... : Harvey Hill Leeds, Que.
70 Chalcopyrite .... " " " "
71 Chrysocolla and Melaconite. Copper Harbor, Michigan, U. S.

Specimen.	Formation.	Locality.	Prov.
72 Porphyry	Intrusive	Grenville	Que.
73 Amygdaloid	"	Bay Chaleurs	N B.
74 Granite	"	Gananoque	Ont.
75 "	"	Stanstead	Que.
76 Syenite	"	Grenville	"
77 Trachyte	"	St. Lambert	"
79 Buhrstone	Laurentian	Grenville	"
79 Sandstone Conglomerate	L. Carboniferous	River Philip	N.S.
80 Limestone "	Levis	Metis	Que.
81 Gneiss	Laurentian	Grenville	"
82 "	"	Tudor	Ont.
83 Sandstone	L. Carboniferous	River Philip	N.S.
84 "	Potsdam	Rideau Canal	Ont.
85 Dolomite	Niagara	Rockwood	"
86 Lithographic stone	Birds-eye and Blk River	Harvey	"
87 Limestone, with graphite	Laurentian	Ross	"
88 "	Trenton	Montreal	Que.
89 "	Laurentian	Grand Falls Calumet Isd.	"
90 "	Black River	Pacquette Rapids	"
91 Argillite		Windsor	"
92 Bituminous shale	Devonian	Beliveau	N.B.
93 Mica schist	Huronian	Potton	Que.
94 Hydro-mica schist with copper	"	Harvey Hill Leeds	"
95 Hornblende schist	Laurentian	Sheffield	Ont.

Presented by Geo. Dickson, M.A., Hamilton :

Iron.

1 Bog iron ore . . . . Lake Erie, Ont.
1 Specular " . . . . Lake Superior, Ont.
2 Hæmatite " . . . . Lake Huron, North shore, Ont.
2 Magnetite . . . . Lake Superior, Ont.
2 Pyrite . . . . " "

Lead.

1 Galenite . . . . Peterboro, Ont.

Carbon.

1 Graphite . . . . Lake Superior silver plot, Ont.

Lime and Magnesium.

1 Gypsum .... Cayuga, Ont.
1 " (selenite) .... Hamilton, Ont.
1 Calcite .... " "
2 Apatite crystal .... North Burgess, Ont.

Alumina.

1 Cryolite .... Greenland

Silica.

1 Quartz .... Lake Superior, Ont.
1 Amethyst .... " "
1 Phlogopite crystal .... North Burgess, Ont.
1 Feldspar .... " "
1 Hornblende schist .... " "
1 Serpentine .... " "

Also a number of fossils from the Hudson river, Clinton, Niagara, and Corniferous formation.

Presented by Wm. Kennedy:

1 Bottle of Mineral Water from Ancaster Sulphur Spring.
2 Bottles of Mineral Water from Onondago Sour Spring.
1 Piece of Gum Bed from oil region, Petrolia.
1 Bottle of clear Petroleum.
1 " crude "
1 " Naptha.
1 " Petroleum Tar.
1 " Machine Oil.
1 " Salt Brine from Enterprise Well, Brussels, Ont.
6 Bottles of fragments of Oil Well Core from depths varying from 200 to 1300 feet.

CONTENTS.

ERRATA.

The following corrections were received too late for the printer :

PAGE.

8. Charlton, B. E., delete "and."
10. Dr. Malloch's address should be 70 James St. South.
27. For "14 January" read "14 February."
36. Twenty-sixth line, read "beneficence" for "benificence."
38. Nineteenth line, read "natural history" for "national history."
44. Ninth line, read "Both priests were zealous for the conversion of the heathen to the Roman faith and had long," &c.
51. Seventh line, read "Otinaoutaoua" for "Otinaoustettaoua."
52. Seventeenth line, read "Otinaoutaoua" for "Otinaoustettaoua."
56. Forth line from foot of page, read "Otinaoutaoua" for "Otinaoustettaoua."
57. First line, read "Otinaoutaoua" for "Otinaoustettaoua."
82. Last line, read "many efforts have been made."
83. Third line, delete "its."
89. Fifth line, delete "twenty."
92. Sixth line, delete "to."
95. Twenty-third line, read "great intensity" for "largely intensity."
100. Fifth line from foot of page, read "wire of the same resistance."
102. Twenty-ninth line, read "reduce" for "deduce."
156. Second line, read, "Schoharie" for "Schohaie."