June
to the Royal Socie

REGALIS · SOCIETAS · CANADENSIS

DIVERSIS EODEM NITIMUR STUDIIS

MDCCCLXXXII

MÉMOIRES

ET

COMPTES RENDUS

DE

LA SOCIÉTÉ ROYALE

DU

CANADA

TROISIÈME SÉRIE—TOME XIV

SÉANCE DE MAI 1920

EN VENTE CHEZ
J. HOPE ET FILS, OTTAWA; LA CO. COPP-CLARK, (LIMITÉE), TORONTO
BERNARD QUARITCH, LONDRES, ANGLETERRE
1921

PROCEEDINGS

AND

TRANSACTIONS

OF

THE ROYAL SOCIETY

OF

CANADA

THIRD SERIES—VOLUME XIV

MEETING OF MAY, 1920

FOR SALE BY
JAS. HOPE & SON, OTTAWA; THE COPP-CLARK CO. (LIMITED), TORONTO
BERNARD QUARITCH, LONDON, ENGLAND
1921

TABLE OF CONTENTS

APPENDICES

SECTION I

SECTION II

SECTION III

SECTION IV

SECTION V

SECTION V

THE ROYAL SOCIETY OF CANADA

Founder: HIS GRACE THE DUKE OF ARGYLL, K.T., *&c.*
(WHEN GOVERNOR-GENERAL OF CANADA IN 1882)

OFFICERS *for* 1920-1921

HONORARY PATRON:

HIS EXCELLENCY THE DUKE OF DEVONSHIRE, K.G. *&c., &c.*

PRESIDENT: A. P. COLEMAN, M.A., Ph.D., F.R.S.

VICE-PRESIDENT AND HONORARY SECRETARY: DUNCAN C. SCOTT

HONORARY TREASURER...C. M. BARBEAU
HONORARY LIBRARIAN....D. B. DOWLING

OFFICERS OF SECTIONS:

SEC. I.—*Littérature française, histoire, archéologie, sociologie, économie politique et sujets connexes.*

PRÉSIDENT....................ERNEST MYRAND
VICE-PRÉSIDENT...............L. A. PRUD'HOMME
SECRÉTAIRE...................C.-MARIUS BARBEAU

SEC. II.—*English Literature, History, Archæology, Sociology, Political Economy and Allied Subjects.*

PRESIDENT....................BRIGADIER-GENERAL E. A. CRUIKSHANK
VICE-PRESIDENT...............HON. WILLIAM R. RIDDELL, LL.D.
SECRETARY....................LAWRENCE J. BURPEE, F.R.G.S.

SEC. III.—*Mathematical, Physical and Chemical Sciences.*

PRESIDENT....................J. C. FIELDS, PH.D., F.R.S.
VICE-PRESIDENT...............DOUGLAS McINTOSH, PH.D.
SECRETARY....................F. T. SHUTT, M.A., D.SC.

SEC. IV.—*Geological Sciences (including Mineralogy).*

PRESIDENT....................WILLIAM McINNES, B.A.
VICE-PRESIDENT...............W. A. PARKS, B.A., PH.D.
SECRETARY....................R. A. A. JOHNSTON

SEC. V.—*Biological Sciences.*

PRESIDENT....................A. P. KNIGHT, M.A., M.D.
VICE-PRESIDENT...............FRANCIS E. LLOYD, M.A.
SECRETARY....................R. B. THOMSON, B.A.

ADDITIONAL MEMBERS OF COUNCIL:

Permanent Members

FRANK D. ADAMS, PH.D., F.R.S., F.G.S.   BENJAMIN SULTE, LL.D.

Past Presidents

W. D. LIGHTHALL, M.A., B.C.L., F.R.S.L.   HON. R. LEMIEUX, LL.D.
R. F. RUTTAN, M.D., C.M., D.SC.

THE ROYAL SOCIETY OF CANADA

LIST OF FELLOWS, 1919-1920

The date given is the date of election; c denotes a charter member.

SECTION I.—LITTÉRATURE FRANÇAISE, HISTOIRE, ARCHÉOLOGIE, SOCIOLOGIE, *Etc.*

1919—AUCLAIR, L'ABBÉ ELIE-J., S.T.D., J.C.D., Archevêché, *Montréal.*
1916—BARBEAU, C.-M., LL.L., B.Sc. *et* Dipl. Anth. (Oxon.), Geological Survey, *Ottawa.*
1905—BRUCHÉSI, S. G. MGR. PAUL, Th.D., archevêque de Montréal, *Montréal.*
1902—CHAPAIS, THOMAS, Litt.D.; Ch. Légion d'honneur, Sénateur, M. Conseil Legislatif, *Québec.*
1916—CHARTIER, CHANOINE EMILE, Ph.D. (Romain), Litt.Lic. (Paris), M.A. (Laval) Université de Montréal, *Montréal.*
1914—CHOQUETTE, ERNEST, M. conseil législatif, *Saint-Hilaire.*
1917—CHOUINARD, H.-J.-B., LL.B., L.H.D., C.M.G., *Québec.*
1890—DAVID L.-O., Ch. Légion d'honneur, sénateur, *Montréal.*
1885—DECELLES, A.-D., C.M.G., LL.D., Litt.D., Ch. Légion d'hon., *Ottawa.*
1919—DELÂGE, CYRILLE-F., surintendant de l'Instruction publique, *Québec.*
1918—DESPRÉS, L'ABBÉ AZARIE-COUILLARD, *Frelighsburg, Québec.*
1918—FAUTEUX, AEGIDIUS, B.Litt., *Montréal.*
1898—GÉRIN, LÉON, *Coaticook.*
1911—GOSSELIN, MONSIGNOR AMÉDÉE-E., M.A., *Québec.*
1920—GOSSELIN, CHANOINE D., *Charlesburg, Québec.*
1918—GROULX, L'ABBÉ LIONEL, M.A., Ph.D., Th.D., *Montréal.*
1908—LEMIEUX, RODOLPHE, LL.D., M. Conseil privé (Can.), off. Légion d'hon., ancien Président, *Ottawa.*
1911—LOZEAU, ALBERT, off. d'Académie, *Montréal.*
1920—MASSICOTTE, E.-Z., LL.B., *Montréal.*
1908—MIGNAULT, PIERRE-BASILE, LL.D., C.R., *Ottawa.*
1914—MONTPETIT, ÉDOUARD, LL.D., Dipl. Ecole S. p. et Coll. S. Soc. (Paris), off. Inst. publique, *Montréal.*
1916—MORIN, VICTOR, B.A., LL.D., *Montréal.*
1909—MYRAND, ERNEST, Litt.D., *Québec.*
1903—PAQUET, MONSIGNOR LOUIS-AD., Th.D., *Québec.*
1919—PELLETIER, GEORGES, *Montréal.*
1917—PERRAULT, ANTONIO, LL.D., C.R., Faculté de droit, *Montréal.*
1899—POIRIER, PASCAL, Ch. Légion d'hon., sénateur, *Shédiac.*
1903—PRUD'HOMME, L.-A., juge., *Saint-Boniface.*
1920—RINFRET, FERNAND, M.P., *Montréal.*
1908—RIVARD, ADJUTOR, M.A., Litt.D., *Québec.*
1915—ROUILLARD, EUGÈNE, Litt.D., off. d'Académie, *Québec.*
c—ROUTHIER, SIR ADOLPHE-B., C.G.C. (Saint-Grégoire), LL.D., Litt.D., ancien président, *Québec.*
1904—ROY, L'ABBÉ CAMILLE, Litt.D., Litt.Lic. (Paris), *Québec.*
1911—ROY, PIERRE-GEORGES, Litt.D., off. l'Inst. publique, *Lévis.*
1917—SCOTT, L'ABBÉ, H.-A., Th.D., Litt.D., *Ste-Foy, Québec.*
c—SULTE, BENJAMIN, LL.D., Litt.D., ancien président, *Ottawa.*

Section II.—ENGLISH LITERATURE, HISTORY, ARCHÆOLOGY, SOCIOLOGY, *Etc.*

1919—Brett, George S., University of Toronto, *Toronto.*
1901—Bryce, Rev. George, M.A., LL.D., *Winnipeg* (Ex-president).
1911—Burpee, Lawrence J., F.R.G.S., Sec'y. International Joint Commission, *Ottawa.*
1917—Cappon, James, M.A., LL.D., Dean of the Faculty Arts, Queen's University *Kingston.*
1906—Coyne, J. H., M.A., LL.D., *St. Thomas.*
1917—Currelly, Charles Trick, M.A., F.R.G.S., The Royal Museum of Archæology, *Toronto.*
1906—Cruikshank, Brigadier-General E. A., LL.D., *Ottawa.*
c—Denison, Col. G. T., B.C.L., *Toronto.* (Ex-president; life member).
1905—Doughty, Arthur G., C.M.G., Litt.D., Dominion Archivist, *Ottawa.*
1915—Edgar, Pelham, Ph.D., Victoria College, *Toronto.*
1916—Falconer, Sir Robert A., K.C.M.G., LL.D., Litt.D., President of the University of Toronto, *Toronto.*
1911—Grant, W. Lawson, M.A. (Oxon.), Principal of Upper Canada College, *Toronto.*
1919—Herrington, Walter C., K.C., *Napanee, Ont.*
1913—Hill-Tout, Charles, *Abbotsford, B.C.*
1917—Howay, Judge Frederick William, LL.B., *New Westminster, B.C.*
1913—Hutton, Maurice, M.A., LL.D., University of Toronto, *Toronto.*
1910—King, Hon. W. L. Mackenzie, C.M.G., Ph.D., LL.D., *Ottawa.*
1919—Leacock, Stephen, B.A., Ph.D., LL.D., McGill University, *Montreal.*
1902—Lighthall, William Douw, M.A., B.C.L., F.R.S.L., *Montreal,* (Ex-president).
1898—Longley, Hon. Mr. Justice, LL.D., *Halifax.*
1916—MacMechan, Archibald, B.A., Ph.D., LL.D., Dalhousie University, *Halifax.*
1917—Macnaughton, John, M.A., LL.D., University of Toronto,*Toronto.*
1910—Macphail, Sir Andrew, B.A., M.D., *Montreal.*
1920—Martin, Chester, M.A., B.Litt., University of Manitoba, *Winnipeg.*
1914—Mavor, James, Ph.D., University of Toronto, *Toronto.*
1911—McLachlan, R. Wallace, F.R.N.S., *Westmount.*
1918—Murray, Walter C., M.A., LL.D., President of University of Saskatchewan, *Saskatoon, Sask.*
1906—Raymond, Ven. Archdeacon W. O., LL.D., *Toronto, Ont.*
1917—Riddell, Hon. William Renwick, LL.D., *Toronto, Ont.*
1899—Scott, D. Campbell, Deputy Superintendent General of Indian Affairs, *Ottawa.*
1900—Scott, Rev. Frederick George, C.M.G., *Quebec.*
1906—Shortt, Adam, C.M.G., M.A., LL.D., *Ottawa.*
1916—Skelton, Oscar D., M.A., Ph.D., Queen's University, *Kingston.*
1920—Stewart, Herbert Leslie, M.A., Ph.D.. Dalhousie University, *Halifax.*
1911—Walker, Sir Edmund, C.V.O., *Toronto.*
1905—Wood, Lt.-Col. William, *Quebec.*
1908—Wrong, George M., M.A., University of Toronto, *Toronto.*

SECTION III.—MATHEMATICAL, PHYSICAL AND CHEMICAL SCIENCES

1914—ALLAN, FRANCIS BARCLAY, M.A., Ph.D., University of Toronto, *Toronto.* (Life member).

1909—ALLEN, FRANK, M.A., University of Manitoba, *Winnipeg.*

1918—ARCHIBALD, E. H., M.A., Ph.D., F.R.S.E., University of British Columbia, *Vancouver, B.C.*

1915—BAIN, JAMES WATSON, B.A. Sc., University of Toronto, *Toronto.*

1899—BAKER, ALFRED, M.A., LL.D., University of Toronto, *Toronto,* (Ex-president).

1916—BRONSON, HOWARD L., B.A., Ph.D., Dalhousie University, *Halifax.*

1913—BURTON, E. FRANKLIN, B.A., Ph.D., University of Toronto, *Toronto.*

1915—CLARK, A. L., B.Sc., Ph.D., Queen's University, *Kingston.*

1897—DAWSON, W. BELL, M.A., Ma.E., D.Sc., M. Inst. C.E., *Ottawa.*

1918—DELURY, ALFRED T., M.A., University of Toronto, *Toronto.*

c—DEVILLE, E., LL.D., I.S.O., Surveyor General, *Ottawa.*

1891—ELLIS, W. H., M.D., University of Toronto, *Toronto.*

1910—EVE, A. S., D.Sc., McGill University, *Montreal.*

1909—FIELDS, JOHN CHARLES, Ph.D., F.R.S., University of Toronto, *Toronto.*

1902—GLASHAM, J. C., LL.D., *Ottawa.*

1891—GOODWIN, W. L., D.Sc., *Kingston, Ont.*

1908—HARKNESS, JAMES, M.A. (Cantab. & Lond.), McGill University, *Montreal.*

1911—HERDT, LOUIS A., D.S.c, E.E., McGill University, *Montreal.*

1914—JOHNSON, F. M. G., M.Sc., Ph.D., F.I.C., McGill University, *Montreal.*

1911—KENRICK, FRANK B., M.A., Ph.D., University of Toronto, *Toronto.* (Life member).

1915—KING, LOUIS VESSOT, M.A. (Cantab.), D.Sc., McGill University, *Montreal.*

1910—KLOTZ, OTTO, LL.D., F.R.A.S., Director Dominion Observatory, *Ottawa.*

1911—LANG, COL. WILLIAM R., D.Sc., F.I.C., University of Toronto, *Toronto.*

1913—MACKENZIE, A. STANLEY, B.A., Ph.D., D.C.L., LL.D., President of Dalhousie University, *Halifax.*

1900—MCGILL, ANTHONY, B.Sc., LL.D., Chief Analyst, *Ottawa.*

1909—MCINTOSH, DOUGLAS, Ph.D., University of British Columbia, *Vancouver, B.C.*

1903—MCLENNAN, J. C., Ph.D., University of Toronto, *Toronto.*

1911—MCCLUNG, ROBERT K., M.A., D.Sc., B.A. (Cantab.), University of Manitoba, *Winnipeg.*

1899—MILLER, W. LASH, Ph.D., University of Toronto, *Toronto.* (Life member).

1919—PARKER, MATTHEW A., B.Sc., F.I.C., University of Manitoba, *Winnipeg.*

1918—PATTERSON, JOHN, M.A., Physicist with Meteorological Service of Canada, *Toronto.*

1910—PLASKETT, J. S., B.A., D.Sc., Astrophysical Observatory, *Victoria, B.C.*

1896—RUTTAN, R. F., M.D., C.M., D.Sc., McGill University, *Montreal.*

1917—SATTERLY, JOHN, A.R.C.Sc., D.Sc., M.A., Physics Building, University of Toronto, *Toronto.*

1899—SHUTT, F. T., M.A., D.Sc., F.I.C., F.C.S., Chemist, Central Experimental Farm, *Ottawa.* (Life member).

1913—STANSFIELD, ALFRED, D.Sc., A.R.S.M., McGill University, *Montreal.*

1901—STUPART, SIR FREDERIC, Kt., Director of the Meteorological Service, *Toronto.*

1917—SULLIVAN, CHARLES THOMPSON, B.A., M.Sc., Ph.D., McGill University, *Montreal.*

1909—TORY, H. M., M.A., D.Sc., LL.D., President of the University of Alberta, *Edmonton, Alta.*

Section IV—GEOLOGICAL SCIENCES (INCLUDING MINERALOGY)

1896—Adams, Frank D., Ph.D., D.Sc., F.R.S., F.G.S., McGill University, *Montreal.* (Ex-president).
1900—Ami, Henry M., M.A., D.Sc., F.G.S., *Ottawa.* (Life member).
c—Bailey, L. W., M.A., LL.D., University of New Brunswick, *Fredericton.*
1920—Bancroft, J. Austen, M.A., Ph.D., McGill University, *Montreal.*
1911—Brock, Reginald W., M.A., F.G.S., F.G.S.A., University of British Columbia, *Vancouver, B.C.*
1918—Camsell, Charles, B.A., Deputy Minister of Mines, *Ottawa.*
1900—Coleman, A. P., M.A., Ph.D., F.R.S., University of Toronto, *Toronto.*
1919—Collins, William H., B.A., Ph.D., *Ottawa.*
1912—Dowling, D. B., B.Sc., Geological Survey, *Ottawa.*
1915—Dresser, John A., M.A., *Montreal.*
1913—Faribault, E.-Rodolphe, B.A.Sc., Geological Survey, *Ottawa.*
1920—Graham, Richard, P.D., B.A., M.Sc., McGill University, *Montreal.*
1919—Johnston, R. A. A., Geological Survey, *Ottawa.*
1920—Kindle, Edward M., A.B., M.S., Ph.D., Geological Survey, *Ottawa.*
1920—Knight, C. W., B.Sc., Asst. Provincial Geologist, *Toronto.*
1913—McConnell, Richard G., B.A., *Ottawa.*
1912—McInnes, William, B.A., LL.D., Geological Survey, *Ottawa.* (Life member).
c—Matthew, G. F., M.A., D.Sc., *St. John, N.B.* (Life member).
1911—Miller, Willet G., B.A., LL.D., F.G.S.A., *Toronto.* (Life member).
1915—Parks, William Arthur, B.A., Ph.D., University of Toronto, *Toronto.*
1910—Tyrrell, Joseph B., M.A., B.Sc., F.G.S., *Toronto.* (Life member).
1919—Walker, Thomas L., M.A., Ph.D., University of Toronto, *Toronto.*
1910—White, James, F.R.G.S., Assistant to Chairman and Secretary, Commission of Conservation, *Ottawa.*

Section V—BIOLOGICAL SCIENCES

1910—Bensley, Benj. A., Ph.D., University of Toronto, *Toronto.*
1909—Buller, A. H. Reginald, D.Sc., Ph.D., University of Manitoba, *Winnipeg.*
1885—Burgess, T. J. W., M.D., *Montreal.* (Life member).
1919—Cameron, John, M.D., D.Sc., F.R.S.E., Dalhousie University, *Halifax.*
1920—Cameron, A. T., M.A., B.Sc., F.I.C., University of Manitoba, *Winnipeg.*
1912—Faull, J. H., B.A., Ph.D., University of Toronto, *Toronto.*
1920—Fitzgerald, J. G., M.B., University of Toronto, *Toronto.*
1916—Fraser, C. McLean, M.A., Ph.D., Biological Station, *Nanaimo, B.C.*
1919—Geddes, Sir Auckland, *Washington, D.C.*
1916—Harris, D. Fraser, M.D., D.Sc., F.R.S.C., Dalhousie University, *Halifax.*
1910—Harrison, Francis C., B.S.A., D.Sc., Macdonald College, *Quebec.*
1913—Huard, Chanoine Victor-A., D.Sc., Conservateur du Musée de l'Instruction publique, *Québec.*
1916—Hunter, Andrew, M.A., B.Sc., M.B., Ch.B., Edin., University of Toronto, *Toronto.*
1917—Huntsman, Archibald Gowanlock, B.A., M.B., Biological Department, University of Toronto, *Toronto.*
1912—Knight, A. P., M.A., M.D., Queen's University, *Kingston.*
1918—Lewis, Francis J., D.Sc., F.R.S.E., F.L.S., University of Alberta, *Edmonton, Alta.*

1916—LLOYD, FRANCIS E., M.A., McGill University, *Montreal.*
1900—MACALLUM, A. B., Ph.D., D.Sc., LL.D., F.R.S., Administrative Chairman of Research Council of Canada, Ottawa. (Ex-president).
1888—MACKAY, A. H., LL.D., B.Sc., Superintendent of Education, *Halifax.* (Life member).
1919—MACLEOD, J. J. R., M.B., Ch.B., University of Toronto, *Toronto.*
1909—MACKENZIE, J. J., B.A., M.B., University of Toronto, *Toronto.*
1909—MCMURRICH, J. P., M.A., Ph.D., University of Toronto, *Toronto.*
1915—MCPHEDRAN, ALEXANDER, M.B., University of Toronto, *Toronto.*
1913—MOORE, CLARENCE L., M.A., Dalhousie University, *Halifax.*
1908—NICHOLLS, A. G., M.A., M.D., D.Sc., Dalhousie University, *Halifax.*
1902—PRINCE, E. E., B.A., LL.D., F.L.S., Dominion Commissioner of Fisheries, *Ottawa.* (Life member).
1917—THOMSON, ROBERT BOYD, B.A., Professor of Botany, University of Toronto, *Toronto.*
1915—WALKER, EDMUND MURTON, B.A., M.B., University of Toronto, *Toronto.*
1912—WILLEY, ARTHUR, D.Sc., F.R.S., McGill University, *Montreal.*

CORRESPONDING MEMBERS

SECTION I

SALONE, ÉMILE, professeur d'histoire au Lycée Condorcet, 68 rue Jouffray, *Paris.*
HANOTAUX, GABRIEL, de l'Académie française, 21 rue Cassette, *Paris.*
LAMY, ÉTIENNE, secrétaire perpétuel de l'Académie française, 3 place d'Iéna, *Paris.*
LORIN, HENRI, professeur d'histoire coloniale à l'Université de Bordeaux, 23 quai des Chartons, *Bordeaux.*

SECTION II

BRYCE, RT. HON. VISCOUNT, D.C.L., *London, England.*
GANONG, DR. W. F., *Northampton, Mass.*
PARKER, SIR GILBERT, Bart., D.C.L., M.P., P.C., *London, England.*
SIEBERT, WILBUR H., B.A., M.A., Ohio State University, *Columbus, Ohio.*

SECTION III

BONNEY, REV. T. G., D.Sc., LL.D., F.R.S., *Cambridge, England.*
METZLER, W. H., Ph.D., F.R.S., Edin., Syracuse University, *Syracuse, N.Y.*
THOMSON, SIR JOSEPH J., O.M., F.R.S., *Cambridge, England.*

SECTION IV

WHITE, CHARLES DAVID, B.Sc., United States Geological Survey, *Washington, D.C.*

SECTION V

OSBORN, DR. HENRY FAIRFIELD, Columbia University, *New York, N.Y.*

RETIRED MEMBERS

1902—ADAMI, J. G., F.R.S., M.A., M.D., University of Liverpool, *Liverpool, Eng.*
1902—BARNES, H. T., D.Sc., F.R.S., McGill University, *Montreal.* (Life member.)
c—BÉGIN, S. E., Le Cardinal, L-N., Th.D., Archevêque de Québec, *Québec.*
1892—BETHUNE, REV. C. J. S., M.A., D.C.L., *Guelph, Ont.*
1895—CALLENDAR, HUGH L., M.A., (Cantab.), F.R.S., *London, England.*
1899—CHARLAND, PÈRE PAUL-V., Litt.D., *Québec.*
1909—COLBY, CHAS. W., M.A., McGill University, *Montreal.*
1897—COX, JOHN, M.A. (Cantab.), *London, England.*
1891—FOWLER, JAMES, M.A., Queen's University, *Kingston.*
1904—GORDON, REV. CHARLES W., LL.D., *Winnipeg.*
c—HAANEL, E., Ph.D., Director of Mines, *Ottawa.*
1911—LEATHES, JOHN B., B.A., F.R.C.S., B.Ch. (Oxon.), *Sheffield, England.*
1909—MACBRIDE, ERNEST W., M.A., F.R.S., *London, England.*
1889—MAIR, CHARLES, *Prince Albert, Sask.*
c—OSLER, SIR W., Bt., M.D., F.R.C.P., F.R.S., *Oxford, England.*
1902—OWENS, R. B., M.Sc., Franklin Institute, *Philadelphia, U.S.A.*
1898—PARKIN, G. R., C.M.G., LL.D., *London, England.*
1914—PETERSON, SIR WILLIAM, K.C.M.G., LL.D., *Northend, Hampstead, London, N.W. 3, England.*
1900—POOLE, H. S., M.A., F.G.S., *Spreyton, Stoke, Guildford, England.*
1890—ROBERTS, C. G. D., M.A., *London, England.*
1900—RUTHERFORD, E., B.A. (Cantab.), M.A., F.R.S., *Manchester, England.*
1910—THOMSON, E. W., F.R.S.L., *Ottawa.*
1909—VINCENT, SWALE, M.D., D.Sc., University of London, *London, England.*
c—WATSON, J., M.A., LL.D., *Kingston.*
1900—WILLISON, SIR JOHN S., LL.D., *Toronto.*
1910—WILSON, HAROLD A., F.R.S., *Houston, Texas.*
c—WRIGHT, R. RAMSAY, M.A., B.Sc., *Bournemouth, England.* (Ex-president.)

LIST OF PRESIDENTS

1882–1883	Sir J. W. Dawson
1883–1884	L'honorable P.-J.-O. Chauveau
1884–1885	Dr. T. Sterry Hunt
1885–1886	Sir Daniel Wilson
1886–1887	Monsignor Hamel
1887–1888	Dr. G. Lawson
1888–1889	Sir Sandford Fleming, K.C.M.G.
1889–1890	L'abbé Casgrain
1890–1891	Very Rev. Principal Grant
1891–1892	L'abbé Laflamme
1892–1893	Sir J. C. Bourinot, K.C.M.G.
1893–1894	Dr. G. M. Dawson, C.M.G.
1894–1895	Sir J. Macpherson LeMoine
1895–1896	Dr. A. R. C. Selwyn, C.M.G.
1896–1897	Most Rev. Archbishop O'Brien
1897–1898	L'honorable F.-G. Marchand
1898–1899	T. C. Keefer, C.M.G.
1899–1900	Rev. William Clark, D.C.L.
1900–1901	L. Fréchette, C.M.G., LL.D.
1901–1902	James Loudon, LL.D.
1902–1903	Sir J. A. Grant, M.D., K.C.M.G.
1903–1904	Col. G. T. Denison, B.C.L.
1904–1905	Benjamin Sulte, LL.D.
1905–1906	Dr. Alex. Johnson
1906–1907	Dr. William Saunders, C.M.G.
1907–1908	Dr. S. E. Dawson, C.M.G.
1908–1909	Dr. J.-Edmond Roy
1909–1910	Rev. Geo. Bryce, LL.D.
1910–1911	R. Ramsay Wright, M.A., B.Sc.
1911–1912	W. F. King, LL.D., C.M.G.
1912–1913	W. Dawson LeSueur, B.A., LL.D.
1913–1914	Frank D. Adams, PhD., F.R.S., F.G.S.
1914–1915	Sir Adolphe-B. Routhier
1915–1916	Alfred Baker, M.A., LL.D.
1916–1917	A. B. Macallum, Ph.D., F.R.S.
1917–1918	W. D. Lighthall, M.A., B.C.L., F.R.S.L.
1918–1919	Hon. Rodolphe Lemieux, LL.D.
1919–1920	R. F. Ruttan, M.D., C.M., D.Sc.
1920–1921	A. P. Coleman, M.A., Ph.D., F.R.S.

LIST OF ASSOCIATED SOCIETIES

Ontario

Hamilton Association for the Promotion of Science, Literature and Art.
The Hamilton Scientific Society.
L'Institut canadien-français d'Ottawa.
The Women's Wentworth Historical Society.
The Entomological Society of Ontario.
Women's Canadian Historical Society of Ottawa.
Elgin Historical and Scientific Institute.
Women's Auxiliary of the Elgin Historical and Scientific Institute.
Ontario Historical Society.
The Huron Institute.
Niagara Historical Society.
The Ottawa Field Naturalists' Club.
Royal Astronomical Society of Canada.
Canadian Institute, Toronto.
Historical Society, Kingston.
Toronto Astronomical Society.
Lundy's Lane Historical Society.
Women's Canadian Historical Society of Toronto.
United Empire Loyalists' Association of Canada.
Peterborough Historical Society.
Canadian Forestry Association.
Hamilton Ladies' College Alumnæ.
Club littéraire canadien-français d'Ottawa.
The Historic Landsmarks Association of Canada.
Waterloo Historical Society.

Quebec

Société du Parler français au Canada, Québec.
Société de Géographie de Québec.
Société d'Économie sociale et politique de Québec.
The Quebec Society for the Protection of Plants from Insects and Fungus Diseases.
The Antiquarian and Numismatic Society of Montreal.
L'Institut canadien de Québec.
Natural History Society of Montreal.
Microscopical Society, Montreal.
Société historique de Montréal.
Cercle littéraire et musical de Montréal.
Literary and Historical Society, Quebec.

British Columbia

The Natural History Society of British Columbia.

Nova Scotia

The Nova Scotia Historical Society.
The Nova Scotian Institute of Science.

Manitoba

Manitoba Historical and Scientific Society.

New Brunswick

New Brunswick Historical Society.
New Brunswick Loyalists' Society.
Miramichi Natural History Association.
Natural History Society of New Brunswick.

Prince Edward Island

Natural History and Antiquarian Society of Prince Edward Island.

THE ROYAL SOCIETY OF CANADA

PROCEEDINGS FOR 1920

THIRTY-NINTH GENERAL MEETING

SESSION I.—(*Wednesday, May 19*).

The Royal Society of Canada held its thirty-ninth annual meeting in the Victoria Memorial Museum, Ottawa, on May 19, 20 and 21.

The President, Dr. R. F. Ruttan, took the chair at 10 a.m. and, having called the meeting to order, requested the Honorary Secretary to call the roll.

The following Fellows answered to their names or arrived later during the session.

OFFICERS OF THE SOCIETY

President..................Dr. R. F. Ruttan.
Vice-President............Dr. A. P. Coleman.
Honorary Secretary.........Mr. Duncan C. Scott.
Acting Honorary Treasurer..Mr. C. M. Barbeau.
Honorary Librarian.........Mr. D. B. Dowling.

SECTION I.—Auclair, E. J.; Barbeau, C. M.; Chapais, Thos.; DeCelles, A. D.; Després, A. C.; Fauteux, A.; Gérin, Léon; Groulx, Lionel; Gosselin, D.; Mignault, P. B.; Morin, Victor; Montpetit, Edouard; Myrand, Ernest; Pelletier, Georges; Perrault, A.; Poirier, P.; Rinfret, Fernand; Sulte, Benjamin.

SECTION II.—Bryce, George; Coyne, J. H.; Cruikshank, E. A.; Currelly, C. T.; Doughty, A. G.; Edgar, Pelham; Grant, W. L.; Howay, F. W.; Lighthall, W. D.; Longley, J. W.; McLachlan, R. M.; McMechan, Arch.; Riddell, R. W.; Scott, Duncan C.; Shortt, Adam; Stewart, H. L.

SECTION III.—Allan, F. B.; Allen, Frank; Archibald, E. H.; Bronson, H. L.; Clark, A. L.; Dawson, W. Bell; DeLury, A. T.; Deville, E.; Ellis, W. H.; Eve, A. S.; Fields, J. C.; Glashan, J. C.; Goodwin, W. L.; Harkness, James; Herdt, Louis A.; King, L. V.; Klotz, O.; MacKenzie, A. S.; McClung, R. K.; McGill, A.; McIntosh, D.; McLennan, J. C.; Patterson, John; Plaskett, J. S.; Ruttan, R. F.; Satterly, John; Shutt, F. T.; Stupart, Sir Frederic; Sullivan, C. T.

SECTION IV.—Adams, Frank D.; Baily, L. W.; Brock, R. W.; Coleman, A. P.; Collins, W. H.; Dowling, D. B.; Dresser, John A.; Johnston, R. A. A.; Kindle, E. M.; McConnell, R. G.; McInnes, William; Miller, W. G.; Parks, W. A.; Walker, T. L.; White, James.

SECTION V.—Buller, A. H.; Cameron, A. T.; Faull, J. H.; Fitzgerald, J. G.; Harris, D. Fraser; Harrison, F. C.; Huard, Canon; Hunter, Andrew; Huntsman, A. G.; Knight, A. P.; Lloyd, F. E.; Macallum, A. B.; MacKay, A. H.; MacKenzie, J. J.; Macleod, J. J. R.; McMurrich, J. P.; Prince, E. E.; Thompson, R. B.; Walker, E. M.

Letters of regret for absence were received from the following: Bruchesi, Mgr.; Gosselin, Mgr.; Chouinard, H. J. J. B.; Burgess, T. J. W.; Wrong, George M.; Roddick, Sir Thomas G.; Herrington, W. C.; Tory, H. M.; Murray, Walter C.; Bancroft, J. Austen; Raymond, W. O.; Scott, H. A.; Roy, Camille; Delâge, C. F.; Cappon, James; Wood, William; Massicotte, E. L.; Roy, P. G.; Paquet, Mgr. L. A.

It was moved by Mr. Lighthall, seconded by Dr. George Bryce, that the minutes of the annual meeting of last year as contained in the printed proceedings of last year in the hands of the Fellows be confirmed.—Carried.

The Annual Report of Council, printed copies of which had been delivered to the Fellows, was then presented by the Honorary Secretary. The Report was as follows:

REPORT OF COUNCIL

FOR THE YEAR 1919-1920.

To the Fellows of The Royal Society of Canada,

The Council have the honour to present the following report on the work of the Society during the past year:—

The last Annual Meeting was held in Ottawa on May 20, 21 and 22. The meeting was a very successful one. Owing to the formation of a new Section, and the lack of accommodation for Sectional meetings at the Chateau Laurier, the Council has found it necessary this year to hold the general meetings of the Society, as well as the Sectional meetings, in the Victoria Memorial Museum. It is to be hoped that the accommodation provided will prove quite satisfactory to the Fellows.

I.—Proceedings and Transactions of the Society.

In order to economize in the cost of production in our Transactions, it was found necessary this year to revert to the issue of one single volume, instead of the quarterlies.

The volume consists of 888 pages, with illustrations, and a bound copy will be laid upon the table for inspection; distribution will be made promptly after the meeting.

The agenda this year shows a slight decrease in the number of papers, as compared with the previous year, but the programme is an extensive and varied one, and speaks well for the interest of the Fellows in the work of their respective Sections.

II.—Election of New Fellows.

This year there were vacancies in Sections I, II, IV and V. The Council have much pleasure in reporting that the following candidates received a majority of the votes cast, and their election is submitted for confirmation:

Section I.

Fernand Rinfret, B.A., M.P.
Le chanoine D. Gosselin.
E. Z. Massicotte, LL.B.

Section II.

Herbert Leslie Stewart, M.A., Ph.D.
Chester Martin, M.A., B.Litt.

Section IV.

Edward M. Kindle, A.B., M.S., Ph.D.
C. W. Knight, B.Sc.
J. Austen Bancroft, M.A., Ph.D.
Richard P. D. Graham, B.A., M.Sc.

Section V.

A. T. Cameron, M.A., B.Sc., F.I.C.
J. G. Fitzgerald, M.B.

III.—Deceased Members.

It is with deep regret that we record two vacancies, caused by death, in the ranks of the Fellows: Sir James Grant, K.C.M.G., and Dr. C. Gordon Hewitt.

Sir James Grant was a charter member, and a Past President of the Society. Dr. Hewitt was elected in 1913, and, in the following year, was made Treasurer, a position which he held until his death.

The biographical sketch of Sir James Grant was prepared by Professor E. E. Prince, and that of Dr. Hewitt by the Honorary Secretary.

SIR JAMES GRANT, K.C.M.G., M.D.

The death of Sir James Grant, on February 5, 1920, leaves in the ranks of The Royal Society of Canada a very marked vacancy. For nearly forty years he filled a place of peculiar distinction in the Society, and for close on seventy years was prominent in the public life of the Dominion. During this long period—nearly three-quarters of a century—there were few important occasions in which he did not take part. He was one of the few remaining original Fellows of The Royal Society who were present at the impressive inaugural meeting on May 25, 1882, in the Senate Chamber, when the Duke of Argyll (then Marquis of Lorne and Governor-General) and Her Royal Highness the Princess Louise were present as sponsors. He was the last of the original officers of The Royal Society, being the Society's first honorary treasurer, and holding the office for some years. At the first meeting of the Section of Geological and Biological Sciences he presented a short paper on the fragment of a seal's skeleton found in the glacial clay bed nine miles below Ottawa, and he never failed to attend and take part in the Section's proceedings to the last. No Fellow was more faithful in his attendance, and his striking appearance, courtly presence and dignity, made him conspicuous at the meetings, while he was a ready and eloquent speaker, and usually participated in the discussions. To young scientific workers he was always ready to give encouragement; but his most prominent characteristic was his unfailing optimism and his boundless faith in the future of the Dominion. Early in his career he had been impressed with the resources and vast possibilities of Canada's North-West Territories, then remote and little appreciated. He was quite a youth, a medical student indeed at McGill (1849–50), when he met, under the roof of the Hon. Allen Macdonald, ex-chief factor of the Hudson's Bay Company, Sir George Simpson, Governor of the Company, and a number of assembled high officials serving under that distinguished chief, and listened to their views as to the practically unknown regions of the north. This early experience gave him a theme upon which he was eager to speak whenever the opportunity offered. It was appropriate, therefore, that when he was Member of Parliament for the County of Russell,

Sir James Grant, K.C.M.G.

he should be asked by Sir John A. Macdonald, Prime Minister, to introduce the first Bill in the House of Commons, which led to the building of the Canadian Pacific Railway. It was a well-merited distinction. That was in 1872; but it is interesting to observe that he had prophesied the construction of such a transcontinental railway from Atlantic to Pacific, in an address in 1860 to the old Mechanics' Institute (later the Ottawa Literary and Scientific Society), the object of which would be "to strengthen the very fibre of our country, and to promote, as far as possible, trade and commerce for the advantage of our people," to quote from his Empire Club address in Toronto, on December 2, 1915. He rose to be the leading physician of the capital, and came in contact with the various men of Imperial eminence, who held the office of Governor-General, being physician at Government House from Lord Monck's time until 1905. He valued highly the friendships thus formed, and he continued on terms of intimacy with the Duke of Argyll, the Marquis of Lansdowne, Earl Dufferin, and others.

In spite of his busy professional duties, he found time to write over sixty articles and addresses, mainly in the chief medical journals of England and this continent. One remarkable contribution appearing in the columns of the *British Medical Times and Gazette* in 1863 might have led to an epoch-making discovery, viz.: Serum-Therapy; but Sir James did not pursue his skin-disease experiment further, and it was left for German bacteriologists to scientifically establish the treatment. While at Queen's University, Kingston, he gave much tutorial instruction, and when passing through his medical course at McGill University later he delivered systematic lectures to students on the Nervous System, a subject which he dealt with, it is interesting to note, in the last series of lectures he ever delivered, viz., a course to hospital nurses in Ottawa two or three years ago.

Born in Inverness in 1831, he was always proud of his Scottish ancestry, and, arrayed in Highland dress, he was an impressive figure at St. Andrew's Day festivals. During his long career he held many prominent offices, and met a great number of the more notable men and women of this continent and the Empire. He was President of the Canadian Medical Association, and of the College of Physicians and Surgeons of Ontario, and at the great International Medical Congress was chosen Vice-President for Canada, a high distinction, while the British Medical Association elected him an honorary member. He valued greatly the position of President of the Canadian Tuberculosis Association, which he had been mainly instrumental in organizing, and he was President of the International Congress of

Hygiene in Canada, in 1909; but his highest honour was that of knighthood in the year of Queen Victoria's Jubilee, 1887. His visit to the Queen at Balmoral was perhaps his most treasured experience.

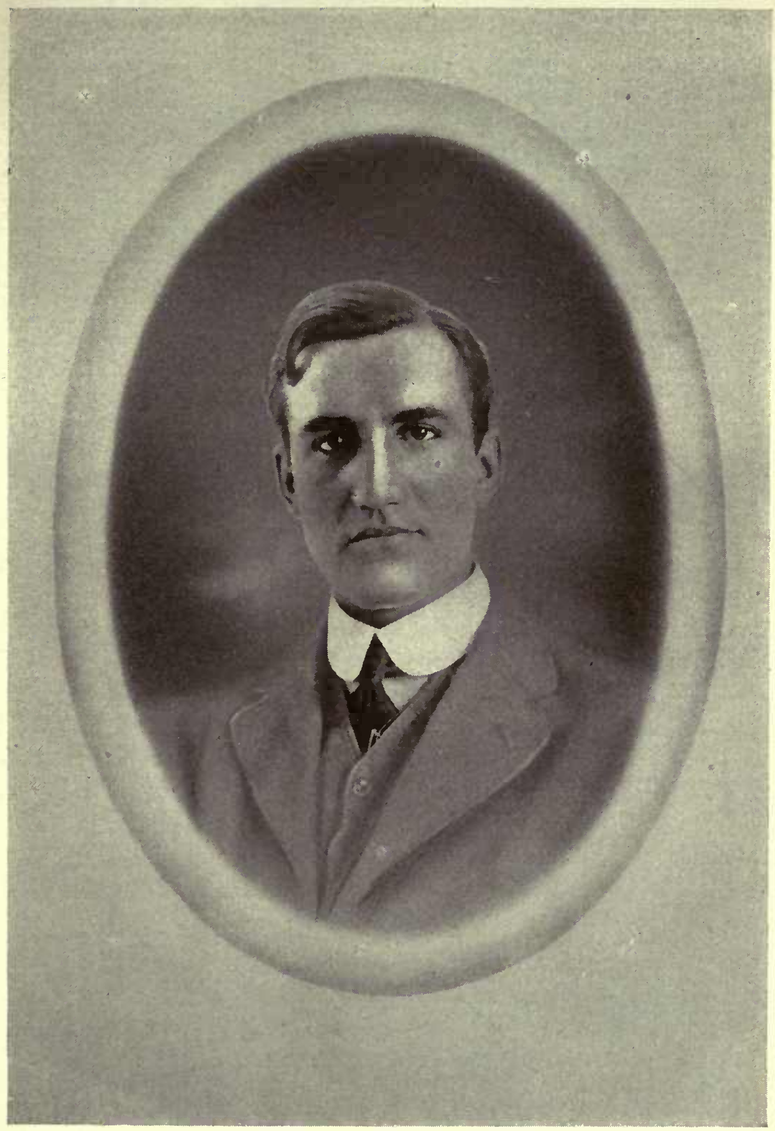
There never was a more patriotic Canadian, nor one having greater faith in the Dominion's future development; but he ceaselessly held up the high standard of statesmanship, and of lofty public policy of the Motherland. He often expressed grave fears of decline in Canadian public life were British ideals to lose their power and influence in the Dominion. In Parliament he was one of those who urged generous public support, by the Government, to scientific research and intellectual advance, and was ready on all occasions to advocate the cause of literature and culture amongst our people.

He regarded the Presidency of The Royal Society of Canada, to which he was elected in 1909, as one of the greatest honours received by him during his long life.

CHARLES GORDON HEWITT.

Dr. Charles Gordon Hewitt was born near Macclesfield, England, on February 23, 1885. He was the son of Thomas Henry Hewitt and his wife, Rachel Frost. He received his early education at the King Edward VI Grammar School, Macclesfield, afterwards entering Manchester University, from which institution he received the degrees: B.Sc. in 1902; M.Sc. in 1903; D.Sc. in 1909. In 1902 he was appointed by his alma mater Assistant Lecturer in Zoology, and in 1904–9 occupied the position of Lecturer on Economic Zoology. In 1909 he left England for Canada, having received the appointment of Dominion Entomologist. In 1916 his title was changed to that of Dominion Entomologist and Consulting Zoologist. It is unnecessary here to recapitulate his activities in this important office. He entered on his duties with enthusiasm and succeeded in a few years in establishing one of the most efficient branches of the public service. The most important legislation which has been enacted under his recommendation is the Destructive Insect and Pest Act, 1910.

His successful efforts in establishing a treaty between Canada and the United States for the protection of migratory birds was recognized by the presentation of a gold medal by the Royal Society for the Protection of Birds, March 12, 1918. Probably his strongest single effort in the suppression of a dangerous pest was the work he accomplished, in co-operation with the provinces of Nova Scotia and New Brunswick, in the suppression of the brown tail moth.



C. Gordon Hewitt

He was the author of important books and memoirs. His chief published work is the well-known book on the house-fly of which there were two editions. A smaller book on the same subject appeared later as one of the Cambridge Manuals of Science and Literature. His departmental publications consist of a series of annual reports (1910–1916), and bulletins. Chief among the latter are those dealing with the Honey Bee and the Large Larch Sawfly. Very recently he completed an important work on the conservation of the wild life of Canada, the manuscript for which is now ready for the press. The publication in 1919 of an important volume on the insects collected by the Canadian Arctic Expedition, 1913–1918, was brought about under his direction.

His recognition as one of the foremost entomologists of the world was freely conceded. In the year 1913 he was elected a Fellow of the Entomological Society of America; in 1915 he was elected President of the American Association of Economic Entomologists; in 1913 he accepted the Presidency of the Entomological Society of Ontario. He was a Fellow of the Entomological Society of London (England), a corresponding member of the Zoological Society of London (Eng.), and was an Honorary Fellow of the Royal Society for the Protection of Birds, London (Eng.).

His election as a Fellow of the Royal Society took place in 1913. In the following year he was elected honorary treasurer of the Society. From the moment that he entered our Society he devoted himself to its problems, and the Council had come to depend upon him for real work in its business as well as for advice.

His death was tragic in its suddenness. He had attended the meetings of the Commission of Conservation, at Montreal, on February 19 and 20, at which he presented an important paper on "Fur-bearing Animals, their Economic Significance and Future."

Soon after his return to Ottawa, on the 20th, he was taken seriously ill with influenza; this soon developed into pleural pneumonia, and he died about 11 p.m. on February 29, 1920.

He seemed to be on the threshold of a long career, in which added years would bring even greater success, and would fulfil all that he was destined to accomplish. His gifts were varied, and his sympathies deep and general. He touched life at so many points that one cannot think that his interest ever flagged. His knowledge and appreciation of the arts and *belles lettres* were finely balanced by a warm love of nature, and this led him into enthusiasms for our wild life. His ideal habitation was always surrounded by a garden, and every foot of soil was made to yield either use or beauty. There was in all his work a rare combination of earnestness, with lightness of touch. Highly characteristic, too, was a fine sense of humour, which kept all things in their proper relation. His personality was of that even bearing that finds the best in all men, and gives duly the best in itself. Even his causal acquaintances had sorrow when he died. To those who knew him well there will remain a deep regret; to those who received fully the intimate charm of his personality in familiar intercourse there cannot be any mitigation of his loss, for he was a peerless friend.

IV.—Increase in Parliamentary Grant.

We have very much pleasure in stating that the Government has restored the annual grant voted by Parliament for the purposes of the Society to $8,000.

On January 31, 1920, a deputation waited on the Hon. Sir Henry L. Drayton, K.C.M.G., and presented a memorial, a copy of which follows:—

January 20, 1920.

Hon. Sir Henry Drayton,
Minister of Finance,
Ottawa.

Sir,

We, the undersigned, have the honour of bringing to your notice a matter which is of vital importance to the future of The Royal Society of Canada; in fact the continuance of the most important activity of this Society, namely, the publication of its Proceedings and Transactions, is no longer possible owing to insufficiency of its monetary resources, and this is the matter to which, on behalf of the Society, we have to ask your most earnest consideration.

From the date of its foundation by act of Parliament (1882) to the year 1913, the Society received an annual grant of $5,000 to assist in the publication of its Proceedings and Transactions. In October, 1912, a deputation from the Society waited upon your predecessor in office and requested an increase in this grant. Our request was very generously met, in a spirit which acknowledged the value of the Society's labours, and the grant was increased to $8,000. It was continued at that rate until last year when it was cut down to $4,000. By reducing the contents of our volume we have succeeded in continuing our publication, but it must cease with the current issue unless it is found possible to restore the previous grant of $8,000.

The costs of printing and paper, and of the reproduction of the valuable illustrations to our scientific papers have steadily grown heavier. We further would call attention to the fact that the Society has twice increased its annual membership fee, and last year we increased it from $5 to $10, to cover the expenses of the annual meetings, none of which are charged to the Parliamentary appropriation; that is entirely reserved for the expenses of printing and for the administration of the library.

It would not have been possible to issue the Proceedings and Transactions for 1919 had the Advisory Council for Scientific Research not made a special grant of $3,000 to The Royal Society.

Canada has no other scientific periodical in which the results of Canadian scientific research can be announced to the public. This donation of the Advisory Council was made to enable The Royal Society to publish in its Transactions the more valuable researches in the fields of Biology, Physics, Chemistry and Geology, instead of having these papers scattered in American and English periodicals.

The Transactions of the Society are sent to all the important libraries of the world and there they represent the scientific and literary activities of our Country. Our experience shows that they are highly valued. The scientific papers are abstracted in the United States, England, France and Germany and all libraries are careful to keep their sets of our publications up-to-date and complete. We submit that it would be in the best interests of Canada to maintain and strengthen the Society, and we hope that the Government will not allow the record of the nation's intellectual effort to disappear from the places where it has been sought for and honoured.

Signed on behalf of the Society,

(Sgd.) R. F. Ruttan,
President.

V.—Report of the Honorary Librarian.

The Honorary Librarian begs to report that the routine of receiving and cataloguing the books and pamphlets received as exchanges has been carried on as usual. The receipts are noteworthy in the resumption, after a lapse of four years, of many valuable journals and reports. Many of those received are accumulations, owing to lack of transportation, but, in the case of many of the Belgian scientific publications, there was an entire suspension of publication during the war years.

The following list, prepared by the Librarian, indicates the additions to the library, other than the exchanges which have been received regularly. A note is added, that, of the publications that have been received, 52 were bound volumes, making a total of bound volumes in the library of 2,041.

No. of bound vols. received during the year, 1919–1920, 52; making the number of bound vols to date, 2,041.

Publications renewed after a lapse of four years or more, as follows:—

Svenska Acad., Stockholm. 56 publications.
Bologne Acad. 11 publications, 1913–18.
Lund Univ. 10 publications, 1913–18.
Linnean Soc., N.S.W. 40 publications, 1914–18.
Chemical Soc., London. 60 publications, 1914, to date.
Belgium, Roy. Botanical Soc., Part 1914 and 1919 (Brussels)
Belgium, Royal Geographical Soc. Part 1914 and 1919.
Annales de l'observatoire royale, Vol. 5, part V, 1914.
Belgium, Annales de l'observatoire royale. Vol. 5, part 4, 1914; Vol. 6, part 1, 1914; Vol. 6, part 2, 1918.
Belgium, Annales d'astronomie. Vol. 6, part 2, 1918.
Belgium, Annuaire de l'observatoire, 1915–16–17–18–19–20.
Belgium, Acad. royale, Bulletin, Beaux-Arts, 1914, Nos. 2, 3, 4. 1919, Nos. 4, 6.
Belgium, Acad. royale, Bulletin, Lettres, 1919, Nos. 4, 5, 6.
Belgium, Acad royale., Bulletin, Sciences, 1914, Nos. 2, 3, 4.
Belgium, Acad. royale, Bulletin, Sciences, 1919, Nos. 4, 5.
Toulouse, Acad., Memoires, 1914 to 1918.
Bordeaux, Soc. sc., Memoires, 1914–1917–18.
Rennes, Sc. et médicine, Procès-verbeaux, 1914–1918.
Kobenhavn. Publications, 1916.

Other Publications Received.

British Museum. Three publications, 1919.
British War Office. Book of official maps (war).
London—Statutes of Research Council and Allied Unions.
Copy of "Treaty of Peace," Dept. of External Affairs. (Library).

Author's Copies Received.

Tingle, J. B. 44 separates.
Hopkins, J. C. Can. Annual Review.
Gorini, Prof. C. 4 papers.

D. B. Dowling,
Hon. Librarian.

VI.—Report of the Honorary Treasurer.

The following financial statement covers the year ending April 30, 1920. It includes the Government grant account and the general account; it has been audited by Dr. J. C. Glashan and Dr. Adam Shortt, two members of the Society appointed for that purpose.

FINANCIAL STATEMENT OF THE ROYAL SOCIETY OF CANADA FOR THE YEAR ENDING APRIL 30, 1920.

GOVERNMENT GRANT ACCOUNT.

Receipts.

By	Balance in the Bank of Montreal, April 30, 1919	$ 347.63
"	Grant from Dominion Government	3.333.34
"	Grant from Hon. Advisory Council for Scientific and Industrial Research	3,000.00
"	Bank interest on account	91.84
		$6,772.81

Expenditures.

To	Printing and publication of *Transactions*	$4,582.83
"	Maintenance of library and librarian's salary	720.00
"	Clerical assistance	365.00
"	Insurance	45.00
"	Miscellaneous expenditures	20.00
"	Outstanding cheque, dated April 25, 1919 (61)	5.57
"	Balance in Bank of Montreal, April 30, 1920	1,094.41
		$6,832.81
Less outstanding cheque		60.00
		$6,772.81

GENERAL ACCOUNT.

Receipts.

By	Balance in The Merchants' Bank of Canada, May 1, 1919	$2,791.08
"	Annual subscription and initiation fees	1,320.62
"	Sale of *Transactions*	28.63
"	Interest on Investments	838.06
"	Bank interest on account	75.09
		$5,053.48

Expenditures.

To	Railway fares of members	$551.23
"	Expenses of Annual Meeting	119.65
"	Miscellaneous expenditures	71.78
"	Sir John Murray's Memorial Lecture	250.00
"	Balance in Merchants' Bank of Canada on April 30, 1920	4,060.48
		$5,053.48

Audited and found correct:

J. C. GLASHAN
ADAM SHORTT } *Auditors.*

Ottawa, May 11, 1920.

C. MARIUS BARBEAU,
Honorary Treasurer.

When the Honorary Secretary had finished reading the Report it was moved by Dr. J. H. Coyne, seconded by Canon Huard, that the Report of Council be received and that the question of adoption be voted on tomorrow.—Carried.

It was moved by Dr. Victor Morin, seconded by Dr. Ernest Myrand that the election of Chanoine D. Gosselin, M. M. E. L. Massicotte and M. Fernand Rinfret be confirmed.—Carried.

It was moved by Dr. George Bryce, seconded by Mr. W. D. Lighthall, that the election of Mr. Chester B. Martin and Dr. Herbert L. Stewart as Fellows of Section II be confirmed.—Carried.

It was moved by Mr. J. A. Dresser, seconded by Mr. E. R. Faribault, that the election of Mr. J. Austen Bancroft, Mr. Richard P. D. Graham, Mr. Edward M. Kindle and Mr. Cyril W. Knight as Fellows of Section IV be confirmed.—Carried.

It was moved by Dr. A. H. MacKay, seconded by Canon V. A. Huard, that the election of Mr. A. T. Cameron and Dr. J. G. Fitzgerald as Fellows of Section V be confirmed.—Carried.

The following new Fellows who were present were introduced: M. Fernand Rinfret, Chanoine Gosselin, Dr. H. L. Stewart, Mr. Edward M. Kindle, Mr. A. T. Cameron, Dr. John G. Fitzgerald, and Mr. R. A. A. Johnston, elected in 1919.

The President then gave a short address suggesting certain lines of activity to the Society and paying feeling tribute to Sir James Grant and Dr. C. Gordon Hewitt, who had passed away since the last meeting.

The Presidential Address—(*Wednesday Evening, May 19th*)

The Presidential Address was delivered on Wednesday evening in the concert hall of the Chateau Laurier. The chair was occupied by the Vice-President, Dr. A. P. Coleman. The President's subject was "International Co-operation in Science." The address will be found printed in full as Appendix "A."

SESSION II.—(*Thursday Afternoon, May 20th*)

The President took the chair at 3 p.m.

It was moved by Dr. Victor Morin, seconded by Prof. W. L. Grant, that the report of Council be adopted.—Carried.

The reports of the following associated societies were then presented:

The Historic Landmarks Association; The Ottawa Women's Canadian Historical Society; The Hamilton Scientific Association;

Huron Institute; Ontario Historical Society; The Elgin Historical and Scientific Institute; Lundy's Lane Historical Society; Niagara Historical Society; Institut Canadien-Francais; Société Historique de Montréal; Antiquarian and Numismatic Society of Montreal; Nova Scotian Institute of Science, Halifax; Nova Scotia Historical Society.

In pursuance of notice for amendment of the by-laws, it was moved by Dr. W. McInnes, seconded by Dr. A. P. Coleman, that line 13 of Section 6 of the By-Laws be amended to read: "Applicable to Sections I, II, III and IV;" that line 46 be amended to read: "Applicable to Section V."—Carried.

It was moved by Dr. J. P. McMurrich, seconded by Dr. A. G. Huntsman, that the Royal Society of Canada learns with satisfaction that an attempt is being made to secure the co-operation of Canada with Newfoundland and the United States of America in the scientific investigation of the hydrographic and biological conditions of the western waters of the north Atlantic, especially as these bear upon the development and conservation of the Fisheries. The Society would respectfully urge upon the Government of the Dominion that it further such an attempt in whatever ways lie in its power, in view of the vast importance of our marine fisheries, and the pressing need for more intensive and extensive investigation into the conditions that determine our supply of food fishes.—Carried.

It was moved by Dr. A. P. Knight, seconded by Dr. J. J. MacKenzie, that whereas during the coming summer a Pan-Pacific Scientific Congress is to be held at Honolulu, Hawaiian Islands, to plan for the co-operative investigation of the biological and hydrographic conditions of the Pacific, especially in their bearings on the fisheries. And whereas it is expected that the Congress will include representatives from Japan, Java, the United States, New Zealand, Australia and, it is hoped, Canada. Resolved that the Royal Society of Canada feels that the great interest which the Dominion as a whole has in the development and conservation of its West Coast Fisheries makes it advisable that it should have one or more scientific representatives at the Congress, and would request the Government to arrange for the appointment of such representatives and make provision for their travelling expenses.—Carried.

Dr. Adam Shortt reported that a committee of representatives from each of the sections met and considered the question of payment of travelling expenses to Fellows attending the annual meeting. It was moved by Dr. Shortt and seconded by Dr. Myrand that the Council of the Society should be requested to consider the possibility of paying the full return railway fare to Fellows of the Society residing west of Port Arthur and east of Quebec.—Carried.

It was moved by Dr. E. Deville, seconded by Dr. F. T. Shutt, that C. C. Smith, Dominion Observatory, R. K. Young, Astrophysical Observatory, and Dr. Louis King, McGill University, be nominated as representatives of the Royal Society of Canada on the National Committee for Canada of the International Astronomical Union.—Carried.

It was moved by Dr. E. Deville, seconded by Dr. F. T. Shutt, that Prof. L. B. Stewart, University of Toronto, the Seismologist of the Dominion Observatory, and C. A. French, Magnetician, Dominion Observatory, be nominated as representatives of the Royal Society of Canada on the National Committee for Canada of the International Union of Geodesy and Geophysics.

Mr. William McInnes, Secretary of Section IV, reported to the General Meeting that at a meeting of the section Dr. R. W. Brock, University of British Columbia, Vancouver, was appointed to represent the section on the National Committee for Canada of the International Union of Geodesy and Geophysics.

Dr. C. T. Currelly presented the following report of the committee regarding the Military Monument:

To the President of the Royal Society:

Your committee regarding the Military Monument met with the Committee of the Royal Academy, the Royal Institute of Architects, the Town Planning Institute.

The Committee was unanimous in recommending that a building which would contain the trophies captured by our victorious troops, and be at the same time of a monumental character, should be erected in Ottawa. They further recommend that the committee be changed into a commission, which should have the general supervision of the plans for this future building. The Committee interviewed the Acting Prime Minister and laid the matter before him. No answer has yet been received, but it seems probable that this arrangement will be made.

It would be advisable to appoint the same committee for another year.

It was moved by Dr. Currelly and seconded by Prof. W. L. Grant that the report be adopted.—Carried.

It was moved by Dr. J. C. Fields, seconded by Prof. F. E. Lloyd, that a standing committee on science and scientific conditions in Canada be appointed for the purpose of formulating, on matters pertinent to these subjects, resolutions and plans embodying the views of the Royal Society of Canada subject to the approval of the Society as expressed by it in general meeting assembled or through its Council, the members of such committee to consist of representatives selected by Sections III, IV and V.—Carried.

The members of the committee selected by the sections and appointed by the Society were:

Section III—J. C. Fields, J. C. McLennan.
Section IV—D. B. Dowling, T. L. Walker.
Section V—F. E. Lloyd, Andrew Hunter.

The Popular Lecture—(*Thursday evening, May 20*)

Some Great War Inventions

The annual popular lecture on the above subject was given in the ballroom of the Chateau Laurier at Ottawa before the Fellows and guests of the Royal Society of Canada by Professor A. S. Eve.

In 1902, Dr. R. B. Owens, Professor of Electrical Engineering at McGill University, took out a patent for guiding a ship by means of coils placed upon it. These coils received a current by induction due to an alternating current in an insulated cable placed beneath the sea or river. This experiment was successfully tested by Dr. Herdt in the River St. Lawrence. During the war this plan was revived partly due to information received as to German activity, and partly to the initiative of a young Canadian, Captain Manson, who had on the western front employed a similar method for locating breaks in land lines used for signalling. Owing to recent developments and improvements in electronic valves this method became of practical service in guiding ships of the Royal Navy along swept channels through minefields. The scheme was for a time kept secret, but has recently been released by the British Admiralty.

Various methods of locating submarines by hydrophones and hydrophone fish were described. Some account was given of experiments on the West Coast of Scotland to test the pressures exerted by exploding mines.

The remainder of the lecture was devoted to a description of developments occurring in Wireless Telegraphy and Telephony. A comparison was made between effects obtained by sound and those in Wireless Telegraphy. In particular, resonance, beats and damping were shown with tuning forks, and the analogy to Radio work was pointed out. Two one-quarter kilowatt generators, of frequency 240, were employed to illuminate tungsten filament lamps. As the phase was altered lamps were made to "wink" in a manner analogous to beating forks. An account was given of the Edison effect and of the evolution of the diodes and triodes of various nations. The Duddell singing arc was exhibited as an illustration of arc transmission.

The Radio Branch of the Department of the Naval Service, through the kindness of the Lieutenant Commander Edwards, the Director of that Branch, arranged to fit up a complete set of receiving apparatus in the ballroom and to suspend an aerial from an adjacent building. Signals were rendered audible to the whole of the audience by means of a loud speaking magnavox telephone. During the course of the lecture, complimentary messages to the Royal Society were received from the Kingston, Ont., Coast Station, and the Barrington, N.S., Naval Station, and signals were received from the following stations among others: Montreal, 2 K. W. Spark 600 meters; steamers off New York and on the Great Lakes, Spark 600 meters; New Brunswick, Alexanderson alternator, 13,600 meters; Annapolis, Md., Arc, 17,000 meters; Barrington Passage, Nova Scotia, Arc, 4,000 meters; Kingston, Ont., Spark, 600 meters.

By the kindness of the Marconi Wireless Telegraph Company of Canada, radio telephone transmitters were installed at the Naval test room, Ottawa, and at the Marconi works in Montreal.

Miss Lutton, of Montreal, sang into the transmitter at that point and her voice was well heard at Ottawa in the telephone receivers, and, with the assistance of the loud speaking telephone above mentioned, was rendered audible to the whole audience. It is believed that this is the first occasion upon which a large audience has, by means of the wireless telephone, received speech through space over a distance exceeding a hundred miles. The articulation was, to some extent, impaired by reason of the many amplifications necessary to operate the loud-speaking telephone. Trouble was also present due to atmospheric disturbances, which were severe at the time. Nevertheless, the experiment was sufficiently successful to demonstrate the potentialities of the radio telephone, the more so, as owing to the conditions under which the lecture was given, a rehearsal was impossible and the audience had the interesting experience of seeing the experiments carried out for the first time, during the lecture. The telephonic speech, gramaphone music, etc., received from the wireless telephone transmitter installed at the Naval test room at Ottawa was excellent as in this case, owing to the strength of signals it was possible to receive on a small loop and thus eliminate local interference and atmospherics.

A rotating coil was installed in the ballroom and connected with the receiving apparatus and the direction finding effect of a loop was demonstrated, and the application of this arrangement as an aid to navigation of ships at sea, and aircraft, was explained.

Time did not permit to make reference to the important work of other Canadians in various inventions during the Great War. The activities of Professor J. C. McLennan in connection with helium are well known, but much of his work in connection with other developments has not yet been published. Professor R. W. Boyle, of the University of Alberta, also did work of the highest order in connection with special detectors to which Sir Charles Parsons made reference in his Presidential Address before the British Association in 1919.

Special thanks are due to the Minister of the Department of Naval Service, to Lt. Commander Edwards and his staff of the Radio-Telegraph Department, to the Marconi Wireless Telegraph Company of Canada, and their representative, Mr. Runciman, to Miss Lutton and to the personnel of the Chateau Laurier. Their energetic cooperation made the lecture successful.

SESSION III.—(*Friday afternoon, May 21*).

REPORT OF THE SECTIONS

Section I

PROCÈS-VERBAL DE LA SECTION I

Membres présents ou inscrits: MM. Victor Morin, Ernest Myrand, Fernand Rinfret, Benjamin Sulte, Ægidius Fauteux, Edouard Montpetit, Marius Barbeau, M. le chanoine David Gosselin, MM. les abbés Élie-J. Auclair, Lionel Groulx, A. Couillard Després, MM. P.-B. Mignault, A.-D. DeCelles, P. Poirier, T. Chapais, Léon Gérin, Georges Pelletier et Antonio Perrault.

Se sont excusés de leur absence: MM. E.-Z. Massicotte, P.-G. Roy, E. Rouillard, H.-J.-J.-B. Chouinard, Cyrille Delâge, Mgr. L.-A. Paquet, M. l'abbé H.-A. Scott.

Travaux lus ou présentés:

1. Troupes du Canada, 1670-1687, par Benjamin Sulte.
2. Sur un journal inédit du siège de Québec en 1759, par Ægidius Fauteux.
3. Les censitaires du coteau Sainte-Geneviève (banlieue de Québec), de 1636 à 1800, par l'abbé Ivanhoe Caron.

4. Un éducateur d'il y a cent ans, par l'abbé Élie-J. Auclair.
5. Blason et géographie populaires de Québec, par Marius Barbeau.
6. Jean Jolliet et ses enfants, par Mgr. Amédée Gosselin.
7. L'ancienne noblesse au Canada, avant 1667, par Régis Roy.
8. Le Tyrol autrichien, par le S. E. le cardinal Bégin.
9. Le régionalisme littéraire, par Albert Lozeau.
10. Georges-Antoine Belcourt, missionnaire à la Rivière-Rouge (1874), par le Juge L.-A. Prud'homme.
11. La tragédie acadienne, par Placide Gaudet (hors programme).
12. Un gouverneur de Trois-Rivières: Louis de la Porte de Louvigny, par P.-Georges Roy (au programme, mais inachevé au temps des séances).

Les séances du deuxième jour se tinrent conjointement, l'une, avec la section II, et l'autre, avec la section II et la Société de folklore d'Amérique (section d'Ontario); à la première séance, M. Sulte présenta le travail de M. Régis Roy.

Les résolutions suivantes furent proposées et unanimement acceptées:

—D'accorder un délai d'un an à S. G. Mgr. Paul Bruchési et à M. Adjutor Rivard pour leur permettre de maintenir leur nom sur les listes de la Société en se conformant aux règlements (prop., M. l'abbé Auclair; sec., M. Montpetit).

—De prier le conseil général de la Société de suspendre l'opération de ses règlements, pour des raisons particulières qui seront expliquées, et de placer le nom de S. E. le cardinal Bégin sur la liste des membres en retraite (prop., M. Morin; sec., M. Myrand).

—De prier le conseil général de remettre sur la liste de la section I le nom de M. Albert Lozeau qui en avait été retranché en vertu des règlements; l'état précaire de sa santé et la présentation d'un travail aux séances présentes sont portées à l'appui du désir de la section (prop., M. Morin; sec., M. Perrault).

—De recommander au gouvernement de Québec la fondation d'archives provinciales, étant donné que la seule province française du Canada n'a pas encore suivi l'exemple de plusieurs provinces sœurs, qui ont leur bureau d'archives provinciales bien qu'elles ne soient pas aussi riches que Québec en documents historiques (prop., M. Myrand; sec., M. l'abbé Groulx).

—De proposer que deux vacances en tout soient établies pour l'élection des candidats au cours du prochain exercice.

Au cours des séances, on discuta sans arriver à une conclusion unanime le projet d'incorporer les sciences de langue française aux sujets embrassés par la section I; on discuta aussi la possibilité d'organiser des réceptions locales pour les membres de la section et de "couronner" certaines œuvres canadiennes; et on conseilla au comité de nominations de motiver leur communication personnelle en faveur de certains candidats.

Élection des dignitaires pour l'année qui commence:

Président, M. Ernest Myrand;

Vice-président, M. le juge L.-A. Prud'homme;

Secrétaire, M. Marius Barbeau;

Comité de nominations: MM. Léon Gérin, P.-Georges Roy, Ægidius Fauteux (secrétaire).

Comité de lecture: MM. A. Rivard, M. Barbeau et F. Rinfret.

Comité de publications: MM. B. Sulte et Léon Gérin.

C.-MARIUS BARBEAU,
Secrétaire de la Section I.

On the motion of Dr. Victor Morin, seconded by Mr. C. M. Barbeau, the report of Section I was adopted.

REPORT OF SECTION II

The section met on Wednesday 19th May, 1920, the President being in the chair.

Five meetings in all were held, on the 19th, 20th and 21st May, the following members being in attendance; Messrs. Bryce, Coyne, Cruikshank, Currelly, Edgar, Grant, Howay, McLachlan, Lighthall, Longley, MacMechan, Riddell, Scott, Shortt, Stewart.

In the absence on public official duty of Mr. Burpee, J. H. Coyne and Dr. MacMechan acted as secretaries pro tempore.

Brig. Gen. Cruikshank and Professor Edgar were appointed representatives of the section on the nominating committee of the Society.

It was decided to suspend action under regulation 8 in the case of Professor Hill-Tout and to retain his name in the list of members.

Dr. Shortt was requested to meet representatives of other sections to consider the question of increasing the allowance for expenses of members of the Society.

Messrs. Shortt, Coyne and Currelly were nominated as a committee to consider and report on the question of a national museum building.

An advisory committee on nominations of candidates for election to the section was appointed, consisting of: Dr. Shortt, chairman, Prof. Edgar, secretary, Dr. Coyne, W. D. Lighthall, Dr. MacMechan, Dr. Bryce, Judge Howay.

It was decided to elect three Fellows for the ensuing year.

A printing committee composed of Messrs. Shortt, Cruikshank and Burpee was appointed for the section.

The papers announced in the printed programme were read in extenso or by title. (List appended).

A resolution of sympathy with Professor Ganong, Corresponding member for the section, in his bereavement through the loss of his wife was passed, and the Secretary requested to forward a copy to him.

The following officers were elected: President, Brig. Gen. Cruikshank, Vice-President, Hon. Mr. Justice Riddell, Secretary, L. J. Burpee.

On the motion of Dr. Archibald MacMechan, seconded by Brig. Gen. Cruikshank, the report of Section II was adopted.

SECTION II.—ENGLISH LITERATURE, HISTORY, ETC.

1.—Presidential Address. By W. Lawson Grant, M.A.

2.—The Attitude of Governor Seymour towards Confederation. By Judge Frederick William Howay, LL.D., F.R.S.C.

3.—Old Victoria with the Hudson's Bay Company. By Rev. George Bryce, M.A., LL.D., F.R.S.C.

4.—Extra Territorial Criminal Jurisdiction in British Canada. By Hon. William Renwick Riddell, LL.D., F.R.S.C.

5.—When International Arbitration Failed. By Hon. William Renwick Riddell, LL.D., F.R.S.C.

6.—The Slave in Canada. By Hon. William Riddell, LL.D., F.R.S.C.

7.—Humours of the Time of Robert Gourlay. By Hon. William Riddell, LL.D., F.R.S.C.

8.—The Declining Fame of Thomas Carlyle. By H. L. Stewart, M.A., Ph.D.

9.—A Plea for Coriolanus. By Walter S. Herrington, K.C., F.R.S.C.

10.—English Poetry in the Twentieth Century. By Pelham Edgar, Ph.D., F.R.S.C.

11.—Afoot in Ultima Thule. By Archibald MacMechan, B.A., Ph.D., F.R.S.C.

12.—An Unpublished Document relating to Fleury Mesplet. By R. Wallace McLachlan, F.R.S.C.

13.—The Life of a Nootka Indian. By E. Sapir, Ph.D. Presented by D. C. Scott, F.R.S.C.

14.—The "Blond" Eskimos. By Diamond Jenness, M.A., F.R.A.I. Presented by J. H. Coyne, F.R.S.C.

15.—The Legend of Saint Brendan. By James F. Kenny. Presented by A. G. Doughty, F.R.S.C.

16.—A Visit to the Fisher-folk of Gaspé. By C.-M. Barbeau, F.R.S.C.

REPORT OF SECTION III

The meeting of 1920 must rank with the most successful in the history of the Section; the attendance was above the average and the papers presented were of marked scientific interest and value.

The Section was again honoured by the presence of Professor Dayton C. Miller, D.Sc., of the Case School of Applied Science, Cleveland, Ohio, who in an illustrated address described his further studies and their results in connection with sound waves from large guns and projectiles, with special reference to velocity of explosive sounds in free air.

Five sessions were held at which thirty-nine papers were read in full or in abstract. The programme included many papers of importance and may be considered as representative of research and investigation by Canadian workers during the past year in the sciences of mathematics, physics and chemistry. The discussions following the papers were taken part in by a large number of the Fellows present and added much to the interest and value of the matter presented by the several authors.

The following Fellows were in attendance: Dr. A. S. Eve, President; Dr. J. C. Fields, Vice-President; Dr. Frank T. Shutt, Secretary; Messrs. Allan, F. B.; Allen, Frank; Archibald, E. H.; Bronson, Howard L.; Clark, A. L.; Dawson, W. Bell; DeLury, Alfred T.; Deville, E.; Ellis, W. H.; Glashan, J. C.; Goodwin, W. L.; Harkness, James; King, Louis Vessot; Klotz, Otto; MacKenzie, A. Stanley; McIntosh, Douglas; McLennan, J. C.; McClung, R. K.; Patterson, John; Plaskett, J. S.; Ruttan, R. F.; Satterly, John; Stupart, Sir F.; Sullivan, C. T.

The following resolutions were carried by the Section:

That the following Fellows constitute the Editorial Committee for the ensuing year: Dr. J. C. Fields, Dr. Louis V. King, Dr. Otto Klotz and Dr. Francis B. Allan. All papers presented to the Section for publication will be submitted to this Committee.

That a Committee on Membership be appointed to prepare a list of the available scientific men in Canada which Section III could draw upon in filling vacancies. This Committee would investigate the qualifications of possible candidates for membership in the Section throughout the Dominion and report the results of their findings, with suggestions, to the Secretary of the Section before December 1st, a copy of this report to be forwarded to each member of the Section by the Secretary of the Section as soon as may be possible after its receipt.

The following Fellows were subsequently appointed to constitute this Committee on Membership for the ensuing year: Dr. J. C. Fields, Dr. R. F. Ruttan, Dr. Otto Klotz and Mr. John Patterson.

That Dr. Fields and Dr. Shutt be appointed to act on behalf of the Section on the Joint Printing Committee of Sections III, IV and V.

That the Council of the Society be urged to favourably consider the granting of fifty reprints, with covers, free of charge, to authors of papers.

That the Representatives to be recommended for election by the Royal Society, as members of the National Committee for Canada of the International Research Council, be the following:

International Astronomical Union: C. C. Smith, Dominion Observatory; R. K. Young, Dominion Astrophysical Observatory; Louis V. King, McGill University.

International Union of Geodesy and Geophysics: Professor L. B. Stewart, University of Toronto; The Seismologist, Dominion Observatory; C. A. French, Magnetician, Dominion Observatory.

That in the opinion of this Section it is highly desirable that a Standing Committee of the Royal Society of Canada, composed of members of Sections III, IV and V, be appointed to consider and from time to time to report on scientific conditions and matters of scientific interest and importance to Canada. This Committee would be a body that might express the mind of the Royal Society in matters pertaining to scientific progress in Canada and also serve to strengthen the Honorary Advisory Council for Scientific and Industrial Research in all its efforts towards the promotion of pure scientific research of a fundamental character, apart from the application of such research to the industries.

The following members of Section III were subsequently appointed to act on this Committee: Dr. J. C. Fields and Dr. J. C. McLennan.

That all vacancies in the Section occurring throughout the year be filled in the usual manner at the Annual elections.

The election of officers for the ensuing year resulted as follows: President, Dr. J. C. Fields; Vice-President, Dr. Douglas McIntosh; Secretary, Dr. Frank T. Shutt.

The following papers were read in full or by abstract at the sessions of the Sections:

List of Papers Read in Section III

1.—Presidential Address. Dr. A. S. Eve, F.R.S.C. Relativity.

2.—On the Calculation of Thermal Molecular Pressure in Gases. By Louis V. King, D.Sc., F.R.S.C.

3.—On an Elementary Proof of Rayleigh's Law of Molecular Scattering of Light. By Louis V. King, D.Sc., F.R.S.C.

4.—Note on the Distribution of Velocities in the Neighbourhood of a two-dimentional Air Jet flowing into a Stagnant Atmosphere. By Louis V. King, D.Sc., F.R.S.C.

5.—The Adiabatic Condensation of the Ether Vapor. By Professor A. L. Clark, Ph.D., F.R.S.C.

6.—The Capacity and Resistance of the Capillary Electrometer. By Professor A. L. Clark, Ph.D., F.R.S.C.

7.—The Scattering of Light by dust-free Liquids. By Frank B. Kenrick, Ph.D., F.R.S.C., and W. H. Martin.

8.—The Velocity of Sound in Air. By J. A. Gray, O.B.E., D.Sc. Presented by Dr. A. S. Eve, F.R.S.C.

9.—The Application of Measurements of the Velocity of Sound to Meteorology. By J. A. Gray, O.B.E., D.Sc. Presented by Dr. A. S Eve, F.R.S.C.

10.—The Scattering of Roentgen and Gamma Rays. By J. A. Gray, O.B.E., D.Sc. Presented by Dr. A. S. Eve, F.R.S.C.

11.—The Absorption of Gamma Rays by Substances of High Atomic Weight. By J. A. Gray, O.B.E., D.Sc. Presented by Dr. A. S. Eve, F.R.S.C.

12.—The Range of Beta Rays scattered by Lead. By J. A. Gray, O.B.E., D.Sc., and A. V. Douglas. Presented by Dr. A. S. Eve, F.R.S.C.

13—A Review of Some Physical Problems which arise in Studying the Influence of Atmospheric Conditions upon Health. By A. Norman Shaw, D.Sc. Presented by Dr. A. S. Eve, F.R.S.C.

14.—Anemometric Tests with the Kata-thermometer. By L. H. Nichol, B.A. Presented by Dr. A. S. Eve, F.R.S.C.

15.—The Graphical Analysis of Estuary Tidal Records. By Miss Violet Henry, M.Sc. Presented by Dr. A. S. Eve, F.R.S.C.

16.—An Electrical Thermo-regulator. By Robert Clark, Esq. Presented by Dr. A. S. Eve, F.R.S.C.

17.—A Peculiar Radio-active Mineral. By Robert Clark, Esq. Presented by Dr. A. S. Eve, F.R.S.C.

18.—The Coefficient of Viscosity of a Gas—An elementary laboratory experiment. By John Satterly, F.R.S.C.

19.—Impact, Harmonic Motion and the Elasticity Moduli—a Laboratory Experiment. By John Satterly, F.R.S.C.

20.—The Hatchet Planimeter. By John Satterly, F.R.S.C.

21.—The Practical Study of a Catenary. By John Satterly, F.R.S.C.

22.—On Certain Expansions in Terms of Cylindrical Functions. By Professor James Harkness, F.R.S.C.

23.—An Application of a Theorem by Lie on the Torsion of a Curve belonging to a linear complex. By C. T. Sullivan, Ph.D., D.Sc., F.R.S.C.

24.—The Smelting of Titaniferous Iron Ores. By W. M. Goodwin. Presented by Dr. R. F. Ruttan, F.R.S.C.

25.—The Reaction of certain derivatives of Phthalic Anhydride with Benzene in the presence of Aluminium Chloride. By F. B. Allan, Ph.D., F.R.S.C., and W. A. Lawrence.

26.—The Preparation of the Three Benzoylbenzoic Acids. By F. B. Allan, Ph.D., F.R.S.C., and M. E. Smith.

27.—Analysis of Earthquake Waves. By Dr. Otto Klotz, F.R.S.C.

28.—The Orbit and Dimensions of U Coronæ. By J. S. Plaskett, F.R.S.C.

29.—The Intensity of the Hydrogen Lines and the Continuous Spectrum in X Cassiopeiæ. By H. H. Plaskett, B.A. Presented by J. S. Plaskett, F.R.S.C.

30.—The Alkali-content of Soils as related to Crop Growth. By Frank T. Shutt, D.Sc., F.R.S.C., and A. H. Burwash, B.A. (by title).

31.—The Electrical Conductivity of Aqueous Solutions of Potassium Chloroplatinate as affected by Hydrolysis. By E. H. Archibald, D.Sc., F.R.S.C.

32.—A Photographic Study of the Sound Waves from Large Guns and Projectiles with Special Reference to Velocity of Explosive Sounds in Free Air. By Dayton C. Miller, Ph.D. Presented by Dr. A. S. Eve, F.R.S.C.

33.—The Measurement of Small Capacities. By E. S. Bieler. Presented by Dr. A. S. Eve, F.R.S.C.

34.—On the Permeability of Thin Fabrics and Films to Hydrogen and Helium. By Professor J. C. McLennan, F.R.S.C., and W. W. Shaver, B.A.

35.—On the Electrical Conductivity of Copper Fused with Mica. By Miss M. I. Mackey and Miss Ida Giles, with Introduction by Professor J. C. McLennan, F.R.S.

36.—Vacuum Spark Spectra of Various Elements in Helium in the Extreme Ultra-Violet. By Professor J. C. McLennan, F.R.S., and A. C. Lewis, M.A.

37.—On the Absorption and Series Spectra of Lead. By Professor J. C. McLennan, F.R.S., and R. V. Zumstein, M.A.

38.—On the Mobilities of Ions in Helium at High Pressure. By Professor J. C. McLennan, F.R.S., and E. Evans, M.A.

39.—Arc Spectra in Vacuo and Spark Spectra in Helium and of Various Elements. By Professor J. C. McLennan, F.R.S., J. F. T. Young, M.A., and H. J. C. Ireton, M.A.

FRANK T. SHUTT,
Secretary.

On the motion of Dr. Shutt, seconded by Professor A. T. DeLury, the report of Section III was adopted.

REPORT OF SECTION IV

Section IV begs to submit the following report: Four sessions of the Section were held at which 15 members were present, namely:

J. A. Dresser, President; W. McInnes, Secretary; L. W. Bailey, R. W. Brock, A. P. Coleman, W. H. Collins, D. B. Dowling, E. R. Faribault, R. A. A. Johnston, E. M. Kindle, W. G. Miller, R. G. McConnell, W. A. Parks, T. L. Walker, James White. In addition many visitors were present at each Session.

Edward M. Kindle, A.B., M.S., Ph.D., C. W. Knight, B.Sc., J. Austin Bancroft, M.A., Ph.D., Richard P. D. Graham, B.A., M.Sc., were elected members of the Section during the year.

The following officers were elected for next year: President, William McInnes; Vice-President, W. A. Parks; Secretary, R. A. A. Johnston.

The Committee on Printing of last year, E. R. Faribault, James White, William McInnes, were re-elected.

There are two vacancies on the membership of the Section and it was resolved by the Section that two members be elected to fill the vacancies, and that the General Meeting be asked to authorize an increase of two in the membership of the Section.

The following papers were presented at the Session of the Section:

1.—A Devonian Glacier. By G. F. Matthew, D.Sc., F.R.S.C.

2.—Granite Segregations in the Serpentine Rocks of Quebec. By J. A. Dresser, M.A., F.R.S.C.

3.—The Relationships of the Palæozoic to the Pre-Cambrian along the Southern Border of the Laurentian Highlands in South-eastern Ontario and the Adjacent Portions of Quebec. By M. E. Wilson, B.A., Ph.D.

4.—The Killarnean Diastrophism in the Lake Superior Region. By W. H. Collins, B.A., Ph.D., F.R.S.C.

5.—The Norite Rocks of the Lake Athabaska Region. By Frederick J. Alcock, B.A., Ph.D.

6.—A Local Occurrence of Differentiation in Granite on the Churchill River, Northern Manitoba. By Frederick J. Alcock, B.A., Ph.D. Presented by D. B. Dowling, B.Sc., F.R.S.C.

7.—Eastern Shore Deposits of the Cretaceous Sea. By D. B. Dowling, B.Sc., F.R.S.C.

8.—The Origin of the Rocky Mountain Trench, British Columbia. By S. J. Schofield, M.A., B.Sc., Ph.D., F.G.S.A., Geological Survey, Canada. Presented by William McInnes, B.A., F.R.S.C., F.G.S.A.

9.—The Origin and History of the Great Canon of Fraser River. By Charles Camsell, B.Sc., F.R.S.C., F.G.S.A.

R. W. Brock addressed the Section on his experiences in Palestine during the war and outlined in a most interesting way the physiography and geology of the region.

William McInnes,
Secretary Section IV.

On the motion of Dr. William McInnes, seconded by Dr. W. A. Parks, the report of Section IV was adopted.

REPORT OF SECTION V

Section V held four regular sessions.

The following Fellows were present: Professors Macallum, McMurrich, Knight, McLeod, Hunter, Prince, Harris, Faull, Thomson, Cameron, Mackenzie, Walker, Buller, Principal Harrison, Dr. McKay, Dr. Huntsman, Canon Huard.

Professor McMurrich and Professor Knight were nominated to represent the Section upon the general nominating committee of the Society, Professor McMurrich for one year, and Professor Knight for two years.

Professor Macallum, Professor Prince and Dr. Huntsman were appointed the sectional printing committee, Professor Prince and Dr. Huntsman to act upon the general printing committee.

Professor Macallum and Professor MacKenzie were nominated to act with the council in the selection of new Fellows. Two new Fellows were elected to the Section—Professor Cameron and Professor Fitzgerald.

The following resolutions were passed by the Section and transmitted to the general session.

I.—In regard to the North Sea fisheries.

II.—In regard to the Pacific fisheries.

III.—In regard to a National Natural History Museum.

IV.—In regard to greater promptness in the publication of scientific results.

V.—A resolution approving the appointment of a standing committee of the scientific sections to act in an advisory capacity in matters of scientific research. Messrs. Lloyd and Hunter to be representative of Section V.

VI.—A resolution in regard to investigation and research into the value of elevator screenings.

The Section desires to express its sorrow at the loss of two of its most prominent members in the following resolutions:

Moved by Prof. Prince, seconded by Prof. MacKenzie, that this Section desires to give expression to its sense of profound regret in the loss of Sir James Grant, one of its oldest and most widely known members. At the earliest meeting of the Royal Society, Sir James Grant presented papers upon Geology, and from time to time during the long period of forty years he took an active part in the work of Section IV, and was prominent in the general work of the Society, becoming in 1909 President of the Royal Society. As a public man, a member of the Federal Parliament for many years, as a venerable medical practitioner, and as an original Fellow of the Society, his loss is one calling for special record.

Moved by Prof. Lloyd, seconded by Prof. Walker. The members of Section V of the Royal Society of Canada desire to express and to record their sorrow of the loss of one of its most active and influential members by the death of Dr. C. Gordon Hewitt.

Dr. Hewitt was a public-spirited and devoted scientist, true to the best ideals of useful citizenship. His work in the interests of Canada in the field of Entomology and Ornithology have earned him, who has died at a too early age, a lasting place in the memory of his colleagues in The Royal Society of Canada.

The officers for the ensuing year are as follows: President, Professor A. P. Knight; Vice-President, Professor Lloyd; Secretary, Professor Thomson.

It is recommended to council that three (3) new Fellows be elected to the Section next year.

Twenty-three papers were read at the sectional meeting as follows:

1.—Presidential Address. Plant Pathology: its Status and its Outlook. By J. H. Faull, B.A., Ph.D., F.R.S.C.

2.—(1) Anoxæmia and Periodic Breathing in Decerebrate Cats. By J. J. R. Macleod, M.B., Ch.B., F.R.S.C.

3.—(II) The percentage of Lactic Acid in the Arterial Blood of conditions of Asphyxia, Anoxæmia and Shock. By J. J. R. Macleod, M.B., Ch.B., F.R.S.C.

4.—Association, Commensalism and Parasitism among Marine Animals found in the Strait of Georgia. By C. McLean Fraser, M.A., Ph.D., F.R.S.C.

5.—The Mutual Precipitation of Certain Plant Mucilages and Dyes. By Francis E. Lloyd, M.A., F.R.S.C.

6.—(I) On the Occurrence of Resin Canals in Certain Conservative Regions of Some Conifers. By R. B. Thomson, B.A., F.R.S.C. (Lantern).

7.—(II) A Suggested Revision of the Classification of the Conifers. By R. B. Thomson, B.A., F.R.S.C. (Lantern).

8.—(III) Vestigial Centripetal Xylem and Transfusion Tissue in the Leaf of *Pinus Strobus*. By Miss Lilian V. Baker, M.A. Presented by R. B. Thomson, B.A., F.R.S.C. (Lantern).

9.—(IV) Elevator Screenings—Their Source and Composition and Certain Problems Connected with their Disposal and Use. By John R. Dymond, B.A. Presented by R. B. Thomson, B.A.

10.—(V) The Origin of the Ligneous Resin Canals in Pines. By N. C. Hart, M.A. Presented by R. B. Thomson, B.A.

11.—(VI) Tangential Pitting in Certain Fossil Vascular Plants and Lower Seed Plants. By Miss Dixie Pelluet, B.Sc. Presented by R. B. Thomson, B.A.

12.—(VII) Some Characters of the Xylem Tissue in the Cycads. By H. B. Sifton, M.A. Presented by R. B. Thomson, B.A.

13.—(VIII) The Pit-Closing Membrane in Certain Vascular Plants. By Miss Gertrude Wright, M.A. Presented by R. B. Thomson, B.A. (Lantern).

14.—Histoire d'Une Escouade de "Petits Soldors"—Fantaisie entomologique. By Canon V. A. Huard, D.Sc., F.R.S.C.

15.—(I) The Uredinial Stage of the Balsam Rust *Uredinopsis mirabilis*. By H. P. Bell. Presented by J. H. Faull, B.A., Ph.D., F.R.S.C.

16.—(II) The Development of *Collybia velutipes*. By E. H. Moss. Presented by J. H. Faull, B.A., Ph.D., F.R.S.C.

17.—An investigation of the Movement of the Water in the Bay of Fundy and its Effect on the Fauna. By Professor J. W. Mavor. Presented by Dr. A. G. Huntsman, F.R.S.C.

18.—Abscission of fruits in Juglans californica quercina. By F. E. Lloyd, M.A., F.R.S.C.

19.—Some Further Observations on the Heliotropic Reactions of Pilobolus and the Discharge of the Sporangia. Illustrated with lantern slides. By Professor A. H. Reginald Buller, F.R.S.C.

20.—Some Observations on the Red Squirrel and its Fungus Food. By A. H. Reginald Buller.

21.—Nouvelle méthode d'homogénéisation pour la recherche du B. Tuberculeux dans les crachats. Par M. A. Vallée, M.D. Présenté par A. B. Macallum, Ph.D., LL.D., F.R.S.C.

22.—L'étoile de mer et son utilité comme engrais. Par M. l'abbé Alexandre Vachon. Présenté par A. B. Macallum, Ph.D., LL.D., F.R.S.C.

23.—A Systematic Analytical Study of the North American Convallariaceal, except Polygonatum-Trillium, and Medeola, Considered With Regard to Their Origin Through Discontinuous Variation. By R. Ruggles Gates.

J. J. MacKenzie,
Secretary.

On the motion of Dr. J. J. MacKenzie, seconded by Dr. J. P. McMurrich, the report of Section V was adopted.

It was moved by Dr. A. P. Coleman, seconded by Prof. F. Allen, that the Royal Society of Canada express to the Government their great regret at the loss of so many of the more promising younger members of the scientific departments of the Government owing to the inadequate salaries paid them under present conditions. For the development of our natural resources we need the work of these highly trained men, most of whom have spent many years of training in preparation for their work, and we strongly recommend that salaries be so adjusted as to retain them in the service of the country.—Carried.

It was moved by Dr. O. Klotz, seconded by Dr. J. C. Fields, that the Royal Society desires to place on record, as an historical event, that on the occasion of the popular lecture delivered last evening at the Chateau Laurier by Dr. A. S. Eve, F.R.S.C., on "Some Great War Inventions" before the members of the Royal Society and others, for the first time the human voice was heard over a distance of one hundred miles clearly and distinctly by a large audience through the medium of wireless telephony.—Carried.

It was moved by Dr. A. G. Huntsman, seconded by Dr. J. P. McMurrich, that the Royal Society deprecates the proposal to decrease the all too limited accommodation hitherto available for the Natural History collections brought together by the various divisions of the Geological Survey. It respectfully urges upon the Government of Canada that in view of the great importance to our country of its natural resources full and ample accommodation be provided for the storage and display of the natural history material, collected and to be collected, illustrative of those resources. It also urges upon the Government that in view of the great importance of this work there should be formed from the nucleus existing in many of the divisions of the Geological Survey a definite museum organization or staff with well-balanced departments which may be adequate for the collection, study and preparation for display of the necessary collections in the various fields of natural history, such as mineralogy, palæontology, botany, zoology, ethnology, etc., in order that there may develop in the Capital of Canada a representative National Museum to fill for us the need met in Great Britain by the British Museum in London and in the United States by the United States National Museum in Washington. The Society would further urge that in the formation of museum departments the great importance of our fishery and other aquatic resources should be recognized by the creation of a department of marine biology, a field not hitherto covered in the divisions of the Geological Survey. Therefore, be it resolved that a committee be formed to wait as a deputation upon the Government and press for a consideration of this matter, the committee to be appointed by the president elect who should be its chairman.—Carried.

It was moved by Prof. McMurrich, seconded by Prof. Walker, that Section V requests serious consideration by the Society, more especially by the Printing Committee, of the necessity for prompt publication of papers. The section also requests that the custom of granting 50 reprints to the authors of published papers be resumed and that the Printing Committee be authorized to arrange, if possible, for the prompt issuance of the reprints when this may be requested by the authors.—Carried.

It was moved by Prof. Thompson, seconded by Prof. F. E. Lloyd, that whereas present methods of disposal and use of the screenings cleaned from western grain at terminal elevators results in immense losses not only to the grain grower but also to livestock men and to general agriculture; and whereas the proper handling and utilization of these screenings is dependent on information as to the nutritive, pharmacological and chemical properties of the seeds involved, therefore, be it resolved that the necessity for such researches be brought to the attention of the Advisory Committee on Research of this Society for their consideration and action.—Carried.

It was moved by Dr. Pelham Edgar, seconded by Mr. A. B. DeLury, that the cordial thanks of the Society be presented to the Deputy Minister of Mines and the Director of the Geological Survey for their kindness in placing the rooms of the Victoria Memorial Museum at the disposal of the Society for this annual meeting.—Carried.

It was moved by Brig. Gen. Cruikshank, seconded by Dr. A. McMechan, that in the opinion of this Society some fitting national memorial should be established in honour of Archibald Lampman as a pioneer poet of Canada, and especially as a poet of Ottawa, and that steps be taken to bring this matter to the notice of the Dominion Government, and that in the opinion of this Society the most appropriate place for such a memorial would be Nepean Point.—Carried.

It was moved by Dr. Fields, seconded by Prof. Lloyd, that in the opinion of your committee on science and scientific conditions in Canada productive research in our universities and the training of research men are of the very first order of importance for the development of the country. We, therefore, recommend that:

(*a*) The appointment of heads of scientific departments in our universities should be made primarily on the ground of research qualifications.

(*b*) That those members of the teaching staff who are qualified to do research work should be encouraged to follow their inclination and adequate aids thereto should be furnished whether in the form of additional keep or added equipment and supplies.—Carried.

The report of the Nominating Committee was then presented by Prof. Edgar and the following nominations were made: President, Dr. A. P. Coleman; Vice-President, Mr. Duncan C. Scott; Honorary Secretary, Mr. Duncan C. Scott; Honorary Treasurer, Mr. C. M. Barbeau; Honorary Librarian, Mr. D. B. Dowling.

It was moved by Prof. Edgar, seconded by Dr. J. J. MacKenzie, that the report of the Nominating Committee be received and adopted. —Carried.

The newly elected president, Dr. Coleman, then took the chair.

It was moved by Dr. Otto Klotz, seconded by Dr. R. K. McClung, that the following Fellows constitute the General Printing Committee of the Society for the year: Dr. Sulte, Mr. Scott, Dr. Shutt, Mr. Dowling, Dr. Prince, Mr. Gérin, Mr. Burpee, Dr. Fields, Dr. McInnes, Dr. McMurrich.—Carried,

It was moved by Dr. Victor Morin, seconded by Dr. F. B. Allan, that the following Fellows be appointed Auditors for the year 1920–21: Dr. Adam Shortt and Dr. J. C. Glashan.—Carried.

It was moved by Dr. R. K. McClung, seconded by Dr. J. H. Coyne, that the thanks of this meeting be presented to the officers of the Society, the Members of Council and the Auditors, for their very efficient services during the past year.—Carried.

It was moved by Dr. R. F. Ruttan, seconded by Dr. George Bryce, that a special vote of thanks be extended to Sir Henry Drayton, K.C.M.G., Minister of Finance, for the increased grant to the Society for the fiscal year 1920–21.—Carried.

The meeting was then declared adjourned by the President, Dr. A. P. Coleman.

APPENDIX A

PRESIDENTIAL ADDRESS

INTERNATIONAL CO-OPERATION IN SCIENCE

BY

R. F. RUTTAN, B.A., M.D., D.Sc., F.R.S.C.

International Co-operation in Science

A call for efficiency followed the declaration of war. A desire for co-operation has followed the declaration of peace.

Just as the doctrine of relentness efficiency played its important role during the mobilization for war, so to-day the gospel of voluntary co-operation has penetrated and influenced the political, industrial and scientific activities of all the allied nations. It has strengthened the bonds of esteem and friendship that existed during the war, and has cultivated a closer, moral and intellectual union among the allied peoples.

The general recognition of the value of co-operation may be truthfully described as the best positive product of the great war. It has given birth to what may be called the international mind, the moving spring of which is the idea of a world-wide community of the human race and the desire for its realization. Internationalism is everywhere active. There is a growing tendency towards the consolidation of various human interests, a drawing together of humanity which tends towards mutual understanding and mutual happiness among the nations.

The highest ideal of the internationalist is the League of Nations, for it is an effort at world-wide political and national co-operation, "a unification of the whole human race into a single family, organized group or community." Among the less ambitious of the international movements is the International Research Council, which embodies the concept of international co-operation in science.

My task this evening is to present to you some idea of what this International Research Council is and what it may become, and to discuss the influence of international and national co-operation upon the development of scientific research. I must ask your indulgence if it appears too obvious that I am viewing the subject through the eyes of a chemist, and if my illustrations are drawn chiefly from science in the British Empire.

A very few years ago the scientific workers in the British Empire were generally content to work individually in the dissemination of the knowledge of nature and the control of energy. Only in the leisure afforded them from their professional duties did they seek to enlarge the boundaries of knowledge and inspire others to undertake pioneer work. The men of imagination, training and genius, who were reaching out into the unknown and bringing back new things of the greatest importance—the very fundamentals of the research workers of to-day—were comparatively few in number. But through the efforts mainly of this small band of investigators the early years of the 20th century were marked by marvellous developments in science and its applications. Such men must always work alone, never in harness. They are the distinguished and immortal few. Their work springs from themselves, they require no external incentive. The great majority of scientific workers of all grades, from research students to professors and directors of research laboratories, also worked as individuals, as knights errant in the warfare against the unknown. This resulted in ill-balanced investigation, especially in chemistry, where we had duplication in many places and incomplete research in others.

The characteristic feature of this pre-war period, then, was the tendency of the individual to work along his own narrow front, oblivious of the work of others and of the problems of national importance. But British scientific workers were not entirely without concern for the relation of science to public welfare. The Science Guild of Great Britain, as well as able writers, called public attention from time to time to the small recognition accorded to science by the universities and Government of the country; the small amount of science in the curriculum in the secondary schools of the country and the lack of scientific organization in the Government departments. Scientific method, fostered by the universities in ever increasing measure, was receiving greater recognition. Scientific discovery progressed in its slow conquest of the unknown. Men of science had the leisure to think, but were more or less detached from their colleagues in universities, from the industries and from public affairs, and occasionally one could detect a tone of superiority in their relations with the world of affairs. They even compared notes with men of science of other nations, once in two or three years, and then "rendered unto the Teutonic Cæsar the things that were Cæsar's, and some that were not." The chief indication of a desire for cooperation could be seen in the annual meetings of the British Association for the Advancement of Science. The great learned academies of the world continued to play their important part in the encouragement of scientific work. It is a matter of pride to us of the Royal Society of Canada to recognize the splendid work done by the great academies of Europe. To those of us who have taken an interest in the early history of these academies, the part they have played calls for our sincere admiration. The work of the Fellows and Members has always been characterized by an unselfish sincerity in their desire to advance science in all its fields of activity. The oldest of the academies, namely, the Academia del Cimento, in its early days published the investigations of its members anonymously in the name of the Academy. This, Dr. Levene in a recent address has characterized as "perhaps the most sublime example of self-obliteration in the service of an ideal ever known in the history of science."

Some years before the war, the learned societies had established an International Association of Academies, which comprised the National Academies of sixteen countries, and at its triennial meetings far-reaching investigations were projected which involved the common action of men of science distributed throughout the world. Each Academy was pledged to support only such co-operative undertakings as were endorsed by the Association. Although its co-operative work was confined largely to astronomical researches, results of great value in Paleontology and in the establishment of standards of wave lengths in Spectroscopy were attained.

The absence of any national or other organized effort to direct and correlate science in England during the pre-war period was balanced by the development of schools of research in certain institutes, but chiefly in the universities. These groups of scientists were investigating not the application of science, but the most fundamental problems of matter and energy, and found their inspiration in the intellectual gratification they derived from their work, rather than in material gain.

England has had for over half a century a staff of officers of higher command in science, perhaps the finest in the world, men whose researches show the broadest generalizations, the greatest insight and imagination in scientific investigation. They had the opportunities and the leisure to work out the strategy and perfect plans of attack on problems of the highest importance. Unfortunately, however, this remarkably able staff was not provided with the rank and file of scientific workers—with brigades of scientifically trained chemists, engineers and physicists, capable of taking to the army, navy and industries of the country, the latest applications of science to problems of every day life. In all her industries, the proportion of university-trained men to artisans in England was one to 500; in Germany, one to 40. Germany in the industries and associated with her military activities had an army of scientifically trained men, numerically far superior to those of England and France, but her scientific headquarters was not occupied by officers of such vision, training and scientific brilliancy as characterized the higher ranks of science in England and France.

It was not the want of scientific ability and knowledge that placed the Allies at a disadvantage in 1914, but the stagnant condition of applied science. The German policy resulted in the penetration of scientific methods and organization into every type of national activity. The scientific career offered the highest prizes to the young graduate. The university and technical laboratories consequently were crowded by eager students; co-operation and organization of applied science were developed to the highest power. The Industrial Research Institute at Grosslichterfelde, outside Berlin, covered acres of ground, and was staffed by hundreds of men representing branches of science, many of which seem remote from industrial application. A similar institute at Charlottenburg has long been established to study the application of science to problems of war.

Germany did not owe her great strength in 1914 so much to her scientific knowledge as to the power she had attained by the organized combination of national effort to the one end. In the whole history of the world there was never a combination so close and effective. The political, military, financial and scientific resources of the nation were fitted into a gigantic, perfectly working machine, characterized, to quote McAndrew's hymn, by "Interdependence absolute, foreseen, ordained, decreed."

The scientific world knows well that at the outbreak of the war, Germany had largely succeeded in extinguishing in other countries those industries essential to the prosecution of a modern war, and had built up for herself, especially in chemistry, an army of experts and square miles of plant ready to be diverted to the scientific destruction of the rest of humanity. This feature of Germany's long preparation for the war and her method of using it were recognized very early in the struggle and preparations to meet them were promptly made. Fortunately, the advantages were all with us. French and English men of science had for at least a generation given to the world its greatest and most fundamental discoveries and some of their applications. They, therefore, entered the struggle with methods of attacking scientific problems based upon fundamental concepts, which in most cases surpassed the power of Germany to equal. Organization and co-operation developed along natural lines. Each chief of the great centres of research in the universities directed the efforts of his staff to a vital problem, and usually solved it. These research laboratories linked themselves with appropriate industries, and these again were grouped and co-ordinated by the naval and military authorities.

It was frequently stated in the press, according to Sir William Pope, that the science of synthetic organic chemistry, as applied to industries, was one in which the British nation could never hope to excel, as it called for close, tedious, detailed laboratory work, together with great power of organization and co-ordination. The Germans fully believed that they alone were endowed with the attributes of mind which combined an infinite capacity for taking pains with powers of scientific co-operation. What a mistake! When in 1917 and 1918 the colossal mechanism of the British Empire began to work in unison, the whole of England became one vast, interlacing, co-ordinated system of chemical, physical and engineering laboratories. The result was that, by virtue of this scientific co-ordination and system, England made better synthetic drugs, commercial dyes, and even those used for sensitising photographic films, than her enemies, while munitions and the lethal gases were prepared on a larger scale and by better methods than were used in Germany. The result was soon seen, the supremacy of the forces of the Allies upon sea and land, and especially in the air, was in no small degree due to the men whose lives had been devoted to the pursuit of pure science in university laboratories—the men with a hobby for research.

The problems in science presented to the Allies by the war were not only improvements in engines or explosives or guns, which could be effected by the inventive genius of engineers and technical chemists, but higher and more fundamental problems in synthetic chemistry, light, heat, and electricity, such as could only be successfully attacked by those with a profound scholarly knowledge of science and scientific method. The vital problems of the war were those which called, not for the advertised inventive wizard, but for the scientific investigator—the man who by his own laboratory investigations had added to the world's knowledge.

A recent writer of experience (Vernon Kellogg) reports regarding war inventions:—"Every major belligerent had a board of inventions and research, to which every man with an idea was asked to communicate that idea. All of these boards had precisely the same experience—in England, France, Italy and the United States. They all agree that not one suggestion in ten thousand, which came in in this way, was of any value whatever, and that the occasional worth-while idea, which was presented to these boards, was in general arrived at earlier in other ways. We would have less cause for satisfaction regarding the result of the war, had the Allies depended upon the undirected, inventive genius of the people to make the applications of science."

Probably never before in the history of pure science had men, who have devoted their lives to it, such an opportunity of demonstrating its value to the world. The stimulus to effort was simply enormous and the growth of our knowledge was astonishing.

The potential energy of the abstract sciences has long been recognized by a small minority of the people, but it required an upheaval such as we have experienced to demonstrate to every class in the community their value in action. The world at the close of the war was ringing with appreciation of what science had accomplished in the great struggle. It was perhaps a revelation even to those filling the posts of higher command in science, to find how capable of inventive achievement and initiative the ordinary laboratory man became when the incentive was great and when he acted under the stimulus of co-ordinated effort and personal contact with a master mind.

The attitude of England's men of science during the war is most eloquently expressed by Dr. Arthur Schuster in his address, as President of the British Association, in 1915. He says: "Mightier issues are at stake to-day; in the struggle which convulses the world, all intellectual pursuits are vitally affected, and science gladly gives all the power she wields to the service of the state. Sorrowfully she covers her face because that power, accumulated through the peaceful efforts of the sons of all nations, was never meant for death and destruction; gladly she helps, because a war wantonly provoked threatens civilization, and only through victory shall we achieve a peace in which once more science can hold up her head, proud of her strength to preserve the intellectual freedom which is worth more than the material prosperity, to defeat the spirit of evil that destroyed the sense of brotherhood among nations, and to spread the love of truth."

Not only was the science of each nation of the Allies mobilized and concentrated on military problems, but there was the closest confidence and accord among the scientific organizations of the several Allies. Communication by secret code kept the investigators in France, Italy, the United States and England in closest touch with one another regarding the vital problems they were studying in common.

The achievements in science, resulting from this international organization and co-operation during the war, were so outstanding that it seemed highly desirable to continue it in a modified form when the scientific efforts of the Allies would be directed to purposes other than military. Early in 1918 there was centered in Paris a group of those in charge of the international organization of science for the war. Men of greater eminence in their special fields and representing a greater diversity of expert knowledge had never been gathered at any international congress of science. The Conference offered a great opportunity. At the suggestion of the National Academy of Sciences of Washington, its distinguished president, Dr. Geo. E. Hale, launched the idea of an international Research Council, of which this group of eminent men would form the nucleus.

A meeting was held in London in October to discuss the policy of the leading scientific academies, and a further meeting was held in November in Paris, when an executive committee of five, representing France, Great Britain, Belgium, Italy and the United States, was appointed to draft a general constitution, to consult representatives of the different national scientific societies, and to prepare the way for an international congress at Brussels in July, 1919. At this great congress in Brussels were gathered, in the Palais des Academies, about 200 representatives of nearly all branches of science from the allied nations. The delegates were nominated by the representative councils and scientific national academies of the Allies.

Dr. Hale's original plan was simply to replace the international association of academies by an organization in closer touch with the various international associations or unions. A much more elaborate plan was proposed by the European delegates at Paris, which included an inter-allied research institute that would provide the means of reaching a common agreement as to what researches were most vital and should be undertaken either because of the pressure of economic necessity or in the light of recent progress. This institute was to have the power of selecting the countries or associations best adapted to undertake certain researches, and of coordinating the work of the investigators in the different countries. It was to have been established in Paris or Brussels and included an elaborate editorial organization to place the bibliography of science on an inter-allied basis by reducing the number and improving the character of the large reference books of each science, such as dictionaries, monographs, abstracts and other similar publications, all to be in either the French or English language, practically establishing a publishing house for international scientific literature, and replacing the Zeitschrifts, Central-blatts, etc., of Germany. The institute, as suggested by the French and Belgium delegates, would also form an international scientific library and an international bureau of scientific bibliography and would have a complete staff to administer a world-wide research council on the lines of the National Research Council of the United States, and similar organizations in England and France.

This plan of centralizing the control of the scientific research of the world, when studied by the special committee of five, was considered to be a goal perhaps attainable at some future date. It involved clashing of interests and infringed on the rights of the older international societies. It was deemed wiser, therefore, to make a beginning in such form as to insure the active co-operation and loyalty of all the national scientific associations of the Allies.

The final draft of the constitution was submitted by the special committee and unanimously adopted at Brussels. It was largely on the lines originally proposed by Dr. Hale.

The purpose of this International Research Council is, to quote from the statutes of convention:—

"1. To co-ordinate international efforts in the different branches of science and its applications.

"2. To initiate the formation of international associations or unions deemed to be useful to the progress of science.

"3. To direct international scientific activity in subjects which do not fall within the purview of any existing international associations.

"4. To enter, through the proper channels, into relation with the governments of the countries adhering to the International Research Council, in order to promote investigations falling within the competence of the Council."

The International Research Council, organized at the Brussels convention, came into existence on January 1, 1920, nearly all the signatories of the peace treaty and some of the neutral countries having signified their adhesion. It will remain in existence until December 31, 1931, and then, with the assent of the adhering countries, be continued for a further period of twelve years.

The complete statutes of the Brussels convention have just been published. While dealing largely with questions of administration and finance, they include some agreements of general interest, which may be itemized briefly.

The legal domicile of the Council will be at Brussels, where the general assemblies will be held every three years.

The list of countries which may participate in the foundation of the Council, or of any scientific union connected with it, is composed of those who were signatories of the Treaty of Peace.

A country may join the Council either through its principal academy, its national research council or its government.

The affairs of the Council are in charge of an executive committee, consisting of the president, two vice-presidents and the permanent secretary, during the interval between assemblies. The executive committee carry out the resolutions of the assembly and may nominate committees for the discussion or study of any question falling within the purview of the International Research Council.

At the Brussels convention a number of international unions or associations submitted their statutes of convention, applied for admission and were received.

The twelve or thirteen unions, now forming part of the general council, may conveniently be divided for description into two groups, one of which requires units constantly recording observations at different points on the earth's surface. In this group conclusions of value to science can only be drawn by collaborating and integrating the results obtained from a very large number of centres. The other group of unions consists of the associations of the experimental sciences, such as Physics, Chemistry and Biology.

Many of the unions of the first group, such as Geology, Astronomy, Geophysics, etc., existed as international associations in the pre-war period. Their activities, as national and international organizations, were interrupted during the war, and the most important work of the International Council was to bring about their re-organization.

The sciences allied to Astronomy and Geophysics were very strongly represented at the congress, not only in the number, but in the scientific standing of the delegates, who were the leaders in this field of research.

To avoid detail, I shall summarize the organization and field of work of the largest of this group of unions, viz: that of Geodesy and Geophysics. The purpose of the union is, to quote from the statutes:

"1. To promote the study of problems relating to the shape and physics of the earth.

"2. To initiate and organize the conduct of researches which depend on co-operation between different countries, and to provide for their scientific discussion and publication.

"3. To facilitate particular researches, such as the comparison of instruments used in different countries."

A national committee is to be formed in each of the countries belonging to the union. The Royal Society of Canada is asked to nominate at this meeting the Canadian national committee. The function of these committees will be to promote and co-ordinate in their respective countries the study of the various branches of Geodesy and Geophysics, more especially in relation to their international requirements.

As the result of preliminary informal meetings at Brussels of the various national delegations, discussion soon developed practical unanimity in the proposals to have each main branch of Geophysics represented by an independent section. Six such sections were formed: (*a*) Geodesy; (*b*) Seismology; (*c*) Meteorology; (*d*) Terrestial Magnetism and Electricity; (*e*) Physical Oceanography; (*f*) Vulcanology.

Nearly all of these sections formerly existed as separate associations, hence they are allowed a large degree of autonomy. Each has its officers, its central bureau, and, with the sanction of the union, may issue its own publications.

Where the work of the sections was found to over-lap or to be mutually dependent on each other, joint committees were formed to bring about co-ordination, such liaison committees were appointed to connect the work of the section of Meteorology with the International Astronomical Union for investigational work on solar radiation; while international work in atmospheric electricity as far as possible was placed under the direction of a joint committee, partly of the section of Terrestial Magnetism and Electricity, and partly of the section of Meteorology.

These examples are sufficient to illustrate the provisions made by the International Research Council as to cross-relationships between sections of a union or different unions, so as to ensure a proper integration of results and no duplication of effort. It will also be seen how by maintaining largely the individuality of the former international associations, this union has been able to focus its efforts on the major problems of the physics of the earth.

This general organization is typical of the first type of union. The other class of unions, comprising such sciences as Physics, Zoology, Botany, Chemistry, etc., were also formerly known among international associations, but with different functions; little effort was made in these associations to unify these sciences or to plan mass attacks on any special problem. They none the less afforded a valuable meeting ground for the scientists of different countries and were a powerful stimulus to research.

These unions, with the exception of that of Chemistry, are in process of organization; only general statements being made regarding their aims and objects. Each union is, at the time of writing, autonomous, and its relation to the Research Council less defined than in the first group of unions. The International Research Council will serve in an advisory capacity, acting also as a clearing house for information and suggested co-operative investigations.

The objects of these unions of the experimental sciences are stated in very general terms, viz.:

1. To organize permanent co-operation between the associations of the Allied nations.

2. To co-ordinate their scientific and technical resources.

3. To contribute towards the progress of science in the whole of its domain.

The first assemblies of the unions have been fixed for this year. It is expected that the establishment of a system of co-ordinating committees, connecting the activities of these unions one with another, will be the first of their efforts. It is generally recognized by students of the recent development of science that the advancement in experimental sciences to-day is chiefly along the borderland between sciences, *e.g.*, between Physics and Chemistry, Biology and Chemistry, Biology and Physics, Electricity and Chemistry, Geology and Geophysics, Astronomy and Physics, Botany and Pathology, etc.

Of the various unions of the experimental sciences, that of Chemistry, pure and applied, is the most highly organized, because its problems seemed the most pressing, and because, owing to its very extensive application to the industries, it has a higher measure of public financial support than say Physics, Biology or Mathematics.

The Chemistry Union is the first of the unions to attempt the difficult and expensive undertaking of compiling and publishing compendia of the literature of its branch of science.

The well-organized plan for the publication of compendia, monographs, etc., by this union illustrates both the magnitude and importance of the undertaking. The almost exclusive use of German chemical compendia and monographs throughout the whole civilized world has given that country a world-wide influence and prestige, out of all proportion to the value of its contributions to knowledge.

It was agreed that sets of compendia of chemical literature shall be published, some in English and some in French, *i.e.*, a division of the fields of labor. Each country will undertake the preparation of definite volumes with independent financial and scientific organizations for the carrying out of the work, but each country will also undertake to organize support of the work in the other country.

The part undertaken by the United States is the preparation of critical volumes of physical and chemical constants and related numerical data, leaving to the British commission the preparation of compendia of Inorganic and Organic Chemistry.

The physico-chemical tables will not be a mere compilation, such as we have been receiving from Germany, but will represent a critical digest of physico-chemical constants, an invaluable addition to our reference libraries.

This undertaking, which will cost about $100,000, while primarily under the direction of an American committee which will be charged with complete responsibility, both editorial and financial, will nevertheless be conducted on an international basis, with assistant editors and collaborators in the principal nations of the union. The majority of the delegates felt strongly that in nearly all cases where a programme of work was adopted by the union, the most efficient manner of accomplishing it was to centre the responsibility for each part in a given country, rather than to form a central international committee with a consequent distribution of the responsibility.

The plans of the British to prepare compendia of Inorganic and Organic Chemistry are about complete. These will include the subject matter of the great German works, but with many improvements as to arrangement of subject matter, etc.

The magnitude of this undertaking will be appreciated when we are told that the Organic section will consist of 18 volumes of 1,000 pages each, and the Inorganic of 16 similar volumes, and, at prices ruling last January, the total cost will be at least £130,000. It is to be issued in separate volumes and will be a complete record of the literature of Chemistry up to 1920.

The French chemists, under the direction of Dr. Charles Marie, will continue the preparation of the annual tables of constants, etc., and have already organized to bring the tables through 1919.

This effort on the part of the Chemistry Union to emancipate chemists and the universities from the domination of German reference books has every promise of success, and has met with the cordial approbation of the other unions which are preparing to take similar action.

The question has been asked, especially on this continent, why duplicate books of reference? The German books, while leaving much to be desired, are cheap and available. There are several reasons for this course of action. The domination of the reference shelves in the scientific libraries of the world by Germany has been an important factor in attracting graduate students to German universities, and thus inoculating to a certain extent the universities, especially of this continent, with the German method. Many examples have been quoted, especially in Chemistry, where the characteristic Chauvinism of the German editors has been so strong as not only to lessen their appreciation of the work of other nations, but also their accuracy in recording achievements of the "Auslander."

That we should be in possession of summaries of the chemical literature of the last seven years at the earliest possible date is a matter the importance of which was fully appreciated, and no more opportune time to break with the tradition of viewing Chemistry "through German eyes" is likely to arise. Even if the German compendia were impartial, there would still remain the objection that to younger chemists, at any rate, the habit of consulting German works of reference—in default of others—leads by mass suggestion to an appreciation of German effort which is by no means warranted by the facts. Moreover, the German compendia are not impartial.

Such, in outline, is the character of the International Research Council, its associated unions and some of its proposed activities.

Carried to its present stage of development by the momentum imparted to scientific investigation by the war—modeled on the National Research Council of the United States which played such an important role in the organization of science during the war—launched at Brussels in the month of July, 1919, when the Allies were celebrating their hard-earned victory in Paris, London and Brussels, the International Research Council, as a co-operative organization, has been well planned and sent on its way with the heartfelt godspeed of the scientific organizations of all the Allies. Its executive council is composed of a group of eminent scientists, who command the respect and confidence of the scientific world, with Dr. Arthur Schuster, of the Royal Society of England, as its Honorary Secretary.

Let us now consider a little in detail the actual status of the International Research Council, its stability, its possibilities and its influence on the future development of science among the nations of the world. It is obviously the beginning of a human enterprise much vaster than is indicated by its present form. Its title is perhaps too comprehensive, and represents not what it is, but is the expression of a fond hope of what it may become in the future. It is not in a broad sense international. It is now strictly an inter-allied confederation, which will welcome the adherence of the neutral nations, but these were not represented at Brussels and had no voice in drawing up the statutes of the convention. It is at best a nucleus around which may gather the scientific organizations of the allied and neutral nations. It has definitely refused to admit the nationalities which formed the Central Powers.

This is a momentous decision, since it takes from the Council even the outward form of complete internationalism. Before the war there was extensive and fruitful co-operation with Germany in research in certain fields of science through the international association of academies, and through several congresses of scientists, bringing about close personal relations between savants of all the leading countries.

We are all in accord with the conclusion that international co-operation in science cannot be complete until the time comes when it is world wide; we cannot but agree to the essential unity of science and to the exceptional character of the present arrangements; but, until the leading professors of Germany show signs of repentance regarding their servility towards the former German government and declare that they were beguiled by their own propaganda into acquiescence in barbarities which they now deplore, immediate personal relations with their colleagues among the Allies must be denied.

The Congress was emphatic in its verdict that personal relations with the unrepentant signatories of the famous manifesto are out of the question, and even the impersonal and cool co-operation of science is rendered more difficult if it is assumed that we have nothing to forgive and forget.

This attitude of the International Research Council and its associated unions has not met with the approval of the neutral nations. An appeal for a reconsideration of this decision has recently been issued. It is signed by 177 members of Academies represented in the pre-war International Association of Academies, and is being sent to the learned societies and academies in Allied countries. The signatures are chiefly those of Swedes, Norwegians, Danes and Dutch. There are a number of distinguished names on the list, but there is a notable absence from it of the many distinguished neutral savants who were known to sympathize with the cause of the Allies.

The signatories say that they "do not dispute the facts adduced, but only the conclusion that it is impossible to resume personal relations even in science"; they urge that in any case, especially in scientific matters, "it is alike impossible and disadvantageous to propose to neglect work that may be done in Germany, or to decline co-operation."

The answer given by the inter-allied convention was—"With the general sentiments in favor of complete international co-operation all are agreed, but co-operation without confidence is impracticable, and that confidence can only be restored by a formal disavowal of the German methods."

This division of opinion among the people of the neutral nations as to the recognition of Germany follows naturally from their division of opinion regarding the claims of the belligerents during the war. An active propaganda in favor of immediate recognition would, however, not only defeat the very object they have in view, but indefinitely delay and perhaps jeopardize that complete internationalism which demands a universal community of science.

This is the ultimate goal at which we aim; a system in which the International Research Council, composed of delegates from all countries and of affiliated unions, would become the parliament of science, the express image of the science of the world. Here at intervals would be enacted legislation governing the formation of new unions of scientists, as well as plans for the inter-relation and development of unions already in existence. The unions in turn, meeting at more frequent intervals, would be made up of representatives of organizations of special sciences from every country of the civilized world. They would thus serve to develop and integrate for international purposes investigations carried out in different countries, as well as to stimulate research and provide for scientific discussion and publication. Behind these International Unions would stand the National Research Councils, National Departments, or Advisory Councils of Research, whose activities are devoted to the development of science and its applications in each nation. These Councils in turn would have as subsidiary organizations the various scientific societies, such as Physical, Astronomical and Chemical Societies, the scientific departments of the universities, of the industries, of the government and research institutes.

The scientific products of hundreds of thousands of workers throughout the world would become more available and their activities more effective. A world-wide scientific effort would become organized. Of such an organization, co-operation would be the nervous system carrying afferent and efferent impulses in all directions from the centre to the periphery.

Every form of co-operation carries with it the idea of organization. This organization may be either administrative and bureaucratic, that is, imposed by some authority; or of its own making, voluntary and democratic in character. As science is a product of human activity, its methods must be influenced by the spirit of the times. When the countries of the Allies mobilized their scientific forces for the war, the form of organization was of necessity military or bureaucratic in type, and this has left a permanent impress on the organization of science among the Allies. The International Research Council has carefully avoided even the semblance of a supernational authority. It is strictly democratic. This it is which gives a promise of permanency to international co-operation in science, and it is the suggestion, or perhaps the necessity, of some supernational authority which is a source of weakness in the development of the League of

Nations. The administrative form of co-operation persists now in a somewhat paternal form in the departments of science in governments, in councils for industrial and scientific research, national bureaus of science, national research institutes, etc. Almost every country has its central organization, controlling and directing the application of scientific methods to the development of its resources, the utilization of the valuable by-products of industries, and, most important of all from an economic point of view, they are bridging the gap which separates science from its application to industries, ascertaining how the findings of the scientist can be made available to the industrial research worker, and how, on the other hand, the problems of the industrial worker can be massed in such a form as to give a sense of direction to the pure scientist. This problem, so vital to the nations of the world, each laboring under a national debt of almost overwhelming proportions, can only find its solution in co-operative efforts between those who can set the problems and those whose training and knowledge will aid in their solution.

To develop and make permanent in times of peace the "liaison de convenance" hurriedly arranged during the war between science and its applications, is the complex problem now before the central national scientific organizations. They are studying the relations of the universities to national economic questions and the co-ordination of the scientific efforts of departments of the government having control of national resources. They are giving financial assistance to researches, both academic and technical, and encouraging able young graduates to enter the field of research by systems of fellowships, thus providing trained minds for fundamental and technical research. They are encouraging co-operation between allied sciences and arts, *e.g.*, Biology with Agriculture, Chemistry and Physics with Forestry, Psychology and Physiology with problems of industrial hygiene and industrial fatigue. By the formation of unions and guilds they are organizing co-operation among similar industries in research. Such activities as these illustrate what the national councils or similar central bodies are striving to accomplish "through the purely scientific process of organized effort."

The successful development of organized science in each nation taking part in this international co-operative movement lies at the very foundation of the edifice which is designed by the International Research Council. This vast effort directed towards the conquest of practical life by science has behind it the efficient reserves of public opinion. The captains of industry have come to recognize the latent power of scientific research, and those engaged in the application of science have found that co-operation in research secures concentration of effort, minimizes duplication and stimulates progress.

Permit me to pass for a moment from the general to the particular, and to illustrate by a single example how effective co-operation has been developed by national organizations. One of the very successful methods of industrial co-operation is the formation of unions, guilds or associations among manufacturers engaged in the same industry, such as the cotton, iron or textile industry, with a view to improving that industry as a whole by technical research. Each union, by conferences, reaches a clearer idea of its scientific wants and is able to integrate the problems common to all for solution; each association has its special research laboratories, the findings of which are for the benefit of all engaged in that industry. The efforts to form these research unions by the Department of Science in England and the National Council for Research have been crowned with success beyond the highest expectations. The sub-department of industrial relations of the National Research Council of the United States is of very recent formation, but has already organized a number of powerful research unions. But it is in England, the home of individualism and trade secrecy, that this movement has made such astonishing advances. In January last, no fewer than 19 trades and specific industries had formed themselves into associations for the purpose of research work under the government plan, whereby a sum of nearly five million dollars is made available for industrial research of this type alone. These unions must be national in character and must obtain the approval of the research department of the government. After such approval each union receives financial support from the government equal to the amount expended by the association.

The general acceptance of this principle of industrial unions in England would indicate that the policy of industrial secrecy, which has so greatly hampered the application of science to the industries, is now almost obsolete. Manufacturers are becoming alive to the truth of the statement that "the closed door to an industrial plant shuts out more than it shuts in."

This pooling of the expenses and proceeds of scientific research and organization may have a certain Teutonic flavor, but it has transformed isolated crafts to highly developed industries, eliminated needless duplication of effort, and prevented, at this critical period, incalculable loss through arrested development. In Canada, the Research Council has strongly advocated a similar type of co-operation, especially among the more distinctly Canadian industries, such as those related to the Fisheries and Forestry. While some progress has been made, we are really only touching the fringe of opportunity in this field of endeavour, but, as Dr. Coulter has pointed out, "we must remember that to bring into effective co-operation great numbers of isolated, scattered and sometimes conflicting units, takes time and a great controlling motive."

I have endeavoured to show that co-operation and co-ordination are fundamental principles in so vast a project as a world-wide union of science, where we are dealing with groups or regiments of specialists whose common efforts are to be adjusted and correlated by mutual agreement. Further, the direction, in an advisory capacity, of the economic forces of each separate nationality, by bringing about an alignment between production and the scientific principles underlying industries, is based upon co-operation. There are many plans involving the application of this doctrine, by which certain scientific activities of the universities may be linked up with each other and with those of government bureaus and industries to their mutual advantage and for the development of national wealth. Plainly stated, it has come to be generally recognized that co-operation and organization are the most efficient means of capitalizing science, of making it useful.

Permit me to sound a note of warning. There seems a danger of being carried away by the convincing examples of the success of co-operative science to such an extent as to lose sight of the significance of the individual in research, and to exaggerate the utilitarian motive in scientific investigation.

The advocacy of individualism in scientific investigation is regarded today, especially on this continent, as reactionary, but, as Prof. M. P. Armsby states, "It is just as true today as it ever was that the permanent and significant advances in science depend, in the last analysis, on the initiative and originality of individuals." Nothing can alter this fundamental fact, and again, "usually the best thing that can be done for a man of scientific vision, who is capable of the most fundamental kind of research, is to supply him with the necessary equipment and facilities and then let him alone. Committees and co-operators are in danger of being hindrances rather than helps."

While there is much truth in this statement, we must remember that many of the advances of the last century, with which are associated some of the greatest names in science, were in part co-operative. There was the directing mind of the master inspiring a group of scientific workers in association, who in turn stimulated and directed the master. The chemical work of Emil Fischer on the molecular structure of Protein, Purins and Sugars, that of Kekule on the Benzene ring, of Sir Joseph Thompson on Atomic Structure, represent in each case the activities of a large body of research workers, whose investigations were co-ordinated by the master mind, but the workers were largely self-directed and the co-operation was a purely voluntary one.

Problems calling for the application of several branches of science, *e.g.*, Physics, Biology, Chemistry, etc., are especially adapted for co-operative effort, but this co-operation should be voluntary and democratic. Such mass attacks on problems are undertaken, for example, in the National Physical Laboratory, in the Bureau of Standards, in the Mellon Institute, and will form an important part of the activities of the new Canadian Research Institute. Co-operation of this kind has been found to develop rather than suppress individuality among the investigators.

The standard by which the world has come to measure the value of science is its capacity to aid in the production of wealth and power. The public recognition of science as a profitable investment is, to many the silver lining of the great war cloud. Among the recent articles in scientific journals, which are eloquent in the glorification of utility, we find a leader of manufacturers speak of science as "the handmaid of industry," and an astronomer quoting with approval "without the aid of science, the arts would be contemptible; without practical application, science would consist only of barren theories which men would have no motive to pursue." It is obviously true that a scientific discovery has its value enhanced when it admits of practical application, but this surely cannot be regarded as the sole criterion of its importance. The theory of evolution, the electron theory of atomic structure dealing with the infinitely small, or the Copernican theory of the heavens, to take an example from astronomy, cannot be classified as having utility in the ordinary acceptation of that word, nevertheless, these conceptions "have revolutionized our habits of thought and our outlook upon the world in which we live."

It may be generally stated that utilitarian motives, arising from war experiences and accentuated by the requirements of a period of reconstruction, largely dominate the scientific life of the world to-day. We must recognize, however, that researches along these fundamental lines of sciences suffered during the war, particularly in the universities, from the withdrawal of support and from the transference of attention to more urgent needs. Professor Sumner asks, "To what extent is this shifting of emphasis irreversible? The investigator who continues along the newer paths will doubtless be following the lines of least resistance and he will have behind him all the force of public approval." The investigator may, to use the words of Dr. Raymond Pearl, come to "supplicate the great goddess, Truth, with one ear closely applied to the ground."

Why does a scientific man find satisfaction in the study of nature? Schuster, in his presidential address to the British Association in 1915, quotes Poincairé as follows:

"The student does not study because that study is useful, but because it gives him pleasure, and it gives him pleasure because nature is beautiful; if it were not beautiful, it would not be worth knowing and life would not be worth living. I am not speaking, be it understood, of the beauty of its outward appearance—not that I despise it, far from it, but it has nothing to do with science—I mean that more intimate beauty which depends on the harmony in the order of the component parts of nature. Without this intellectual support, the beauty of the fugitive dreams inspired by sensual impressions could only be imperfect, because it would be indecisive and always vanishing. It is this intellectual and self-sufficing beauty, perhaps more than the future welfare of humanity, that impells the scientific man to condemn himself to long and tedious studies. And the same search for the sense of harmony in the world leads us to select the facts which can most suitably enhance it, just as the artist chooses among the features of his model those that make the portrait and give it character and life. There need be no fear that this instinctive and unconscious motive should tempt the man of science away from the truth, for the real world is far more beautiful than any vision of his dreams. And we see that the cult of the beautiful guides us to the same goal as the study of the useful."

Referring to Poincairé's view regarding the connection between the search for the beautiful and the achievement of the useful, Schuster asks, "if the imagination of the mathematician is fired by the beauty and symmetry of his methods, if the moving spring of his action is identical with that of the artist, how much truer is this of the man of science, who tries by the experimental method to reveal the hidden harmonies of nature?"

Schuster's reference to the harmonies of nature suggests that it is because the scientist has an intuitive faith that the world is harmonious and a well co-ordinated organism, that he is inspired to toil for years on a single problem. When he undertakes any investigation, any excursion into the unknown, he consciously or unconsciously is looking for the confirmation or the establishment of harmony in existing knowledge. All the fundamentals of science, such as Newton's Laws of Motion, the conservation of energy, evolution, the Mendelian law, etc., are but a few special instances of the universal harmony of nature. The

Greeks appreciated this. Empodocles says, "but in the strong recess of Harmony established firm abides the perfect sphere."

The scientific spirit which actuated research in the British Empire was largely idealistic until the recent great crisis of humanity forced it to give way to a purely material purpose. It was the times of peace and prosperity that supplied the leisure for intellectual pursuits and created the atmosphere for scientific growth from the bottom, for the accumulation of those scientific fundamentals that enabled us in the defence of the Empire to forestall and excel the enemy in the applications of science.

Now that we are entering upon a new era of peace, should we not endeavour to encourage at least a portion of scientific effort to seek other gods than those of immediate utility? Are we not beating the utilitarian drum too loudly in our university halls? The very life blood of the scientific departments in a university is the pursuit of science for the advancement of truth. Nevertheless we must not forget that the compelling events of recent years call most emphatically for its material application as well. The two objectives are not incompatible; they can be recognized in the same university with advantage to both, but one cannot help feeling there is a danger of the essential function being less developed than the subsidiary function. Should the universities not aim to develop the sciences in such a way as to bring about that very combination of æsthetic satisfaction and useful achievement which Poincairé has so well described?

The high privilege of the universities is the preservation of real knowledge, not only to see that such knowledge once acquired should not be lost, and to play the role of a vestal virgin in "guarding the torch kindled by others," but also to extend the boundaries of human knowledge. Research and the development of initiative in scientific investigation among students distinguish the university from the mere college, and capacity for research is the valuable product the country expects from its universities.

Just as the universities have duties to perform to the country, so have countries duties to perform to the civilized world. It is the duty of every country to participate in the discovery of the laws of nature, to enhance the powers of man and widen the range of his vision. The cultivation of the fields of pure science yields products which are of world-wide necessity and more lasting than the pyramids. Other human achievements wear out and disintegrate with time. The harvest of science persists and increases in value with every generation of workers. The International Research Council stands for co-operative effort among the men of all nations to extend the field of scientific knowledge and to distribute its splendid products. It merits hearty recognition among the nations. It is full of possibilities. A world-wide co-operation in pure science would promote an internationalism which, unlike the League of Nations, would not bring us into "fatal collision with the principle of nationality everywhere active and powerful." It is a type of community life which seems specially adapted to world-wide development, and if so developed should bring us nearer to the unification of mankind than any form of internationalism hitherto suggested. In pure science, communism is a natural law; rank, status, race, religion, nationality should count for nothing. The underlying principle here is the universalism of science and the catholicity of truth.

APPENDIX B

THE METEOROLOGICAL SERVICE OF CANADA

BY

SIR FREDERIC STUPART, Kt., F.R.S.C.

Director, Dominion Meteorological Service.

METEOROLOGICAL SERVICE OF CANADA

Central Office

The regular recognized work of the Central Office has been carried on systematically throughout the year. Forecasts have been issued twice daily to all parts of the Dominion, exclusive of British Columbia, and to Newfoundland. Since the early spring the weather bulletins have been supplied with the utmost despatch to the British Admiralty through Halifax, and also the Government wireless stations for transmission over the Atlantic routes. Also, when deemed necessary, warnings of expected storms have been issued to those ports which are equipped with storm signals.

The warning service has continued throughout the year to ports on the Nova Scotia coast and the season of navigation on the Great Lakes and Gulf of St. Lawrence. The severest storm of the season on the Great Lakes was that of November 29th, but, owing to the lateness of the season and the issue of a timely warning, there were few, if any, marine disasters. A succession of noteworthy storms passed across the Maritime Provinces during February and the first part of March, several of the gales being of great violence. Shipping was warned in each instance.

The daily Weather Map containing the data on which forecasts are based has as for years past been printed in Toronto, and distributed quite widely both in that city and in the country generally, and quite recently arrangements have been completed whereby a similar map will be printed in Winnipeg in order to serve Manitoba.

Physics Branch

It was about the middle of September, 1919, before Mr. J. Patterson, M.A., had sufficiently perfected the process of separating Helium from Natural Gas, on which he had been engaged for nearly two years with the Department of Experiment and Research of the Board of Invention and Research of the Admiralty, to enable him to resume his duties at the Meteorological Office. Since that time he has devoted his time to getting the work of the Physics Branch organized.

The investigation of the upper atmosphere by means of balloons carrying instruments was started immediately, but the company from whom the balloons were obtained have been unable to supply more than two or three, and the work has been temporarily held up until they can furnish them regularly.

Arrangements were nearly completed to send an observer to Fort Good Hope to take Magnetic and Meteorological Observations and send up pilot balloons in co-operation with the Amunsden Expedition before the announcement of Amunsden's expected arrival at Nome was received. It has now been decided by the international committee in charge to postpone this work for one year.

It is expected that during the year at least seven pilot balloon stations will be established across Canada to meet the requirements of the Air Board and for investigating the upper atmosphere.

The investigations on solar radiation and atmospheric electricity will be resumed during the year and it is also hoped to commence work on Earth and Ocean temperatures.

Climatology and Agricultural meteorology

The Monthly Record of Canadian Meteorological data has been printed more promptly than ever before. The preliminary monthly map giving a summary of the weather of the Dominion for each month four days after it closes has been continued and improved; also the 79th Annual Report of the Toronto Observatory has been published.

Special attention is being given to the weather of the Western Provinces, where the dependability of average or better than average weather is being worked out with the idea of mapping out the risks of farming in each district, depending upon the weather alone. The scarcity of observations of rainfall has been a serious drawback and it is hoped that a greater number of rainfall stations may be opened in the future.

Statistical studies of the yield of wheat and oats have been continued and a comprehensive attempt to abstract from all publications of other departments every reference to crops and the weather has been begun, with the idea of determining to what extent other departments of the Government could co-operate with us in obtaining data valuable for study in Agricultural Meteorology without much extra effort or expense.

A paper outlining the main features of a study of the relation of the weather to the quality and yield of the sugar beet will be published this year.

Attention is devoted to the possibility of issuing special forecasts of settled weather conditions about a week in advance during harvest time, but so far we have not felt justified in issuing bulletins to the farming community.

Terrestrial Magnetism

During the fiscal year ending March 31, 1920, the photographic records of the daily changes in the Magnetic elements at Agincourt were obtained without material loss. Magnetic disturbances were of frequent occurrence and often for short periods passed beyond the recording limits of our instruments. The most pronounced disturbances took place on the following dates: 1919—April 7, 17; May 2, 3; August 11, 12; September 19, 20; October 1, 2, 3, 5, 6, 23; December 14, 15; 1920—March 4, 5, 22, 23.

Absolute observations were made weekly to keep control of the base line values of the differential instruments.

Tables showing the Magnetic character of each day have been forwarded as usual to the International Commission on Terrestrial Magnetism. The days selected by the Commission for analysis have been used in the preparation of the Magnetic Reports for both Agincourt and Meanook. The Report for 1919 is now in progress.

At the request of the Surveyor-General, index corrections for the compasses attached to 71 surveyor's theodolites were determined and the results forwarded to him.

Assistance was given to several members of the staff of the Surveyor-General's Department in determining the constants of their Total Force instruments both before and after their field work, and also to Mr. French of the Dominion Observatory in standardizing his magnetometer both before and after his field work.

Special observations were made during the Total Solar Eclipse of May 29 at the request of Dr. Bauer, Director of the Department of Terrestrial Magnetism, Carnegie Institution, Washington, and a report of the results forwarded to him.

At Meanook only the Declination changes are observed photographically and the instrument for this purpose was maintained in operation throughout the year. During the very cold weather of the winter, difficulty was again experienced in keeping the clocks running and a considerable number of hours of record were lost.

Weekly observations were made of Declination and Inclination, and twice monthly of Horizontal Force.

Summary of Results of Magnetic Observations Made at Agincourt for the Fiscal Year 1919-1920

Month	Mean Monthly Values			
	D West	H	Z	I
1919	° ′	γ	γ	° ′
April	6 40·4	15894	58281	74 44·8
May	40·2	891	273	44·8
June	39·9	903	250	43·8
July	40·2	897	240	44·0
August	41·8	873	234	45·2
September	42·2	866	228	45·5
October	42·5	863	233	45·7
November	42·5	878	221	44·7
December	42·9	878	224	44·7
1920				
January	43·4	884	226	44·5
February	43·7	880	221	44·6
March	44·8	858	215	45·7

Agincourt Daily and Monthly Ranges

Month	D			H			Z		
	Mean daily range		Absolute monthly range	Mean daily range		Absolute monthly range	Mean daily range		Absolute monthly range
	From hourly readings	From max. and min.		From hourly readings	From max. and max.		From hourly readings	From max. and min.	
1919	′	′	° ′	γ	γ	γ	γ	γ	γ
April	13·6	25·7	1 12·6	52	106	504	29	68	381
May	11·5	32·9	2 21·9	66	153	783	57	126	540
June	15·6	21·2	0 47·1	54	81	169	19	57	170
July	14·9	20·6	0 49·9	48	82	338	19	51	352
Aug.	17·1	31·7	3 43·7	66	128	930	34	92	979
Sept.	13·5	29·9	1 37·8	51	108	515	39	90	474
Oct.	10·1	37·7	2 27·0	48	151	882	38	112	617
Nov.	6·8	15·2	0 52·3	24	47	150	9	39	123
Dec.	6·2	16·5	1 27·1	22	62	422	19	37	386
1920									
Jan.	8·6	15·1	0 31·6	34	53	98	7	31	53
Feb.	9·4	14·8	0 43·8	31	52	155	9	19	102
Mar.	11·2	33·6	3 47·8	70	159	1192	22	107	1069

Summary of Results of Magnetic Observations Made at Meanook for the Fiscal Year 1919-1920

Month	Mean Monthly Values					
	D	East	H	Z	I	
1919	°	′	γ	γ	°	′
April	27	41·3	12948	60414	77	54·2
May		41·0	46	345		53·5
June		39·2	48	346		53·4
July		39·5	59	326		54·2
August		40·6	46	465		54·9
September		41·0	56	460		54·3
October		41·1	54	468		54·5
November		40·8	31	369		54·6
December		40·5	29	291		53·8
1920						
January		39·9	34	375		54·5
February		39·6	19	219		53·5
March		40·6	12	298		54·8

Meanook Daily and Monthly Ranges

Month	From hourly readings	From max. and min.	Absolute monthly range	
1919	′	′	°	′
April	14·4	57·6	3	27·9
May	19·9	61·5	3	09·5
June	18·5	31·2	1	35·7
July	18·0	35·1	2	20·2
August	21·7	49·4	3	56·9
September	16·5	50·2	3	31·3
October	10·7	72·5	3	55·8
November	6·3	28·8	2	18·2
December	8·8	32·9	3	51·4
1920				
January	6·8	24·1	1	37·2
February	6·4	28·3	2	49·3
March	11·9	69·6	5	06·6

Seismological Observations

The Milne Seismographs at Toronto and Victoria have been kept in efficient working order, with comparative little loss of record, throughout the fiscal year. No change has been made in the adjustments of the instruments, both booms being kept at a period of 18 seconds.

In Toronto, 158 unfelt earthquakes were recorded. This is the largest number recorded at Toronto in any year, being 61 greater than average as deduced from 21 years' data, and 24 greater than recorded last year. The largest monthly total, 21, occurred in May, and the least, 5, in February. There has been marked increased seismic activity since 1914.

The most important quakes were recorded on April 17th and 30th, May 3rd and 6th, August 29th and 31st, September 6th, January 4th and March 29th.

Outside Stations

The *611* Meteorological Stations reporting to the Central Office are divided into two divisions, the first of which includes *333* stations where the observing is performed voluntarily by observers who keep a daily record of the weather, using instruments furnished by the Government. In many instances the record kept is most comprehensive, and to the observers at these stations the country owes a debt of gratitude for data which is of great value. In the other division are *278* stations where remuneration is allowed. These stations are divided into various classes, according to the work performed, as follows: 15 Chief Stations; 41 Telegraph Stations; 109 Rainfall Stations; 72 Climatological Stations; 39 Bulletin Stations and 2 Magnetic Stations.

There are also *101* Meteorological agents whose duty it is to attend to the display of storm signals.

The daily forecasts are based on bi-daily reports from 41 Telegraph Reporting Stations and 6 of the Chief Stations, together with about one hundred reports from the United States. The utmost regularity and promptness is required from observers at these stations in filing their reports for transmission by wire to the Central Office, every day throughout the year, including Sundays and holidays.

Phenological Observations, 1919

Mr. F. F. Payne of the Central Office of the Meteorological Service presents the following report on the Phenological Observations of 1919.

While the interest in phenological reporting flagged somewhat in most provinces it increased in Saskatchewan, where several new observers were added, and the total number of reports received was about the same as for 1918. For these additional reports and a few others we are indebted to Mr. W. H. Magee, Inspector of Schools for Battleford District.

The tables containing mean dates for Nova Scotia, kindly supplied by Dr. A. H. Mackay, Superintendent of Education, Halifax, which were prepared by his assistants, are excellent as usual, and it is to be regretted that the same enthusiasm for this voluntary work cannot be maintained in other provinces.

Vegetation in British Columbia made rapid progress up to the end of April and at that date was somewhat more forward than usual. After that date, however, normal conditions were general.

In Alberta, Saskatchewan and Manitoba the progress of vegetation was somewhat similar to that in British Columbia, plant life making unusually rapid progress during April, and becoming normal or slightly backward in May.

The conditions which prevailed in the western provinces were more marked in Ontario and many plants were in bloom unusually early in April. During the first part of May, however, vegetation made little progress although it was normal by the end of that month.

In the Province of Quebec vegetation was quite backward up to May 15th, after which it made rapid progress, and by the end of June the condition of plant life was normal.

In the Maritime Provinces where there was much cloudy weather during April and May, vegetation was very backward but much bright sunshine during June caused rapid progress during that month.

"The Province of Nova Scotia is divided into its main climatic slopes or regions which are not in some cases co-terminus with the boundaries of the counties. Slopes, especially those to the coast, are subdivided into (*a*) coast belts, (*b*) inland belts, and (*c*) high inland belts. Where these letters appear in the tables they refer to these slopes or regions. Dates for slopes IX and X were combined in computing the average for the province. The following regions are marked out, proceeding from south to north and from east to west as orderly as it is possible."

	Region or Slopes	Belts
I.	Yarmouth and Digby Counties.....	(a) Coast, (b) low inlands, (c) High inlands.
II.	Shelburne, Queens and Lunenburg Counties....................	" "
III.	Annapolis and Kings Counties......	(a) South Mts., (b) Annapolis Valley. (c) Cornwallis Valley. (d) South Mts.
IV.	Hants and Colchester Counties, South to Cobequid Bay.......	(a) Coast, (b) Low inlands, (c) High inlands
V.	Halifax and Guysboro Counties.....	" "
VI.	(A) Cobequid Slope to S (B) Chignecto Slope to N.M....................	(a) Coast, (b) Inlands.
VII.	North'rland Sts. Slopes (to the north).	(a) Coast, (b) Low inlands (c) High inlands
VIII.	Richmond and Cape Breton Counties	" "
IX.	Bras d'Or Slope (to the southwest)..	" "
X.	Inverness Slope (to Gulf, northwest)	" "

Owing to the great number of observers and others taking part in the production of the tables for Nova Scotia their names are omitted from the following list.

List of Stations and Observers

W. H. Hicks, Agassiz, B.C.
Stanley R. S. Bayne, Alberni, B.C.
A. B. Taylor, Atlin, B.C.
A. C. Murray, Fort St. James, B.C.
Mrs. Hugh Hunter, Princeton, B.C.
John Strand, Quesnel, B.C.
Geo. W. Johnson, Summerland, B.C.
Mrs. C. F. Walker, Tzouhalem, B.C.
A. S. Barton, Victoria, B.C.
Mrs. W. L. Fulton, Halkirk, Alta.
Thos. B. Waite, Ranfurly, Alta.
Miss F. M. Thomas and Pupils, Bathgate, Sask.
Miss J. E. Ewart and Pupils, Battleford, Sask.
Miss E. H. Caffrey and Pupils, Denholm, Sask.
W. Brown, Dundurn, Sask.
L. B. Potter, Eastend, Sask.

M. V. Wilkinson and Pupils, Fielding, Sask.
Miss J. Holmes and Pupils, Forest Hall, Sask.
R. H. Carter, Fort Qu'Appelle, Sask.
Miss G. E. Holicky and Pupils, Hatherleigh, Sask.
Miss H. Wallace and Pupils, Horizon, Sask.
Geo. Lang, Indian Head, Sask.
Miss S. A. Burns and Pupils, Kinistino, Sask.
A. M. Calder and Pupils, Lilac, Sask.
Miss M. E. Carter and Pupils, Maymont, Sask.
Miss H. Duhaine and Pupils, Meota, Sask.
Miss M. C. Melburn and Pupils, North Battleford, Sask.
Miss V. G. Armatage and Pupils, Prince, Sask.
Mrs. M. E. Brown and Pupils, Rabbit Lake, Sask.
M. Milliken, Scott, Sask.
C. W. Bryden, Shellbrook, Sask.
Mrs. H. Graham and Pupils, Wanganui, Sask.
William Irvine, Almasippi, Man.
Allan Campbell, Brandon, Man.
A. Goodridge, Oakbank, Man.
Miss M. J. McCarthy, Portage La Prairie, Man.
J. D. Plaice, Rapid City, Man.
Miss M. Moffitt and Pupils, Cape Croker, Ont.
W. E. McDonald, Lucknow, Ont.
Miss H. M. Meighen, Perth, Ont.
L. G. Morgan, Port Dover, Ont.
M. A. Thompson, Queensboro, Ont.
F. F. Payne, Toronto, Ont.
David McKenzie, Abitibi, Que.
T. F. Ritchie, Lennoxville, Que.
R. G. Mowatt, Dalhousie, N.B.
W. H. Moore, Scotch Lake, N.B.

Phenological Observations, Canada, 1919

Year 1919

Date of the year corresponding to the last day of each month

January	31	July	212
February	59	August	243
March	90	September	273
April	120	October	304
May	151	November	334
June	181	December	365

When first seen

Year 1919	Alberni, B.C.	Agassiz, B.C.	Atlin, B.C.	Fort St. James, B.C.	Princeton, B.C.	Quesnel, B.C.	Summerland, B.C.	Tzouhalem, B.C.	Victoria, B.C.	Halkirk, Alta.	Ranfurly, Alta.	Bathgate, Sask.	Battleford, Sask.
1. Alder (Alnus incana)......Shedding pollen	95		122		97								
2. Canada Thistle (Cirsium arvense) Fl'w'rng.	188	175				194	163		187		201		
3. Trailing Arbutus (Epigaea repens) "													
4. Dandelion (Taraxacum officinale) "	51	110	153	154	109	126	100	6	40	138	137	132	136
5. Violet, Blue (Viola palmata cucullata) "	116	112	152	151	100	119		121			135	152	120
6. Violet, White (Viola blanda) "		114	144		113	125			74		140		
7. Columbine (Aquilegia) "	155	129	169	169	151		133	140			161		
8. Trees appear green.....................	112	104	152		126	96	117	123	85	142	127		
9. Red Clover (Trifolium pratense) Flowering	149	143			170	140	152	91	148				
10. White Clover (Trifolium repens) "	146	138			122	135	138	152	144				
11. Wild Raspberry (Rubus strigosus) "	161	145	181		151	190		154			175		
12. Cultivated Currant (Ribes rubrum) "	115	121			125	206	124	121	94		123		117
13. Wild Rose (Rosa) "	149	145	169	178	151	150	147	142	131	166	152	161	147
14. Trillium (Trillium) "	92	91						91	95				
15. Anemone (Anemone) "		111	111		140			111		106	110	93	199
16. Maple (Acer) "	111	125						109	91		·121		117
17. Strawberry Wild (Fragaria Virginiana).. .	93	131	163	154	107		115	93	96	128	135	104	129
18. Strawberry Wild (Fragaria Virginiana) Fruit ripe........................		150	208	187	140	173		119	142		171	144	160
19. Crocus, Cultivated (Crocus) Flowering	67	73						30	25		136		
20. Lilac (Syringa vulgaris)......... "	134	124			154	142	134	125	122		137		
21. Apple (Pyrus malus)............ "	128	113			134		119	124	116		130		
22. Plum. Cultivated (Prunus domestica")	126	92					122	112	96				
23. Cherry, Wild (Prunus).... "	124	94						124	115		140	182	132
24. Cherry, Cultivated (Prunus cerasus) "	119	104					114	117	102		153		

When becoming common

Year 1919	Alberni, B.C.	Agassiz, B.C.	Atlin, B.C.	Fort St. James, B.C.	Princeton, B.C.	Quesnel, B.C.	Summerland, B.C.	Tzouhalem, B.C.	Victoria, B.C.	Halkirk, Alta.	Ranfurly, Alta.	Bathgate, Sask.	Battleford, Sask.
1. Alder (Alnus incana)......Shedding pollen													
2. Canada Thistle (Cirsium arvense) Fl'w'rng.	201	193							210				
3. Trailing Arbutus (Epigaea repens) "													
4. Dandelion (Taraxacum officinale) "		119			117	136			96	146	139	144	140
5. Violet, Blue (Viola palmata cucullata) "		120			110				60		140	161	130
6. Violet, White (Viola blanda) "		120			122						145		
7. Columbine (Aquilegia) "	162	146			156				163		171		
8. Trees appear green.....................	121	146			135				117		130		
9. Red Clover (Trifolium pratense) Flowering		160			179								
10. White Clover (Trifolium repens) "		144			128	150			155				
11. Wild Raspberry (Rubus strigosus) "	163	153			180	201					181		
12. Cultivated Currant (Ribes rubrum) "	121	126			130				106		126		130
13. Wild Rose (Rosa) "		146			157	163		157	144	170	161	160	
14. Trillium (Trillium) "	116	102							102				
15. Anemone (Anemone) "	155	121			149					113	114	105	103
16. Maple (Acer) "	119	128							117		130		130
17. Strawberry Wild (Fragaria Virginiana).. .	110	138			130				108	174	140	134	129
18. Strawberry Wild (Fragaria Virginiana) Fruit ripe........................	161	155		213	168	186					176	162	170
19. Crocus, Cultivated (Crocus) Flowering	74	83						60	57		140		
20. Lilac (Syringa vulgaris)......... "	148	133			157	152			129		145		
21. Apple (Pyrus malus)............ "	137	125			142				126		140		
22. Plum. Cultivated (Prunus domestica")	130	105							108				
23. Cherry, Wild (Prunus).... "	130	96									142	227	140
24. Cherry, Cultivated (Prunus cerasus) "	121	121							110		161		

122	132	144		81	107		97	57	117	184			25. Buttercup (Ranunculus acris)..... "	130	144			90	121			106	127	191		
							158			166			26. Yellow Pond Lilly (Nuphar advena) "	227										173		
						162				154	201	157	27. Blue-eyed Grass (Sisyrinchium) "	160	155									161	206	150
125	149		158	124		107	123	116		140		136	28. Saskatoon(Amalanchier Canadensis) "	134				130						144		140
				204	199				188	190			29. Golden Rod (Solidago) "	228				213					196	195		
		105	95	86	98		112	115	88	92	97	109	30. Wild Geese..........................	121				88					92	100		
		98	88		95				62	95			31. Wild Ducks..........................											100		
	49	122	91	62	79		66		89	108		97	32. Robins (Merula).............		74			85	115		66			110		
80	75			78		37			99	107	.	97	33. Meadow Larks (Sturnella).......		104			85					107	110		
	81	98	88	69	85	81		52					34. Blue Birds (Sialia sialis)...............		89			86	110			44		128		
		130			153					111			35. Flickers or Golden Woodpeckers (Colaptes auratus)..........................											117		
	148		89	83						36	141	108	36. Song Sparrows (Melospia fasciata).......					86						122		
81	148	127			124	85	81	84		131			37. Swallows (Clivicola riparia)............		156				150			96		134		
			88								160	135	38. Juncoes (Junco hyemalis)...............											100		
149									150				39. Orioles (Icterus galbula)................													
149						139				136			40. King Birds (Tyrannus tyrannus)..........											143		
106	102			129	180	121	91			160			41. Humming Birds (Trochilus colubris).....		123			134				102				
65	86	122		93	159	98	67	52	96	100		109	42. Frogs Piping..........................	69	90			95			67	69	106			
	80			91		79				93			43. Earth Worm Casts (frost out of ground)..		86			93								
		147	126							109			44. Lakes Open..........................													
			110	84	93								45. Rivers Open..........................													
	48		116	97	121	80			108	93	101	97	46. Ploughing..........................		83			99						110	110	110
	86		122	104	132	102		106	111	97	105	98	47. Sowing..........................		92			111				115		111	111	100
189	163	213	209	188	203	147	155	156	191	34			48. Hay Cutting..........................	201	174			195				152	202	257		
234	203			232	233	206		209	223	240	215	203	49. Grain Cutting..........................		217		215	237				227	230	247	222	205
100	125	144	122	111	148	105		46	142	130			50. Potato Planting..........................	148	146			134				108		140		

Phenological Observations, Canada, 1919

Year 1919

Date of the year corresponding to the last day of each month

January	31	July	212
February	59	August	243
March	90	September	273
April	120	October	304
May	151	November	334
June	181	December	365

When first seen

	Denholm, Sask.	Dundurn, Sask.	Eastend, Sask.	Fielding, Sask.	Forest Hall, Sask.	Fort Qu'Appelle, Sask.	Hatherleigh, Sask.	Horizon, Sask.	Indian Head, Sask.	Kinistino, Sask.	Lilac, Sask.	Maymont, Sask.	Meota, Sask.
1. Alder (Alnus incana)......Shedding pollen									138				
2. Canada Thistle (Cirsium arvense) Fl'w'rng.		191				156			179				
3. Trailing Arbutus (Epigaea repens) "													
4. Dandelion (Taraxacum officinale) "	145	133		144	148	129	154		134	125	150	136	
5. Violet, Blue(Viola palmata cucullata "	124	130	138		132	128	139	132	138	125	135	132	
6. Violet, White (Viola blanda). "		126				133			136				
7. Columbine (Aquilegia) "									165				
8. Trees appear green.....................		127	130			126			136				
9. Red Clover (Trifolium pratense) Flowering		135				157			165				
10. White Clover (Trifolium repens) "		137							159				
11. Wild Raspberry (Rubus strigosus) "		136				169			145				
12. Cultivated Currant (Ribes rubrum) "			143			138			140	146	138		
13. Wild Rose (Rosa) "	151	121		148	153	148	148	146	153	148		148	
14. Trillium (Trillium) "													
15. Anemone (Anemone) "	106	98	106	107	111	107	110	91	94	110	93	118	110
16. Maple (Acer) "						123			134				
17. Strawberry Wild (Fragaria Virginiana).. .	131	135	138	130	133	132	135		140	135	145	136	
18. Strawbery Wild (Fragaria Virginiana) Fruit ripe......................	166	181			175	155			167		167	174	
19. Crocus, Cultivated (Crocus) Flowering									140				
20. Lilac (Syringa vulgaris)......... "		144	147						142				
21. Apple (Pyrus malus)............ "			143						141				
22. Plum, Cultivated (Prunus domestica) "			142						138				
23. Cherry, Wild (Prunus).... "				135	136	138			141	100	140	139	
24. Cherry, Cultivated (Prunus cerasus) "	138												

When becoming common

	Denholm, Sask.	Dundurn, Sask.	Eastend, Sask.	Fielding, Sask.	Forest Hall, Sask.	Fort Qu'Appelle, Sask.	Hatherleigh, Sask.	Horizon, Sask.	Indian Head, Sask.	Kinistino, Sask.	Lilac, Sask.	Maymont, Sask.	Meota, Sask.
1. Alder (Alnus incana)......Shedding pollen									143				
2. Canada Thistle (Cirsium arvense) Fl'w'rng.		201				166			181				
3. Trailing Arbutus (Epigaea repens) "										135		152	
4. Dandelion (Taraxacum officinale) "	154	136				132	159		140				
5. Violet, Blue(Viola palmata cucullata "	139	135			133	132	138		144	140	151	140	
6. Violet, White (Viola blanda). "		130				138			144				
7. Columbine (Aquilegia) "									168				
8. Trees appear green.....................		132				130			141				
9. Red Clover (Trifolium pratense) Flowering		130				162			169				
10. White Clover (Trifolium repens) "		141							163				
11. Wild Raspberry (Rubus strigosus) "		140							148				
12. Cultivated Currant (Ribes rubrum) "									142		180		
13. Wild Rose (Rosa) "	164	128				155	150		157		165		
14. Trillium (Trillium) "													
15. Anemone (Anemone) "	109	102		111		118	116	120	102	115	108	122	120
16. Maple (Acer) "						132			136				
17. Strawberry Wild (Fragaria Virginiana).. .	139	140	139		135		138		142	140	135	151	
18. Strawbery Wild (Fragaria Virginiana) Fruit ripe......................	171	189							171		150	181	
19. Crocus, Cultivated (Crocus) Flowering									142				
20. Lilac (Syringa vulgaris)......... "		149							146				
21. Apple (Pyrus malus)............ "									145				
22. Plum, Cultivated (Prunus domestica) "									142				
23. Cherry, Wild (Prunus).... "	141				143	144			143				
24. Cherry, Cultivated (Prunus cerasus) "													

	129				117			140		137			25. Buttercup (Ranunculus acris)...... "		136			125		142		140	
								176					26. Yellow Pond Lilly (Nuphar advena) "							181			
157	159		164	173	158	176		171		140			27. Blue-eyed Grass (Sisyrinchium) "	157					176	177		156	
139		138	135	136	136	136		139	128	154	139		28. Saskatoon (Amalanchier Canadensis) "	139		139	139	140	140	142	135	150	151
	184				208			190					29. Golden Rod (Solidago) "							101			
115	94	90	100	97	94	121	95	110	86	100	100	105	30. Wild Geese..........................		105	92		102		116			
	94	90			97			95					31. Wild Ducks..........................		105	92		105		103			
104	124	97	107		98	107		94	90	95	93		32. Robins (Merula)...............		127	116		114		102			
91	94	91	96	127	104	106	91	93		97	93	95	33. Meadow Larks (Sturnella).......		105	93		110		97			
		83	92					147					34. Blue Birds (Sialia sialis)................			87							
		105			109			104					35. Flickers or Golden Woodpeckers (Colaptes auratus)..........................			110		115		211			
92		93	97	96	104	110		93	107			104	36. Song Sparrows (Melospiza fasciata)......			105		109		96			
					130			140					37. Swallows (Clivicola riparia)............					140		143			
94		95	105		92			92	106	114		91	38. Juncoes (Junco hyemalis)..............			104		105		96			
					143			138					39. Orioles (Icterus galbula)................							140			
105	130	139		147	145	121		144		146		139	40. King Birds (Tyrannus tyrannus).........		135	143				146			
								153					41. Humming Birds (Trochilus colubris).....										
106	103		107	106	104		93	110	98	100		107	42. Frogs Piping..........................		107			115		114			
		93						122					43. Earth Worm Casts (frost out of ground)...										
	94				111			138					44. Lakes Open..........................		102					124			
	103				108		83	102	95				45. Rivers Open..........................									94	
163	97		100	99	102	105		104	112	96		100	46. Ploughing..........................	172	104		105	105			118	100	
160	97	128	116	114	109	110		106	114	100		102	47. Sowing..........................	167	104		114	111					
	166				152			168					48. Hay Cutting..........................		176			161		173			
213	218	223	216		209	217		220	261	219		224	49. Grain Cutting..........................	218	226			213		222			
	128				137			146					50. Potato Planting........................		144								

Phenological Observations, Canada, 1919

Year 1919

Date of the year corresponding to the last day of each month

January	31	July	212
February	59	August	243
March	90	September	273
April	120	October	304
May	151	November	334
June	181	December	365

When first seen

Observation	North Battleford, Sask.	Prince, Sask.	Rabbit Lake, Sask.	Scott, Sask.	Shellbrook Sask.	Wanganui, Sask.	Almasippi, Man.	Brandon, Man.	Oak Bank, Man.	Portage la Prairie, Man.	Rapid City, Man.	Cape Croker, Ont.	Lucknow, Ont.
1. Alder (Alnus incana)......Shedding pollen									113				
2. Canada Thistle (Cirsium arvense) Fl'w'rng.				206						179	185		175
3. Trailing Arbutus (Epigaea repens) "													
4. Dandelion (Taraxacum officinale) "	125	144	130	135	139		131	125	133	109	134	117	110
5. Violet, Blue (Viola palmata cucullata "	125			131	129		136	131	133	132	131		131
6. Violet, White (Viola blanda) "							137	130		132	136		129
7. Columbine (Aquilegia) "				141						152		144	151
8. Trees appear green			131	139	129		135	130	133	127	136	133	134
9. Red Clover (Trifolium pratense) Flowering				170					165	160		139	160
10. White Clover (Trifolium repens) "	148								163	142			159
11. Wild Raspberry (Rubus strigosus) "	159									140	170		158
12. Cultivated Currant (Ribes rubrum) "	135			137						140	145	130	142
13. Wild Rose (Rosa) "	145	148	167	161	144	151	159	161	150	154	147		
14. Trillium (Trillium) "										143			122
15. Anemone (Anemone) "		108		109	98	95	129	107	108	110	106		
16. Maple (Acer) "				132				132		114			128
17. Strawberry Wild (Fragaria Virginiana)..	125	133	132	150	131	152		175		142	136		130
18. Strawberry Wild (Fragaria Virginiana) Fruit ripe	164	164	180	165	149	168			166	174	172	158	159
19. Crocus, Cultivated (Crocus) Flowering				129						128		84	94
20. Lilac (Syringa vulgaris) "	145			147				139	144	145	146		147
21. Apple (Pyrus malus) "								141		143		147	146
22. Plum, Cultivated (Prunus domestica) "				138					138	143			140
23. Cherry, Wild (Prunus)... "					140		138	139	141	139	144		135
24. Cherry, Cultivated (Prunus cerasus) "	142			150						143			130

When becoming common

Observation	North Battleford, Sask.	Prince, Sask.	Rabbit Lake, Sask.	Scott, Sask.	Shellbrook, Sask.	Wanganui, Sask.	Almasippi, Man.	Brandon, Man.	Oak Bank, Man.	Portage la Prairie, Man.	Rapid City, Man.	Cape Croker, Ont.	Lucknow, Ont.
1. Alder (Alnus incana)......Shedding pollen													
2. Canada Thistle (Cirsium arvense) Fl'w'rng.				214						119			187
3. Trailing Arbutus (Epigaea repens) "													
4. Dandelion (Taraxacum officinale) "				141	142		136	130		120		121	127
5. Violet, Blue (Viola palmata cucullata "			136	139			139			135			134
6. Violet, White (Viola blanda) "							138			132			137
7. Columbine (Aquilegia) "				187						152		152	154
8. Trees appear green			137	144	132		139	139		130			
9. Red Clover (Trifolium pratense) Flowering				175						167		155	164
10. White Clover (Trifolium repens) "										148		165	162
11. Wild Raspberry (Rubus strigosus) "										140			163
12. Cultivated Currant (Ribes rubrum) "				144						140		143	146
13. Wild Rose (Rosa) "			171	174		165	161		159	163			
14. Trillium (Trillium) "										147		132	130
15. Anemone (Anemone) "				112		105	131			110			
16. Maple (Acer) "				136				135		121			133
17. Strawberry Wild (Fragaria Virginiana)..		141	148	157		162				144		140	134
18. Strawberry Wild (Fragaria Virginiana) Fruit ripe			183			170						165	164
19. Crocus, Cultivated (Crocus) Flowering										132			
20. Lilac (Syringa vulgaris) "									147	145		158	151
21. Apple (Pyrus malus) "										143		151	149
22. Plum, Cultivated (Prunus domestica) "				141				141		143			144
23. Cherry, Wild (Prunus)... "							142			143			138
24. Cherry, Cultivated (Prunus cerasus) "				154						143			139

121			135	111		117	135		110	117			25. Buttercup (Ranunculus acris) ..... "						119			118			
													26. Yellow Pond Lilly (Nuphar advena) "												
141	165		169	141	165			156	147	156	160		27. Blue-eyed Grass (Sisyrinchium) "									150			
132	133	151	139	140	142		141	141	139	143			28. Saskatoon (Amalanchier Canadensis) "	138	153			174				142			
							196	230	196	195		206	29. Golden Rod (Solidago) "			209						213	201		220
97	95	121	94	89		95			91	89	139		30. Wild Geese		124	104			103						
106			94	89		97		110	83	102			31. Wild Ducks			106			103			144			
98	104	97	105	95		107		115	92	101	61	65	32. Robins (Merula)...............		102	115			113			104		82	
94	102	94	108	106	95	88	102	115	94	92	76	65	33. Meadow Larks (Sturnella).......		106	121			105			104		97	
110						82			96	104	76	78	34. Blue Birds (Sialia sialis)						85			140			
			124						100				35. Flickers or Golden Woodpeckers (Colaptes auratus)									123			
121	90		110			81		115	79		82	79	36. Song Sparrows (Melospiza fasciata)			121			83			124			
131									115	138	113		37. Swallows (Clivicola riparia)									121			
96	102	103	98			141			89				38. Juncoes (Junco hyemalis)		116	100			143			165			
147						141			135	138		133	39. Orioles (Icterus galbula)						143			142			
	157		144						111	145	137	127	40. King Birds (Tyrannus tyrannus).........									121		141	
												138	41. Humming Birds (Trochilus colubris)												
			105	100		104	106	101	107	103	78	79	42. Frogs Piping			106			118			114		95	85
						123	99		105				43. Earth Worm Casts (frost out of ground)...						125					98	
			94				93		108		84		44. Lakes Open												
			91			92	96		108	119	69		45. Rivers Open........................												
		98	97	105	100	104	102		105	107	97		46. Ploughing		104	200	111		107	111		111		104	98
		98	105	97	100	108	111	118	106	138	107	112	47. Sowing		104	107	104		111	120		112		112	
		197	208	205		195	175	201	177	202	176	169	48. Hay Cutting			107			199	184		204	202	184	
		220	210	216	218	196	211	227	204	211		190	49. Grain Cutting........................			120	223		209	214		211	216		
		125	109	140		136	130	132	121	130	108	126	50. Potato Planting		132	228	144		139	142		132	153		146

PHENOLOGICAL OBSERVATIONS, CANADA, 1919

YEAR, 1919

Date of the Year corresponding to the last day of each month

January	31	July	212
February	59	August	243
March	90	September	273
April	120	October	304
May	151	November	334
June	181	December	365

When first seen: Perth, Ont.	Port Dover, Ont.	Queensboro, Ont.	Toronto, Ont.	Abitibi, Que.	Lennoxville, Que.	Dalhousie, N.B.	Scotch Lake, N.B.	Year, 1919		When becoming common: Perth, Ont.	Port Dover, Ont.	Queensboro, Ont.	Toronto, Ont.	Abitibi, Que.	Lennoxville, Que.	Dalhousie, N.B.	Scotch Lake, N.B.
101	110	82	83	137	103	135	110	1. Alder (Alnus incana)	Shedding pollen	103	115	86	92			139	
	166	179	178		179		195	2. Canada Thistle (Cirsium arvense)	Flowering		171	187	181				206
	109	124	108			125	123	3. Trailing Arbutus (Epigaea repens)	"		114		120			136	
117	92	124	107	147	137	132	131	4. Dandelion (Taraxacum officinale)	"	135	94	128	129		145	135	
132	12	127	127		140	139	126	5. Violet Blue (Viola palmata cucullata)	"	132	100	130	132		143	146	
132	16	127	134		142	132	126	6. Violet, White (Viola blanda)	"	132	105	130	138		146	136	
146	156		149		140		172	7. Columbine (Aquilegia)	"	152	166		152		148		
133	139	126	134	146	139	138	132	8. Trees appear green			144	134		154		146	137
166	135	162	157		161		159	9. Red Clover (Trifolium pratense)	Flowering	167	140	165	161				
164	137	161	156	148	166	153	155	10. White Clover (Trifolium repens)	"	167	144	166	161			166	
165	185	161			145		171	11. Wild Raspberry (Rubus strigosus)	"		160	165					
139	186				142	153		12. Cultivated Currant (Ribes rubrum)	"	142	191					161	
175	156		157		162		173	13. Wild Rose (Rosa)	"	182	163		163				
128	109	126	131		126	139	127	14. Trillium (Trillium)	"	132	114	130	136		130	139	134
172	100	155	138		143			15. Anemone (Anemone)	"	174	105	157			153		
114	122	130	85			141	138	16. Maple (Acer)	"	124	127	137	97			142	138
128	125	128	140	154	140	137	131	17. Strawberry Wild (Fragaria Virginiana)	"	137		140	148		175	142	
166	163	158		179	170			18. Strawberry Wild (Fragaria Virginiana)	Fruit ripe	171		167	169		164		
106	79	110	74		106	135	123	19. Crocus, Cultivated (Crocus)	Flowering	109		112	100		109	140	
147	145	146	148		156	164		20. Lilac (Syringa vulgaris)	"	151		148	154		160	168	
145	139	145	146		145	157	147	21. Apple (Pyrus malus)	"	148		147	151		152	164	
134	123		132		143		145	22. Plum, Cultivated (Prunus domestica)	"	141	138		140		152		
142	123	146	135		143	147	148	23. Cherry Wild (Prunus)	"	152	127	147	141		152	151	
149	132		135		145	147	148	24. Cherry, Cultivated (Prunus cerasus)	"	149	145		140		152		
144	135	152	150		156	141	149	25. Buttercup (Ranunculus acris)	"	151	140	155	159		162	152	

171	169	160					183	26. Yellow Pond Lilly (Nuphar advena) .... “	182	176	163					
152	148	151			157	142	155	27. Blue-eyed Grass (Sisyrinchium) .... “	188	155	155			162		
		130						28. Saskatoon (Amalanchier Canadensis) .... “			135					
195	196	208			224		203	29. Golden Rod (Solidago) .... “	206		217			230		
88	63			109		95	122	30. Wild Geese	88	71					103	
88	74	75		105	97	94	90	31. Wild Ducks	88	84	84				102	
63		78	64	101	82	101	65	32. Robins (Merula)	80	72	78	92		100	110	87
83	74	83	77	113	114			33. Meadow Larks (Sturnella)	84	80	85	91		120		
80	74	78	77	102	79		108	34. Blue Birds (Sialia sialis)	80	79	78	95		105		
104	84	93	66	120	113	127	111	35. Flickers or Golden Woodpeckers (Colaptes auratus)	105	90	94	105		120	139	103
79	100	113	76	113	82	111	83	36. Song Sparrows (Melospiza fasciata)	84		114	100		96	119	84
104	120	109	122	113	121	136	118	37. Swallows (Clivicola riparia)	104	120	120	130		135	146	
81		83		113	91	102	83	38. Juncoes (Junco hyemalis)	81		84	95		106	103	84
121	150	132	135	123	143			39. Orioles (Icterus galbula)	132	156	134			146		
133	130	139	138		142	127	139	40. King Birds (Tyrannus tyrannus)	133	140	139	138		145	140	
135	140	140	138		144	152	139	41. Humming Birds (Trochilus colubris)		145	140			150		
102	82	96	84	129	104	130	101	42. Frogs Piping	102		98	102			139	112
86	95	102	89	139	103	115	124	43. Earth Worm Casts (frost out of ground)	86	108	110	100		110		127
106	71	93		133	112		111	44. Lakes Open			98					
84	72	79	46	121	85	109	89	45. Rivers Open								100
109		109	79		109	130	99	46. Ploughing	111		121	91			139	118
133		113	110		129	134	127	47. Sowing	146	95	128	132			147	132
182	174	177	175	201	174		195	48. Hay Cutting		181	186	179				
217		195	206		225		226	49. Grain Cutting	227	193	212			227		231
140	104	113	100		140	135	130	50. Potato Planting	142		144	120			139	135

PHENOLOGICAL OBSERVATIONS, CANADA, 1919

YEAR, 1919

Day of the year corresponding to the last day of each month

Jan.	31	July	212
Feb.	59	Aug.	243
March	90	Sept.	273
April	120	Oct.	304
May	151	Nov.	334
June	181	Dec.	365

When first seen

Species	I. Yarmouth and Digby Counties, N.S.	II. Shelburne, Lunenburg and Queens Counties, N.S.	III. Annapolis and Kings Counties, N.S.	IV. Hants and Colchester Counties, N.S.	V. Halifax and Guysboro Counties, N.S.	VIA. Cobequid Slope, N.S.	VIB. Chignecto Slope, N.S.	VII. Northumberland Sts. Slope, N.S.	VIII. Richmond and Cape Breton Counties, N.S.	IX & X. Inverness and Bras d'Or Slope, N.S.	Average Dates
1. Alder (Alnus incana, Wild)	90	90	98	100	101	107		102	109	117	101
2. Aspen (Populus tremuloides)	101	124	106	110	106	115		111	118	115	111
3. May Flower (Epigea repens, L.)	85	93	96	101	109	103		115	113	114	103
4. Field Horsetail (Equisetum arvense)	119	119	120	122	118	121		121	144	134	127
5. Blood Root (Sanguinaria Canadensis)				127	128	130		118	130		127
6. White Violet (Viola Blanda)	116	117	122	120	127	121		126	128	125	122
7. Blue Violet (Viola palmata, *cucullata*)	121	125	125	125	133	124		130	133	126	127
8. Hepatica (Hepatica triloba, etc.)	124	123	124	134	126					123	125
9. Red Maple (Acer rubrum)	113	125	127	127	123	126		129	132	133	126
10. Strawberry (Fragaria Virginiana)	120	123	121	123	128	127		127	128	129	125
11. Strawberry (Fragaria Virginiana) Fruit ripe	154	162	162	161	165	160		162	167	166	162
12. Dandelion (Taraxacum officinale)	122	124	126	125	131	130		131	134	131	128
13. Adder's Tongue (Erythronium Americanum)	118	130	138	126	127	129		126	134	137	129
14. Gold Thread (Coptis trifolia)	129	130	135	133	136	133		137	135	137	134
15. Spring Beauty (Claytonia Caroliniana)			156	123	131	122		122	136	166	136
16. Ground Ivy (Nepeta Glechoma)	142	137	138	132	137	133		145	141	131	137
17. Indian Pear (Amelanchier Canadensis)	139	136	136	135	138	142		139	146	143	139
18. Indian Pear Fruit ripe					210						210
19. Wild Red Cherry (Prunus Pennsylvanica)	139	142	142	141	142	143		142	149	148	143
20. Wild Red Cherry ((Prunus Pennsylvanica) Fruit ripe				207	218	237					220
21. Blackberry (Vaccinium Can. and Penn)	136	140	141	141	152	143		143	147	155	144
22. Blackberry (Vaccinium Can. and Penn) Fruit ripe					234			199			216
23. Tall Buttercup (Ranunculus acris)	142	144	149	148	154	151		150	153	144	148
24. Creeping Buttercup (R. Repens)	150	144	153	156	163	150		157	164	164	155
25. Painted Trillium (Trill. erythrocarpum)	142	145	141	144	145	143		147	152	152	145

When becoming common

Species	Average Dates	I. Yarmouth and Digby Counties, N.S.	II. Shelburne, Lunenburg and Queens Counties, N.S.	III. Annapolis and Kings Counties, N.S.	IV. Hants and Colchester Counties, N.S.	V. Halifax and Guysboro Counties, N.S.	VIA. Cobequid Slope, N.S.	VIB. Chignecto Slope, N.S.	VII. Northumberland Sts. Slope, N.S.	VIII. Richmond and Cape Breton Counties, N.S.	IX & X. Inverness and Bras d'Or Slope, N.S.
1. Alder (Alnus incana, Wild)	110	104	102	109	106	107	115		108	114	127
2. Aspen (Populus tremuloides)	117	119	132	114	115	113	119		117	123	119
3. May Flower (Epigea repens, L.)	115	98	104	108	109	115	138		119	120	122
4. Field Horsetail (Equisetum arvense)	128	121	128	126	130	126	122		130	135	138
5. Blood Root (Sanguinaria Canadensis)	133				132	136	135		129	135	
6. White Violet (Viola Blanda)	134	129	125	128	127	134	129		132	133	173
7. Blue Violet (Viola palmata, *cucullata*)	133	130	131	133	131	139	131		136	138	134
8. Hepatica (Hepatica triloba, etc.)	138		154	128	137	134	138				
9. Red Maple (Acer rubrum)	133	126	131	133	132	127	134		133	144	130
10. Strawberry (Fragaria Virginiana)	133	130	130	131	131	134	132		135	135	137
11. Strawberry (Fragaria Virginiana) Fruit ripe	168	168	170	170	171	172	176		172	177	141
12. Dandelion (Taraxacum officinale)	133	125	130	134	131	137	137		137	139	125
13. Adder's Tongue (Erythronium Americanum)	137		133	143	136	135	135		136	138	140
14. Gold Thread (Coptis trifolia)	139	136	136	142	135	141	135		141	140	141
15. Spring Beauty (Claytonia Caroliniana)	140		146	160	129	138	132		128	142	152
16. Ground Ivy (Nepeta Glechoma)	145	153	145	143	139	144	138		147	151	143
17. Indian Pear (Amelanchier Canadensis)	144	144	140	141	141	143	143		143	150	149
18. Indian Pear Fruit ripe	215					215					
19. Wild Red Cherry (Prunus Pennsylvanica)	146	145	136	148	146	148	147		137	152	154
20. Wild Red Cherry ((Prunus Pennsylvanica) Fruit ripe	223				209	223	237				
21. Blackberry (Vaccinium Can. and Penn)	149	146	151	146	147	156	147		147	155	149
22. Blackberry (Vaccinium Can. and Penn) Fruit ripe	221					204			203		
23. Tall Buttercup (Ranunculus acris)	156	152	149	154	157	162	149		158	161	157
24. Creeping Buttercup (R. Repens)	161	161	153	158	162	168	159		160		171
25. Painted Trillium (Trill. erythrocarpum)	150	142	150	146	150	150	151		153	167	157

142	144	146	145	149	144	148	156		147	26. Rhodora (Rhododendron Rhodora)	151	147	147	151	152	155	151	152	159	
143	147	145	149	157	146	149	150	151	148	27. Pigeon Berry (Cornus Canadensis)	154	150	156	142	155	162	150	156	156	156
						240			240	28. Pigeon Berry (Cornus Canadensis)........Fruit ripe	240							240		
143	145	148	146	141	145	151	153	147	146	29. Star Flower (Trientalis Americana)	153	153	155	154	152	147	151	156	156	157
145	161	148	153	158	152	155	156		153	30. Clintonia (Clintonia borealis)	158	151	155	153	159	161	156	162	162	161
	157	155	158		156	168	161	152	158	31. Marsh Calla (Calla palustris)	162		161	159	166		158	169	165	156
148	147	153	158	156	161	161	157	161	157	32. Lady's Slipper (Cypripedium acaule)	161	153	157	159	165	162	163	165	162	163
153	149	154	154	159	154	159	164	162	157	33. Blue-Eyed Grass (Sisyrinchium angustifol)	161	157	159	155	159	164	160	164	169	167
153	163	168	163	158	161	166	171	152	161	34. Twinflower (Linnæa borealis)	167	163	163	171	168	164	167	170	175	163
149	161	162	155	166	149	158	154	155	156	35. Pale Laurel (Kalmia glauca)	161	148	167	166	160	171	162	163	156	160
153	162	169	158	178	153	159		151	160	36. Lambkill (Kalmia augustifolia)	164	163	167	171	167		158	164		161
159	159	156	153	158	158	159	160		158	37. English Hawthorne(Cratægus oxyacantaha)	162	167	162	159	156	163	162	162	169	
156	158	154	157	159	161	159	163	164	159	38. Scarlet Fruited Thorn (Cratægus coccinea, etc.)	163	158	163	158	162	165	170	162	168	167
158	159	159	163	164	163	164	169	162	162	39. Blue Flag (Iris versicolor)	167	165	162	164	169	169	169	166	173	164
156	158	160	160	167	160	160	168	163	161	40. Ox-eye Daisy (Chrysanthemum Leucanth)	168	164	167	165	167	172	168	169	173	170
157	163	167	157	167	165	162	165	168	163	41. Yellow Pond Lilly (Nuphar advena)	169	168	167	171	165	173	171	163	169	171
156	159	162	155	164	157	156	163	149	158	42. Raspberry (Rubus strigosus)	164	165	167	167	158	171	163	160	169	160
			203	205			200		203	43. Raspberry (Rubus strigosus).............Fruit ripe	212				211	216			210	
158	167	164	170	170		160	174		166	44. Yellow Rattle (Rhinanthus Crista-galli)	171	162	167	168	174	176	179	167		
159	162	166	165	171	168	162	169	156	164	45. High Blackberry (Rubus villosus)	169	164	170	171	171	175	170	168	173	167
			210	233	245	241	247		235	46. High Blackberry (Rubus Vilosus)........Fruit ripe	240				211	246	245	246	254	
163	163	160	163	166	155	171		128	158	47. Pitcher Plant (Sarracenia purpurea)	162	168	168	163	167	173	157	171		132
164	169	165	157	171	139	178	170	166	164	48. Heal All (Brunella vulgaris)	171	172	173	164	160	177		178	176	170
175	172	172	170	174	169	170			171	49. Common Wild Rose (Rosa lucida)	174		173	176	177	179	170	173		
163	164	165	171	167	166	166	168	171	166	50. Fall Dandelion (Leontodon autumnale)	172	169	169	170	177	174	174	171	172	176
122	169	175	155	175	173	167	168		163	51. Butter and Eggs (Linaria vulgaris)	170		169	179	155	179	170	170	172	
136	134	133	132	133	140	135	139	138	135	52. Trees appear green	147	144	144	142	142	144	159	163	146	145
135	140	143	137	150	152	148	140	144	143	53. Red Currant (Ribes rubrum (cultivated)	150	142	145	149	145	152	153	150	154	150
			199			196	201		198	54. Red Currant (Ribes rubrum).............Fruit ripe	206				207			196	215	

PHENOLOGICAL OBSERVATIONS, CANADA, 1919

YEAR, 1919

Day of the year corresponding to the last day of each month

Jan.	31	July	212
Feb.	59	Aug.	243
March	90	Sept.	273
April	120	Oct.	304
May	151	Nov.	334
June	181	Dec.	365

When first seen

	I. Yarmouth and Digby Counties, N.S.	II. Shelburne, Lunenburg and Queens Counties, N.S.	III. Annapolis and Kings Counties, N.S.	IV. Hants and Colchester Counties, N.S.	V. Halifax and Guysboro Counties, N.S.	VIA. Cobequid Slope, N.S.	VIB. Chignecto Slope, N.S.	VII. Northumberland Sts. Slope, N.S.	VIII. Richmond and Cape Breton Counties, N.S.	IX & X. Inverness and Bras d'Or Slope, N.S.	Average Dates
55. Black Currant (R. nigrum) (cultivated)	137	146	138	143	145	148		147	149	144	144
56. Black Currant (R. nigrum) ... Fruit ripe				207				200	205		204
57. Cherry (Prunus Cerasus)	137	148	143	146	156	152		146	154	151	148
58. Cherry (Prunus Cerasus) ... Fruit ripe									213		213
59. Plum (Prunus domestica)	143	149	145	146	150	155		150	156	157	150
60. Apple (Pyrus Malus)	144	149	145	147	151	151		149	157	158	151
61. Lilac (Syringa vulgaris)	154	158	155	156	158	160		158	165	159	158
62. White Clover (Trifolium repens)	157	161	160	159	162	162		161	166	164	161
63. Red Clover (Trifolium pratense)	150	153	156	156	156	159		161	162	160	157
64. Timothy (Phleum pratense)	178	152	153	169		163		167	168	164	164
65. Potato (Solanum tuberosum)		177		174							170
66. Ploughing first of season	109	110	117	119	123	120		126	118	116	115
67. Sowing	133	120	133	138	132	132		135	137	134	132
68. Potato-planting	123	127	135	137	141	137		138	129	131	133
69. Sheep-shearing	129	125	131	135	135	128		136	122	134	131
70. Hay-cutting					214			213	217		214
71. Grain-cutting				246	252	246		246	246		246
72. Potato-digging				260	256	265		271	269		264
73a. Opening of rivers		79	86	78		109		86	86	99	89
73b. Opening of lakes	69		99	88		119		93	104	109	97
74a. Last snow to whiten ground	109	120	116	120	114	121		120	116	113	116
74b. Last snow to fly in air	111	123	119	121	120	120		122	123	125	120
75a. Last spring frost—hard	123	137	146	126		127		131	130	121	130
75b. Last spring frost—hoar	140	129	142	157				164	152	129	145
76a Water in streams—high	101		108	92		102		119	113	113	106

When becoming common

	Average Dates	I. Yarmouth and Digby Counties, N.S.	II. Shelburne, Lunenburg and Queens Counties, N.S.	III. Annapolis and Kings Counties, N.S.	IV. Hants and Colchester Counties, N.S.	V. Halifax and Guysboro Counties, N.S.	VIA. Cobequid Slope, N.S.	VIB. Chignecto Slope, N.S.	VII. Northumberland Sts. Slope, N.S.	VIII. Richmond and Cape Breton Counties, N.S.	IX & X. Inverness and Bras d'Or Slope, N.S.
55. Black Currant (R. nigrum) (cultivated)	150	147	153	143	148	152	153		151	158	152
56. Black Currant (R. nigrum) ... Fruit ripe	209				210				200	219	
57. Cherry (Prunus Cerasus)	153	143	152	148	152	161	157		150	159	158
58. Cherry (Prunus Cerasus) ... Fruit ripe	213									213	
59. Plum (Prunus domestica)	156	149	156	149	153	158	161		154	163	164
60. Apple (Pyrus Malus)	156	152	155	152	153	156	158		154	161	163
61. Lilac (Syringa vulgaris)	163	161	164	159	161	164	158		162	168	170
62. White Clover (Trifolium repens)	167	164	168	165	165	168	169		167	169	171
63. Red Clover (Trifolium pratense)	166	162		162	163	163	168		167	171	169
64. Timothy (Phleum pratense)	167		160	161	170	173	167		171	168	168
65. Potato (Solanum tuberosum)	179				178					181	
66. Ploughing first of season	128	114	134	130	129	130	126		134	126	130
67. Sowing	139	139	127	141	145	138	139		146	135	142
68. Potato-planting	142	130	133	146	148	146	146		149	142	142
69. Sheep-shearing	137	139	132	139	142	143	131		148	137	126
70. Hay-cutting	219					216			218	225	
71. Grain-cutting	253				251	256	252		251	257	
72. Potato-digging	271				271	257	273		275	281	
73a. Opening of rivers											
73b. Opening of lakes											
74a. Last snow to whiten ground											
74b. Last snow to fly in air											
75a. Last spring frost—hard											
75b. Last spring frost—hoar											
76a Water in streams—high											

											76b. Water in streams—low
			258	255	270		268	264		263	77a. First autumn frost—hoar
			304	276	295		287	288		290	77b. First autumn frost—hard
			302	281	291		289	281		290	78a. First snow to fly in air
			304	324	318		318	316		316	78b. First snow to whiten ground
			336	339			330	335		335	79a. Closing of lakes
			345	335			349	358		346	79b. Closing of rivers
94	92	99	87	70	85		75	93	93	87	81a. Wild ducks migrating, N.
			300	272			307			259	81b. Wild ducks migrating, S.
86	81	99	79	77	79		80	90	85	84	82a. Wild geese migrating, N.
			313	272			312	228		303	82b. Wild geese migrating, S.
79	104	96	88	85	92		91	93	98	92	83. Song Sparrow (Melospiza fasciata) ..... North
86	79	75	76	100	76		85	95	82	84	84. Robin (Turdus migratorius) ..... "
83	83	92	90		106		90	92		90	85. Junco (Junco hiemalis) ..... "
127	128	118	121	125	122		134	137	74	120	86. Spotted Sandpiper (Actitis macularia) ..... "
	104	132	125				135		99	119	87. Meadow Lark (Sturnela magna) ..... "
131	128	118	121	125	122		134	137	74	122	88. Kingfisher (Ceryle Alcyon) ..... "
123		124	126	123	132		131	132		127	89. Myrtle Warbler (Dendroeca coronata) ..... "
126	131	138	135	136	142		141	143	152	138	90. Yellow Warbler (D. æstiva) ..... "
119		108	120	130	145		118	135	147	128	91. White-throated Warbler (Zonotrichia alba) ..... "
141	145	147	147	144	144		147	142	155	145	92. Hummingbird (Trochilus colubris) ..... "
129	150	134	136	138	152		138	151	158	143	93. Kingbird (Tyrannus Carolinensis ..... "
139		139	123	143	136		139	147		138	94. Bobolink (Dolychonyx oryzivorous ..... "
143		144	139	147			141	143		142	95. American Goldfinch) (Spinis tristis) ..... "
102		155	149	145			152	145		141	96. American Redstart (Setophaga ruticilla) ..... "
127	100		150	149	166		153	134	103	135	97. Cedar Waxwing (Ampelis cedrorum) ..... "
91	129	136	141	129	139		134	136	130	129	98. Night Hawk (Chordeiles Virginianus) ..... "
86	89	100	98	101	101		101	109	104	98	99. First piping of frogs ..... "
90	102	110	112	114	122		121	116	108	110	100. First appearance, snakes

Mémoires de la Société Royale du Canada

SECTION I

SÉRIE III MAI, 1920 VOL. XIV

Troupes du Canada 1670-1687.

Par M. BENJAMIN SULTE, M.S.R.C.

(Lu à la réunion de mai 1920.)

La population de la colonie, jusqu'à 1680, n'était composée que de cultivateurs sans aucun élément militaire, mais les maraudes des Iroquois avaient aguerri tous les individus et il en était résulté une forme de milice assez régulière qui se dessine à partir de 1649 puis se constitue encore mieux vers 1664, 1665, sous la direction de Jacques Leneuf de la Poterie, gouverneur par intérim. De 1665 à 1669 nous avons eu le régiment de Carignan et, après son départ, la milice redevint la seule défense du pays. Les Canadiens de marque tels que Boucher, Juchereau, Lemoine, Leneuf, Bellestre, Lotbinière, Denis avaient toute confiance dans l'esprit martial des habitants, qui en étaient à la seconde génération et s'étaient habitués à faire face au incursions de l'ennemi. On fait de meilleurs soldats avec des bons cultivateurs qu'on ne fait des cultivateurs avec des soldats. Cette vérité paraissait évidente à l'intendant Talon, au gouverneur Courcelles, aux chefs canadiens, et par suite à Colbert, ministre des colonies. En 1670, le retrait du régiment royal ramenait l'attention des autorités sur la milice. Nous n'avions que six milles âmes de population établie en Canada, mais c'était une force de mille combattants presque suffisante pour contenir les Iroquois si on l'organisait, en lui donnant un caractère de permanence. Le roi écrivit qu'il avait besoin de toutes ses troupes pour la guerre de Hollande et que les Canadiens devaient pouvoir se protéger eux-mêmes. Ceci tranchait la question.

Une ou deux compagnies de réguliers se formèrent en 1670 comprenant des volontaires de Carignan autorisés à rester ici, des soldats engagés en France, des Canadiens que leur goût portaient à s'enrôler dans un corps actif. Il arriva d'autres escouades en 1671, de sorte que l'on peut compter trois compagnies vers 1672 pour la garde des dépôts de marchandises et des pelleteries dans les postes de Tadoussac, Québec, Trois-Rivières, Montréal, Sorel et Chambly.

Ces troupes "régulières" devaient fournir les garnisons tandis que la milice s'exercerait à domicile pour être prête en temps de guerre.

Louvois, ministre directeur des armées, refusait de s'occuper du Canada. On connait sa jalousie à l'égard de Colbert. Celui-ci résolut de créer un système militaire en Canada, aux frais du trésor des colonies, sans utiliser les "troupes de la marine" qui étaient sous sa direction. Il recruterait en France, on en ferait autant parmi nous, et la solde, l'armement, les habits seraient payés par Colbert et non pas Louvois. Les compagnies de 1670, 1671, étaient ainsi placées sous ce nouveau régime. J'observe que l'infanterie royale de France reçut pour la première fois des uniformes en 1670, mais il est douteux que les soldats de Colbert au Canada aient participé à ce changement. Le costume ordinaire des gens du peuple a dû continuer à servir dans ces "compagnies franches," c'est-à-dire indépendantes de tout régiment ou brigade de France.

Les arrangements faits avec les Iroquois en 1670 leur accordait la rivière Ottawa comme territoire de chasse, une concession énorme qui a lieu de nous surprendre. Dès l'année précédante ces Sauvages avaient formé aux environs de Kingston et Toronto aujourd'hui plusieurs bourgades dans l'intention évidente de s'emparer de la chasse du haut Canada et de vendre leurs pelleteries aux Anglais, Hollandais, etc., des bords de l'Atlantique. Depuis 1648 les Français ne retiraient aucune fourrure du haut Canada.

M. de Courcelles voulut reprendre possession en 1671 et, dans ce but, il leva, de sa propre autorité, un certain nombre de miliciens qui l'accompagnèrent à la baie de Kenté, sur le côté ouest du lac Ontario, pour faire voir aux Iroquois que la route du Saint-Laurent, malgré ses rapides et sa longueur, n'était pas un obstacle à rebuter les troupes. La corvée, ainsi appelée par les Canadiens, ne plaisait guère à ceux-ci—on y voyait trop le seul intérêt des marchands de pelleteries. Mobiliser en pleine saison d'été huit cents hommes, sans paie ni compensation, ne plaisait à personne, mais il fallait obéir en ayant l'air de croire que c'était un bon moyen pour former la milice à la vie militaire.

Le comte de Frontenac, arrivant l'automne de 1672 pour remplacer Courcelles, eut vite pris son parti sur l'ensemble des affaires, avec le conseil des gens qui s'y connaissaient, mais il rencontra le blâme du roi et nous allons voir comment il sortit de l'impasse en complétant l'organisation de la milice.

Les influences qui avaient fait nommer d'Aillebout gouverneur général en 1648 introduisaient l'élément de Montréal dans la direction de la colonie et pour la première fois (1648) on forma un conseil. Ce dernier demanda à chaque localité d'élire un syndic ou représentant pour s'entendre avec lui. Jusqu'à 1663 ce mode d'administration prévalut. Anne d'Autriche et Mazarin ne paraissait pas en avoir eu connaissance, peut-être qu'ils n'y attachèrent nulle portée—le royaume étant dans un état d'anarchie leur attention s'écartait aisément de ce qui se passait en Canada. Dès 1660, cependant, les syndics cessent d'être mentionnés. Etaient-ils abolis? En ce moment, la guerre de Trente Ans finissait; la France en sortait avec tous les avantages; la discorde civile était étouffée. Trois ans plus tard le jeune Louis XIV aidé de Colbert imposait à la colonie un conseil nommé par la couronne et composé uniquement de citoyens de Québec, sans aucun syndic. C'était un corps de marchands de fourrures et le principe de sa formation consistait à faire de tout le pays un comptoir de traite. Frontenac vit de suite que l'administration était toute d'un seul côté. Il dit aux habitants de se réunir en assemblée, chez eux, d'élire des maires, des syndics, afin de pouvoir se renseigner sur les besoins locaux et sur les choses du gouvernement en général, mais le roi fit gronder le tonnerre: "Qu'est-ce que cela! je ne sais à quoi vous pensez; il ne faut admettre personne à parler pour les autres." Outre le fait bien connu que Louis XIV ne souffrait point de représentation nationale, on doit supposer que le conseil de Québec s'était plaint à Colbert de l'innovation de Frontenac, aussi pour compléter la rebuffade l'intendant Duchesneau arriva de France muni de pouvoirs qui annulaient en bonne partie l'autorité du gouverneur, attendu que ce nouveau fonctionnaire avait dans ses attributions la justice, les finances, le commerce, la voirie. Le gouverneur restait avec le titre militaire pour tout partage. Fort heureusement c'était un homme du métier et il le fit voir. Assisté probablement de l'expérience des Canadiens notables, il imagina un système simple et très efficace pour faire de tous les habitants des miliciens pratiques. L'Europe n'avait rien de pareil. Sous un capitaine (habitant) de paroisse, tout garçon ou père de famille en âge et en état de porter un fusil devenait milicien, s'exerçait chez lui au tir et à la connaissance de la discipline, du maniement des armes jusqu'à la formation de l'escouade et même de la compagnie, sans solde ni uniforme. Appelés au service actif, ces écoliers instruits faisaient de bons soldats, selon le genre de guerre que nous avions à employer le plus. C'était de l'infanterie légère propre aux marches, aux embuscades, reconnaissances, tir à volonté, chasse dans les bois, pêche pour se nourrir, campant partout avec adresse, se débrouillant sans le secours des grands chefs et pouvant se grouper ou se disperser de cent manières en très peu d'instants. Les troupes royales n'entendaient rien à tout cela. Il va sans dire que nous n'avions besoin ni d'artillerie ni de cavalerie dans une contrée toute en forêt et dépourvue de routes, mais remplie de rivières et de lacs, de plus couverte de neige durant cinq mois de l'année.

Ce qui est curieux c'est que Frontenac investit les capitaines de paroisse de fonctions diverses au point d'en faire de véritables représentants du peuple tout en leur conservant les apparences d'employés de la couronne. Ils devinrent huissiers, assistants du grand-voyer, inspecteurs, etc. Toutes les communications du gouvernement leur étaient adressées et ils les promulguaient. La plupart des procès nécessitaient leur intervention. Les juges recevaient par eux les instructions d'en haut. Les seigneurs n'étaient rien auprès d'un capitaine de milieu qui agissait comme l'organe des habitants et correspondait directement avec le pouvoir. Par sa situation envers le gouverneur et l'intendant le capitaine de milice prenait une importance qui peut se comparer à nos membres du parlement. Les gens de justice, les gouverneurs locaux, les chefs de poste devaient s'entendre avec ce fonctionnaire non rétribué, homme d'honneur, toujours populaire, cumulant les charges, n'en ayant jamais trop et se considérant très bien payé par les égards qu'on lui témoignait. C'était le maire, le syndic, le coroner, le connétable, le surveillant général, le directeur de ceci et cela, le bureau de renseignement, en un mot l'intermédiaire entre les colons, les tribunaux, les seigneurs, les marchands, le gouvernement. Si un évènement a lieu dans la paroisse ou sur la côte le capitaine de milice fait l'enquête et fournit le rapport officiel. S'agit-il d'un chemin à ouvrir ou à réparer, d'un pont ou d'un arpentage, le grand-voyer ou l'arpenteur se concertent avec le capitaine. Le curé, le missionnaire s'entendent avec lui pour toute action publique. Les autorités, hautes, moyennes et basses vont à lui. Il est de toutes les démarches et l'intendant lui confie beaucoup plus de besogne que le gouverneur général, en raison des devoirs plus nombreux qu'il a à remplir.

Sous cette forme déguisée Frontenac avait rétabli le syndicat et même quelque chose de mieux. Le roi ne s'en aperçut nullement, et laissa faire d'autant plus que cela ne coûtait rien. Le système dura dans toute sa force jusqu'à 1760 après quoi il dépérit lentement, pièce par pièce et vers 1800 il ne restait que le capitaine, très respecté mais n'exerçant que peu ou point de fonction publique.

En présence de la mauvaise volonté de Louvois, Colbert avait créé les compagnies franches du Canada. Devant l'absolutisme du roi, Frontenac inventa le capitaine de paroisse.

Dans les localités ou le nombre des habitants était moindre, ces petits groupes dispersés de miliciens étaient sous un capitaine de la côte (bord du fleuve ou d'une rivière) et de ses lieutenants, en attendant que chaque endroit fut devenu paroisse.

Dès 1675 on peut dire que nous avions deux régimes militaires se soutenant l'un l'autre: les corps de réguliers, puis toute la population mâle comme milice. Ce qui visiblement fit accepter partout l'organisation de la milice était la crainte des Iroquois.

Les coureurs de bois existaient depuis l'origine de la colonie pour répondre aux demandes des marchands de fourrures et c'était un emploi légitime, sauf que, bien souvent, il enlevait des bras à l'agriculture et inspirait à la jeunesse le goût du vagabondage, néanmoins, les fils d'habitant y gagnaient de quoi faciliter leur établissement sur les terres des bords du fleuve et ces courses n'étaient pas devenues répréhensibles avant 1670, mais alors trois ou quatre cents soldats de Carignan, licenciés sous prétexte de devenir colons, s'échappèrent dans les bois et devinrent un fléau parce que leurs chefs faisaient un commerce illicite avec les Anglais du fleuve Hudson ou les Iroquois et en même temps semaient la débauche parmi les Sauvages de près ou de loin. Le Haut Canada était entre leurs mains y compris le territoire de l'Ottawa, et même les régions de l'ouest jusqu'au lac Michigan et le fond du lac Supérieur. Ajoutons à ces bandes presque autant de Canadiens entraînés par l'exemple et l'on ne sera pas étonné des ordonnances qui condamnent tous ces maraudeurs avec une très grande sévérité.

Frontenac n'eut rien de plus pressé que d'écrire pour demander des soldats afin de reprendre au moins la lisière du lac Ontario et l'ancien pays des Hurons. La guerre de Hollande absorbait toutes les ressources de la France et il subit un refus. Se tournant vers la milice il prépara une expédition semblable à celle de son prédécesseur en 1671, n'hésitant pas à faire servir les cultivateurs pour assurer la traite de quelques marchands aux abois. Ces marchands payaient au trésor une somme annuelle convenue et par là jouissaient du monopole du commerce. On voit le tableau. Il est juste de dire que cet argent défrayait la défense du Canada et que, d'autre part, les colons n'étaient taxés que sur les marchandises importées de France. Alors, le service militaire, sans solde, équivalait à un impôt qui portait sur un certain nombre d'habitants.

L'été de 1673 une brigade de miliciens se rendit donc à Cataracoui, érigea un fort en ce lieu, tout en maugréant d'importance, y laissa une garnison probablement composée de soldats des compagnies régulières et de volontaires canadiens, puis rentra dans ses foyers ayant prouvé une fois de plus que les cultivateurs sont aptes à tous les métiers: soldats, constructeurs, chasseurs, caravaniers (si le mot convient ici) et en tout cas "voyageurs" par excellence. Les officiers de cette milice étaient Canadiens: eux seuls pouvaient agir en cette qualité.

Notons que, en 1674, il est fait mention des gardes de Frontenac appelées carabiniers. L'un des officiers était Pierre Godefroy de

Roquetaillade, né en Canada. Par la suite on voit trois de ses frères officiers des troupes de la colonie et cinq ou six autres de cette famille, après 1700, se rencontrent portant divers grades, à part leurs parents officiers de milice.

En 1673 le major Prevost, du régiment de Carignan, qui avaient été sergent-major en 1669, commandait la garnison de Québec.

Tarieu de Lanaudière, du régiment de Carignan, était enseigne des troupes en 1672. Ses descendants l'ont imité.

Sidrac Dugué, aussi de Carignan, était à Cataracoui en 1673.

Jacques Bizard paraît être venu avec Frontenac comme aide-de-camp, puis il devint lieutenant dans les gardes de ce gouverneur. Je suppose que ces gardes ne dépassaient guère une trentaine de soldats. Bizard épousa en 1678 Jeanne-Cécile Closse, née à Montréal.

C'est en 1672 il semble que l'on doit placer l'arrivée de Henri de Tonty. Ce personnage fut plutôt un coureur de bois, mais il était militaire et ami de Frontenac qui lui donna un grade dans les troupes.

Daniel Greysolon Duluth, aussi arrivée en 1672, eut la même carrière que Tonty.

Michel Leneuf de la Poterie dit plus tard de la Vallière, né en Canada, avait été envoyé en Acadie dès 1664 ou 1665. Il s'y maria, revint en Canada, retourna en Acadie. En 1671 il était officier dans l'expédition de Cataracoui. En 1672 il est au Cap Breton. En 1673 on lui concède la seigneurie d'Yamaska, puis en 1676 la seigneurie de Beaubassin en Acadie. Sa carrière a été longue. A partir de 1665 il a toujours été militaire et ses fils pareillement.

Jacques Passard de la Bretonnière était commandant à la rivière du Loup (en haut) vers 1674. Il épousa une Canadienne et ce ménage habita toujours la même seigneurie. En 1684 on le voit officier de milice à la guerre au lac Ontario. Laissa deux filles mariées.

Jean-Baptiste Montgaudon de Bellefontaine brigadier des gardes de Frontenac en 1674, reparait en 1683 et 1686. A cette dernière date il commandait aux Illinois.

Pierre Lemoine (plus tard d'Iberville) né à Montréal, fut nommé garde-marine (aspirant) à l'âge de quatorze ans, en 1675, et partit pour la France.

Pierre de Saint-Ours, du régiment de Carignan, commandait toutes les milices en 1673.

François Berthelot, qui ne vint jamais au Canada, était quelque chose comme grand-magasinier de l'artillerie. Son délégué à Québec était Christophe Martin de Boiscorneau "commissaire des poudres." C'est donc lui qui fournissait des cartouches et des fusils au Canada. On le retrouve ici jusqu'à 1680.

Frontenac constatait en 1675 que, parmi les habitants, il y avait douze cents fusils, et je doute fort que les hommes en état de porter les armes dépassassent quinze cents à cette date. Tous les colons faisaient la chasse au bout de leurs terres; de plus on se souvenait des Iroquois.

Je ne sais si je me trompe, mais il me semble que nos milices avaient adopté de bonne heure certaines pièces d'uniforme puisque, en 1665, on mentionne les capots bleus de Montréal. J'ai vu aussi les tuques blanches de Québec, les tuques rouges des Trois-Rivières citées par occasion. C'est une question à éclaircir. Ces couleurs n'ont pas dû être ordonnées; elles ont surgies au hazard, mais tout militaire sait que le seul uniforme dont on ne saurait se passer pour reconnaître un régiment ou un corps quelconque est la coiffure.

La population ayant atteint en 1680 le chiffre de dix mille âmes on s'aperçut que le nombre des armes-à-feu ne correspondait plus à celui des miliciens. Le roi annonça qu'il allait envoyer quelques centaines de fusils (et même des épées) pour être vendus au prix coûtant par les capitaines des côtes. Le prix coûtant signifiait que, à la guerre, le milicien fournirait son fusil. En temps de paix il s'en servait pour la chasse.

Le relevé officiel de 1681 donne ce qui suit:

	Fusils	Pistolets	Ménages
Montréal	185	1	216
Lachine	91	6	
Laprairie	30	3	28
Longueuil	15	..	10
Ile Ste-Thérèse	8	4	9
Tremblay	1	..	4
Boucherville	27	6	30
Varennes	20	..	15
Verchères	15	..	11
Contrecœur	17	..	12
Saint-Ours	16	..	14
Chambly	21	..	12
Sorel	26	..	20
Villemur	9	..	18
D'Autray	7	..	
Lavaltrie	12	12	
Repentigny	35	..	22
Lachesnaye	17	..	14
Ile Jésus	7	..	4
Québec	204	35	188
Monceaux	18	..	7

	Fusils	Pistolets	Ménages
Gaudarville	13	..	16
De Maure	21	..	34
Neuville	50	..	63
Ecureuils	4	..	
Portneuf	8	6	7
Chavigny	3	..	
St. Charles des Roches	11	..	12
Sainte-Anne	26	..	4
Lotbinière	11	..	8
Villieu	2	..	3
Lauson	51	1	43
Cap Saint-Claude	2	..	5
Beaumont	10	2	9
La Durantaye	7	..	12
Bellechasse	64	..	34
La Bouteillerie	31	..	11
Ile-aux-Oies	8	..	5
Beaupré	145	7	110
Beauport	31	3	43
Bourg Royal	8	..	15
Village St-Claude	..	..	4
Charlesbourg	9	2	15
Village St-Joseph	5	..	8
Village St-Bernard	6	..	9
Petite Auvergne	48	2	60
Côte St-Michel	19	1	19
Ile d'Orléans	39	..	173
Batiscan	45	..	48
Champlain	44	13	41
Fief Hertel	4	..	8
Prairie Marsolet	3	..	
Cap la Madeleine	43	7	38
Trois-Rivières	31	..	26
Rivière-du-Loup	6	..	5
Nicolet	..	..	6
Lintot	..	..	11
St-François	..	..	7
Gouvernement de Montréal	550	32	429
Gouvernement de Québec	854	60	917
Gouvernement de Trois-Rivières	176	20	191
	1580	112	1537

Le recensement de la même année dépasse ces chiffres—il donne 1,840 fusils et 159 pistolets. On y voit aussi que la garnison de Québec était composée de vingt et un hommes commandés par un sergent. Trois-Rivières, Chambly et Montréal devaient en avoir davantage à cause du commerce des pelleteries qui attirait beaucoup de monde dans ces endroits. La garnison de Montréal était, dit-on d'autre part, seulement de six personnes. Cataracoui devait avoir une cinquantaine de soldats réguliers.

Après une douzaine d'années de repos nous allions avoir la guerre. Les Iroquois se tenaient tranquille à cause de notre organisation de milice pourtant bien faible mais suffisante pour leur en imposer. Ils commerçaient avec les Anglais et ravagaient les nations qui tentaient d'attirer les Français chez elles. Ils s'étaient augmentés en nombre d'une manière étonnante et se montraient plus arrogants que par le passé. Un homme habile à la tête de la colonie française pouvait les contenir et empêcher toute rupture mais Frontenac partait et La Barre venait pour tout gâter. Ce nouveau gouverneur s'associa à quatre ou cinq ramasseurs de pelleteries qui allaient en fraude aux Illinois et dont les Iroquois pillèrent les canots, se basant sur l'interprétation des règlements du Conseil Supérieur de Québec et il y a bien de l'apparence que ces Sauvages étaient dans leur droit ou du moins qu'il profitaient adroitement du doute que la loi laissait subsister à l'égard des privilèges de traite.

La Barre écrivit à Versailles demandant des troupes et disant bien fort que les Iroquois étaient plus menaçants que jamais. Au fond, il voulait se venger.

Les deux ou trois compagnies du Canada étaient insuffisante en présence des hostilités que le gouverneur provoquait par sa conduite envers les Iroquois.

En l'absence de tout renseignement sur les officiers et la composition de la petite troupe de la colonie, on glane un nom de place en place dans nos archives. Ainsi, Prevost était toujours major de Québec; en 1677 on mentionne les majors de Montréal et Trois-Rivières. Un nommé Jean Deleau sieur de la Motte commandait à Chambly. Louis Tayon sieur de Lussigny, beau-frère de Duluth, était dans les gardes de Frontenac. Le fameux Laforest qui suivait La Salle et qui peut-être, dès 1676, avait un grade militaire, parcourait le pays des Illinois. Michel Leneuf de la Vallière était commandant en Acadie où il fut remplacé par Perrot en 1684 et alors il devint capitaine des gardes à Québec. Notre Pierre Lemoine revenant de France en 1683 fut chargé d'y retourner avec les dépêches de La Barre qui le recommanda pour le grade d'enseigne de vaisseau. Vers cette date on commence à voir paraître les six garçons (nés en Canada) qui portèrent les noms de Robineau, Bécancour, Neuvillette, Villebon, Meneval, Portneuf, tous frères et excellents officiers. Avec La Barre était arrivé le chevalier comte de Baugis qu'on voit très en faveur jusqu'à 1689.

Le 5 avril 1683 le roi faisait écrire à La Barre qu'il lui enverrait deux cents soldats et des armes. Pierre Lemoine était probablement porteur de la lettre. Jusqu'à cette date notre Canadien s'appelait Pierre Lemoine tout court et par la suite on le nommait sieur d'Iberville. Dans les bureaux de la marine, à Versailles, il y avait un fonctionnaire de marque du nom de d'Iberville. Ne serait-ce pas de lui que notre jeune homme emprunta ce nom qu'il devait illustrer par ses combats et ses navigations?

En novembre 1683 arrivèrent à Québec trois compagnies de volontaires avec les officiers suivants:

Remy de Gillouet sieur Dorvillier, capitaine, qu'on retrouve en 1684 commandant à Cataracoui et par la suite dans les guerres des frontières.

Deux frères ayant le grade de capitaine. Antoine de Crissassy, marquis, et Thomas, le chevalier, ce qui veut dire le cadet, gens de mérite apparentés aux familles princières de Grimaldi et Monaco, qui s'étaient réfugiés en France à la suite des révolutions de Sicile.

Le capitaine Mouet de la Juge, les lieutenants Basile, de la Roevic et de Bellecourt. Aucun des quatre ne se retrouve par la suite.

Le chevalier d'Hosta. Il servit jusqu'en 1691 où il fut tué.

Jacques-François Chevalier, sieur de Bourchemin, enseigne qui épousa quatre ans plus tard Elisabeth Dizy, Canadienne, de la paroisse de Champlain. Il était lieutenant en Acadie en 1695 et y fut tué l'année suivante. Sa fille hérita de la concession qu'il avait reçue à la rivière Yamaska: fief Bourchemin.

Le chevalier Aubéry devait être capitaine d'une compagnie puisque le 2 janvier 1884 le roi la lui enlève et la donne à un officier du nom de Massé que je ne connais point d'ailleurs, puis, le 25 avril 1685 il fait notifier Aubéry d'avoir à rentrer en France.

Dutast était lieutenant de la marine royale et, pour la durée de son emploi au Canada, capitaine d'infanterie réformé, c'est-à-dire que les troupes de la marine n'ayant pas la colonie dans leur attribution, son grade de lieutenant ne lui servait à rien dans ce pays et on lui avait donné le rang de capitaine sans compagnie pour justifier les services qu'il allait remplir. Lahontan et lui partirent de Montréal le 23 juin 1684 et arrivèrent à Cataracoui le 13 juillet, où Dutast fit une inspection et ordonna des réparations considérables, car La Salle, toujours en courses, avait négligé la place.

Louis-Armand de Lom d'Arce, né le 9 juin 1666, au château du village Lahontan, landes de Gascogne, sur les confins du Béaru et des pays basques, perdit son père en 1674 et dès lors devint le baron de Lahontan, un nom qu'il a rendu célèbre par ses écrits. Tout jeune, on lui donna une lieutenance au régiment de Bourbon, puis il passa garde-marine ou aspirant dans la flotte royale. C'est alors qu'il vint dans la Nouvelle-France avec son chef Dutast. En 1685 il est à Boucherville; 1687 au lac Ontario et Niagara; 1688 à Michillimakinac; 1689 à Québec où nous le retrouverons.

A peine débarqué Lahontan écrivait de Québec, le 8 novembre 1683 que La Barre avait demandé sept ou huit cents hommes par une lettre envoyée en France dont était porteur un nommé Maheu (Canadien ?) mais que le roi ne lui accorda que" trois compagnies de marine." Il ajoute que, durant la traversée, un capitaine et plusieurs soldats moururent du scorbut.

L'expression: "de marine" doit se lire, à mon sens: "infanterie de marine" ce qui ne veut pas dire des marins. M. Tricoche, du ministère de la marine et colonie, auteur d'un ouvrage soigné sur ce sujet, m'assure qu'il n'y a pas de trace d'envoi de troupes au Canada et que par conséquent si des hommes de l'infanterie de marine ont formé des compagnies ou des escouades pour cette colonie c'est à titre de volontaires sortant du service royale ou en étant déjà libérés. En tout cas, dit-il, votre "détachement de la marine" était un corps colonial, ce qui signifie, non pas détaché d'un régiment français mais recruté uniquement pour servir dans la colonie. Cette troupe était bien en principe composée d'officiers et hommes de la mère-patrie "mais la proportion des Canadiens dans ses rangs avait fini par être considérable." Plus le temps marcha, à partir de 1683, plus il y eut de Canadiens dans la troupe en question et vers la fin du régime français la très grande majorité y était canadienne. M. Tricoche dit encore: "Les individus qui entraient dans cette branche du service ne le faisaient qu'avec l'intention de s'établir par la suite comme colons au Canada." Cela est vrai mais un bon nombre retournèrent en France.

Ces militaires n'ont pas fondé le Canada, comme on le dit généralement. Ils sont arrivés trop tard et pas assez nombreux pour que leur apport ait donné un élan au pays. Le type du cultivateur qui dominait depuis 1634 est resté solide et il a absorbé aisément ces nouveaux venus.

Le 2 janvier 1684 le roi donne à Massé la compagnie du chevalier Aubéry au Canada. Qui était Massé ?

Il est à supposer que des plaintes contre La Barre étaient parties des conseillers de Québec et autres sources pour informer Colbert de ce qui se passait et la conduite que ce gouverneur avait tenue aux Antilles ne le recommandait nullement. En février 1684 le roi décida son rappel, mais comme la guerre menaçait sur l'Ontario, il alla au plus pressé en recrutant de nouvelles compagnies dont Montortier, l'un des capitaines, fut muni de pouvoirs très amples ou droit de *veto* sur les actes de La Barre, en attendant l'envoi d'un successeur à celui-ci. Le 11 juillet, Colbert annonce que trois cents soldats s'embarquent sur l'*Emérillon*. En ce moment La Barre, avec les réguliers et la milice, faisait une campagne pitoyable aux environs de Cataracoui. Le résultat en fut signalé à Versailles dès la fin de l'automne.

Dans cette expédition qui attira seulement le mépris des Iroquois, on voyait en fait d'officiers canadiens J.-B. Crevier Duvernay, Jean-Amador Godefroy, Beauvais et Montplaisir, lieutenants de milice. La famille Le Gardeur commença à fournir des officiers dont le nombre s'est élevé à une douzaine par la suite; on les trouve sous les noms de Repentigny, Courtemanche, Croisille, Saint-Pierre, Beauvais, Tilly, Montesson, Le Gardeur.

Duguay, Bécard, La Durantaye, tous trois du régiment de Carignan, figurent dans les troupes. Leurs fils ont continué dans la carrière des armes durant un demi siècle.

Villebon, né en Canada, était major de brigade. La Bretonnière déjà mentionné, marié en Canada, était lieutenant.

Il est visible que les Canadiens faisaient leur bonne part du service, tant avec les réguliers que sous forme de miliciens.

Gabriel Lambert dit Dumont, appelé aussi le sieur de Blaignac, né en Canada, était officier à la date où nous sommes.

Il faut compter, dans la milice, la classe des "voyageurs" ou bateliers, si utile en raison des nombreux cours d'eau du pays. Sans eux, les marches devenaient souvent impossibles. Leur étonnante adresse dans ces sortes d'exercices mérite une mention spéciale et, quoiqu'ils fussent généralement payés pour leurs peines, on doit les reconnaître comme un facteur important dans ces expéditions où le Canadien seul était capable de réussir.

Tournons-nous du côté des renforts annoncés. Le 1er mars 1684 le roi décide que le chevalier d'Autresy aura une compagnie au Canada puis, le 6 juin, il révoque cet ordre, et le 7 août, dit que le sieur Audifredy (est-ce le même ?) commandera une compagnie partant pour le Canada, à la place du chevalier d'Osmont. Ces troupes, embarquées le 13 août, formaient cinq compagnies de soixante hommes. Montortier en était, mais M. de Callière qui venait remplacer Perrot à Montréal avait la haute direction. Vers la fin de septembre les navires arrivaient à Québec.

Voici quelques notes sur les officiers de cette date qui me sont connus:

J.-B. Celoron de Blainville, lieutenant; se maria avec une Canadienne, servit longtemps et ses fils continuèrent sa tradition jusqu'à 1760.

Le capitaine François-Claude Fleutelot seigneur d'Autrée marquis de Romprey.

Charles-Paul Marin, enseigne de marine, capitaine en Canada. Il se maria avec une Canadienne. Excellent officier comme le furent aussi ses deux garçons, Pierre-Paul et Louis-Hector.

Deux officiers du nom de Des Cloches, Louis et Pierre-Guillon, se rencontrent de 1684 à 1692 et on voit que le 1er mars 1693 le roi nomme Maupeou à la place du capitaine Pierre-Guillon des Clochés, inhumé à Montréal un an auparavant.

Le lieutenant Alexandre-Joseph de l'Estringuant, sieur de Saint-Martin, était encore dans ce grade en 1688 lorsque Louis XIV le nomma lieutenant de roi, une sorte de doublure du gouverneur et de commandant des postes, ou un suppléant si l'on aime mieux l'expression. Il ne faut pas dire de ce fonctionnaire "lieutenant du roi," car le lieutenant du roi est le gouverneur même. Les juges aussi étaient appelés lieutenants du roi.

La Robayre, capitaine sans compagnie, est blessé à Lachine en septembre 1689, pris par les Iroquois en cette occasion et brûlé à petit feu. Il était arrivé en 1684.

Un lieutenant du nom d'Allord de Ste-Marie est mentionné en 1684. En 1702 il servait à Terreneuve. En 1715 on le dit beau-frère de Castebelle. En 1718 il était en mission à Boston. En 1719 un de ses soldats décéde à Montréal. En 1726 commande l'artillerie à Louisbourg. Il mourut vers 1730 laissant un fils officier d'infanterie.

Louis de Laporte sieur de Louvigny, lieutenant ou capitaine, épouse en 1684 une Canadienne. Son histoire est longue.

Jean-Louis de Hennot (signait Dehennot) sieur de la Croix (pas la Groix) lieutenant, est aussi appelé Hainault, Desnos, des Rioux, compagnon de Montortier, a été confondu avec un autre officier du nom de La Groye ou La Groix.

Jacques Le Picard ou Le Picard de Noré sieur d'Alencour-Dumesnil. Cinq ans plus tard il est capitaine à Lachine. En 1692, à Champlain, il épouse une Canadienne.

Amateur ou Amador Durivault-Huet dit le chevalier, était capitaine de la marine royale. Le 5 mars et 4 août 1684 le roi prescrit que cet officier commandera cent cinquante soldats partant pour Québec sur l'*Emérillon*, et formant une compagnie franche dont il sera le capitaine. Le 2 novembre suivant, la Hontan écrit de Montréal qu'on a appris l'arrivée de Hainaut, Montortier et Durivau qui sont trois capitaines de vaisseau et serviront de conseillers au gouverneur La Barre. Durivau avait la commandement de toutes les troupes du Canada. Les 5 et 10 mars 1685 le roi ordonne le retour en France de Durivau et accorde sa compagnie à d'Orvillier.

Alphonse de Tonty, d'une dizaine d'années plus jeune que son frère Henry, ne vint au Canada qu'en 1684 et fournit la même carrière que celui-ci: coureur de bois, lieutenant, puis capitaine des troupes, commandant du Détroit et autres postes. Il s'est marié avec une Canadienne; ses fils ont servi, comme le père, surtout aux Illinois. Henry est resté célibataire.

Le 1er janvier 1685 le roi nomme le marquis de Denonville à la tête de la Nouvelle-France pour remplacer par un gouverneur chimérique le sieur de La Barre dont la rapacité causait tant d'embarras. Six cents hommes devaient partir avec lui. Le rappel de La Barre est du 10 mars 1685 annonçant que trois cents soldats seulement partiront, mais il y a une lettre de Versailles en date du 5 mars disant que le chevalier de Troyes avec sa compagnie et cinq autres seront envoyés. Le sieur Arnoul, à Rochefort, reçoit instruction de lever cent cinquante hommes pour le Canada. Le roi ajoute qu'il acceptera tous les ans deux gentilhommes (jeunes gens) dans les gardes-marines du royaume. Ceci paraît être le résultat de la demande de Robineau et La Durantaye qui désiraient placer leurs fils dans cette branche du service.

Denonville arriva devant Québec le 29 juillet 1685 et débarqua le lendemain avec Monseigneur de Saint-Valier, trois cents cinquante soldats et une vingtaine d'officiers. La Barre partit quelques jours après. Cent cinquante soldats étaient morts durant la traversée. Selon mes notes cent hommes arrivèrent le 1er août. Lahontan dit, le 2 octobre, que Denonville amenait sa femme et sa famille, suivi de quelques compagnies, formant cinq ou six cents hommes. Ailleurs je vois: dix compagnies indépendantes, ce qui veut dire: pas d'organisation régimentaire, mais des corps de cinquante hommes chacun dont les capitaines communiquaient directement avec le gouverneur-général.

Par un ordre de milice du nouveau gouverneur on voit que le district central des Trois-Rivières se délimitait "depuis le haut du lac Saint-Pierre au dessous de la seigneurie de Sorel, y compris les rivières Ouamaska, Maskinongé et autres du nord et du sud du fleuve qui tombent dans ce lac et le fleuve, jusqu'à la rivière et seigneurie de Saint-Anne (la Pérade) inclusivement." Dans une lettre du 20 août il explique la prétention de M. de Varennes, gouverneur des Trois-Rivières, à ce que son autorité s'étende sur toute la juridiction de la justice de son gouvernement et il ne reconnait pas ce point, mais, ajoute-t-il, "je lui ai donné un ordre pour commander aux troupes et aux habitants." La colonie était formée de trois provinces, pour ainsi dire: Québec, Trois-Rivières, Montréal, avec gouverneur, juge-en-chef, etc. A la guerre les milices formaient trois brigades portant les noms de ces territoires.

Les officiers qui paraissent être venus de France en 1685 sont:

Un frère et un fils de Remy de Gillouet Dorvillier, mentionné en 1683. En 1687 le fils succède à son père à la tête de sa compagnie. Le frère retourna en France et devint capitaine de frégate, ensuite il fut gouverneur de Cayenne; son successeur à Cayenne fut son neveu du Canada. Le Dorvilliers qui figure si longtemps dans nos guerres est celui de 1683.

Le capitaine Jean-Louis de Jadon sieur de Saint-Circq avait servi dans les meilleurs régiments de France et commandé un bataillon en Sicile. Il fut tué en 1691.

Le cadet Larivière est aussi mentionné.

Le capitaine Macary ne garda sa compagnie que durant deux années et il a dû retourner en France. On mentionne Saint-Bazile, son lieutenant.

Le capitaine de Flours décéda en 1687.

Le capitaine Pierre de Troyes mourut en 1688.

Le capitaine Nicolas Daneau de Muy se maria avec une Canadienne et ses fils continuèrent à servir dans les troupes de la colonie.

Capitaine François-Marie Renaud d'Avesnes seigneur des Meloises se maria avec une Canadienne et ses fils ont continué le service militaire en Canada.

Capitaine Philippe Clément sieur du Vault de Valrennes épousa une Canadienne. Pas de descendance.

Raymond-Blaise des Bergères. Il épousa la veuve de Jacques Bizard puis la veuve de Lambert Boucher de Grand-Pré et ses fils ont continué la lignée.

Claude de Lamotte, marquis de Jordis, se maria cette année à Lachine et y fut tué deux ans plus tard par les Iroquois.

Deux frères Joseph et François Desjordis de Cabanac, lieutenants, ont épousé des Canadiennes. Leur descendance est nombreuse; elle a fourni plusieurs officiers militaires.

Le capitaine Pierre Descayrac sieur de Reau fut tué en 1691. Marié à une Canadienne il laissa un garçon et une fille. Son grade de capitaine passe à Michel Leneuf de la Vallière, Canadien.

Claude de Ramesay, lieutenant, obtint la compagnie du défunt Macary en 1687, se maria avec une Canadienne et eut une nombreuse descendance qui compta plusieurs officiers militaires.

René Damours des Chauffours, lieutenant, qui arrive de France en 1685 était né à Québec. Cette famille a fourni plusieurs officiers militaires.

Le chevalier Louis de Larue sieur de Lamotte, lieutenant, reçut ordre de repasser en France l'été de 1687 mais il reste dans la colonie, devint capitaine et fut tué par les Iroquois à Saint-François-du-Lac en 1690.

Le capitaine Guillaume de Lorimier arrivait avec son fils Guillaume seigneur des Bordes. La descendance est assez nombreuse, par le fils, qui épousa une Canadienne. Le père retourna en France avec Denonville, l'automne de 1689. Le fils a dû être promu capitaine dès 1685 parce que cet automne Denonville demande que sa lieutenance soit accordée à Beaumanoir.

Jean Navers, chirurgien, compagnie Valrenne, se maria avec une Canadienne et a laissé une nombreuse famille.

Etienne de la Vernette sous-lieutenant de la compagnie Descayrac mourut à Québec le 25 mai 1691.

Jean de Douhet sieur de Larivière dit L'Etang (signait Lestang) simple cadet des troupes, épousa bientôt après son arrivée une demoiselle de Verchères et fut tué par les Iroquois à la rivière Chambly en 1687.

Robert de Villeneuve, ingénieur, resta huit ans dans la colonie. Nous lui devons des plans très utiles à l'histoire. En 1693 Hyacinthe Boisberthelot de Beaucourt le remplaça.

François Gregoire était chirurgien de la compagnie des Meloises. Il épousa l'une après l'autre deux Canadiennes et laissa une très nombreuse famille.

Charles d'Aillebout était officier depuis quelques années. Cinq de ses frères figurent peu après avec des grades militaires. Tous étaient nés en Canada et on les retrouve ainsi que leurs fils dans le service jusqu'à 1760.

Constant Lemarchand sieur de Lignery devait être enseigne. Il fut nommé lieutenant réformé au printemps de 1687 ce qui veut dire qu'il restait enseigne tout en ayant un grade plus élevé. Marié à une Canadienne, ils ont laissé trois fils officiers militaires de la colonie.

Marin Taillandier, chirurgien de la compagnie Daneau, a été notaire royale et juge seigneurial. Marié à une Canadienne ils ont vécu dans la région de Boucherville. Nombreuse descendance.

Gresolon la Tourette, frère de Duluth, qui apparaît en 1685 au lac Nipigon se nommait Claude-Charles, fut toujours coureur de bois et par moment commanda comme militaire des postes éloignés.

Jacques de Malleray sieur de Noiré et de la Mollerie, lieutenant, s'est marié avec une Canadienne. Deux fils ont été officiers militaires.

Pierre d'O, sieur de Jolliet, capitaine, fut capturé par les Iroquois en 1690, s'échappa et mourut à Montréal en 1694.

Duclos de Beaumanoir est recommandé l'automne de 1685 par Denonville pour recevoir la lieutenance de Lorimier qui passe capitaine: "C'est un gentilhomme très bien fait, élevé auprès de la grande duchesse." On lui donne la lieutenance de Montesson. En 1689, il va en France, est au siège de Québec l'automne de 1690, puis sa trace se perd.

Isaac de Montenon de Larue lieutenant de la compagnie de Troyes. En 1690 il paraît avoir été capitaine.

Vers 1685 Robutel de Lanoue, Gaultier de Varennes, Boucher de Boucherville, les frères Lemoine, tous Canadiens, commencèrent à servir.

Reprenons le fil de l'histoire. M. de Denonville alla, cette année 1685, au fort Frontenac (Cataracoui) avec les compagnies Dorvillier, Macary, Saint-Flours, Saint-Circq et de Lorimier, promenade dont les Iroquois se moquèrent. En cas d'hostilités sérieuses, ces Sauvages comptaient sur l'aide des Anglais, mais Jacques II qui montait sur le trône de la Grande-Bretagne, étant soumis à Louis XIV, comme on sait, devait les désappointer bientôt.

Lahontan dit que Denonville renvoya Dehennot, Montortier, Durivaux et plusieurs autres officiers. Voyons ceci: Lorsque Montortier reçut la permission (Versailles 10 mars) de retourner en France il y était dit que Dehennot pourrait également quitter le Canada mais il ne partit point puisque le 10 septembre 1690, aux Trois-Rivières, il est parrain de "Louise, Anglaise, agée de sept ou huit ans, amenée captive par les Sauvages et achetée d'entre leurs mains." L'acte lui donne le grade de lieutenant réformé. Un mois plus tard, le gouverneur Frontenac ordonne que l'enseigne réformé Hennot sera lieutenant réformé à la place de Bernières rentré en France l'année précédente et Montesson de Repentigny remplace Hennot dans la grade d'enseigne réformé. En 1691 on retrouve Dehennot, témoin d'un duel.

L'intendant écrit au ministre que Montortier a passé l'été (1685) aux Trois-Rivières chez son parent le gouverneur Gaultier de Varennes dont il facilite la traite au mépris des ordonnances et de plus qu'il sème partout le sentiment d'insubordination. Le 28 septembre il annonce le départ de Montortier. Les deux hommes faisaient la paire, chacun à sa façon.

L'intendant Champigny arriva en juillet 1686 pour remplacer de Meulles qui retourna en France peu après. Champigny amenait "quelques compagnies de marine," selon une lettre de Lahontan du 8 juillet. Toujours "de marine" quoiqu'il ne s'agisse pas du tout de marins; et les termes "quelques compagnies" sont assez vagues pour ne dire que le moins possible, soit: une ou deux compagnies.

En 1686 Sidrac Dugué étant capitaine, je vois qu'il y avait dans sa compagnie un lieutenant du nom d'Isaac Laplace dit le chevalier.

Joseph Guyon sieur Dubuisson, Canadien, frère de madame de Cadillac, était lieutenant de la compagnie Subercase. Il a eu une longue carrière militaire.

Au poste de Châteauguay, en 1686, il y avait pour commandant Jean Métayer sieur Demarais qui y fut tué par une bande d'Iroquois, car ces Sauvages commençaient à faire des courses aux environs de Montréal.

Cette année, Prevost est maintenu comme major de la ville et château de Québec.

Frederic-Louis Herbin de Bricourt était dans la colonie en 1686 avec le grade d'enseigne et devint lieutenant en 1703. En 1695 on mentionne son frère, Herbin d'Aucourt, chambelan du roi. Marié en 1704 avec une Canadienne, notre officier vécut jusqu'à 1754, ayant à peu près quatre-vingt-cinq ans. Son seul fils, Louis, né 1711, marié à une Canadienne, était capitaine lorsqu'il partit pour la France en 1760.

Le sous-lieutenant Pierre de Labrosse, sieur de Beaucage, a dû arriver en juillet 1686 avec son parent l'intendant Champigny. Il devint lieutenant et fut tué en 1692 par les Iroquois, au Long-Saut.

Daniel Auger de Subercase, capitaine en France, né au Béaru, est aussi de 1686 parmi nous. Il a été employé surtout dans les régions maritimes.

En janvier 1687 Denonville demande quinze cents vétérans pour faire une campagne sérieuse et s'emparer des cantons iroquois. Vers le même temps, le roi prescrit d'envoyer cinq cents armes à feu au Canada.

Le 8 juin Lahontan écrit de l'île Saint-Hélène, Montréal, que l'on construit des bateaux pour l'embarquement de vint "compagnies de la marine," et il ajoute que les milices campées dans cette île avec les réguliers sont au nombre de quinze cents hommes, de plus cinq cents Sauvages des environs de Québec et Montréal. "M. de Denonville est arrivé à Montréal, il y a trois ou quatre jours, accompagné des milices de tout le pays, qui sont campées avec nos troupes dans l'île Sainte-Hélène. M. d'Amblemont, qui est à Québec depuis un mois avec cinq ou six gros vaisseaux de second rang, ne fut que vingt-huit jours en chemin, de la Rochelle jusque-là. Son escadre a transporté dix ou douze compagnies de marine qui doivent garder la colonie pendant la campagne que nous allons faire au pays des Iroquois."

Si la flotte était à Québec dès le 8 mai et si elle avait été trente-trois jours (pas vingt-huit) comme le dit la correspondance officielle, elle avait dû partir de la Rochelle vers le 5 avril. On cite ce voyage comme le plus court connu. Les navires amenaient huit cents recrues, non des vétérans, divisées en trente-cinq compagnies de vingt-cinq hommes chacunes. Trois compagnies furent passées à des officiers canadiens. La nourriture des officiers à bord des vaisseaux coûtait vingt sous par jour, soit une piastre, au moins, de 1919. La flotte apportait des approvisionnements, équipements et cent soixante huit mille francs en pièces monnayées.

Il y a apparence que le total des soldats de France, au mois de juin, était de seize cents formant trente-deux compagnies de cinquante hommes, mais que la moitié étant des recrues on les laissa dans le Bas-Canada pour recevoir l'instruction.

Denonville partit de Montréal le 13 juin, avec Vaudreuil comme chef d'état-major, les réguliers sous les ordres de Callières, les miliciens dont les capitaines étaient Duguay, Berthier, Lemoine, etc., tous gens du pays. Les réguliers arrivés en 1683-1686 étaient au nombre de huit cent trente-deux. Il y avait neuf cent trente miliciens, trois cents Sauvages et cent hommes pour le service de deux cents bateaux plats et autant de canots d'écorce.

Avant de terminer voici les noms des militaires qui figurent pour la première fois cette année dans les annales de la colonie:

M. de Vaudreuil, qui se maria avec une Canadienne et devint gouverneur général.

Gannes de Falaise se maria avec une Canadienne et leur descendance a fourni plusieurs officiers militaires.

Claude-Charles de Grès et Lacrois, seigneur de Merville, signait Merville, était capitaine et son frère, chevalier des Preaux, se rencontrent de 1687 à 1708. En 1688 tous deux demandaient une concession de traite au lac Témiscamingue mais sans résultat.

Le chevalier de la Guerre, lieutenant de Merville tué d'un coup d'épée (1687) Henri Duporteau, enseigne de la même compagnie, prend la fuite.

Jean-Joseph Belon sieur du Portail était de la compagnie des Bergères. Il se maria en 1692 avec une Canadienne.

François le Gantier de la Giloizerie sieur la Vallée-Rané, compagnie Merville, se maria en 1689 avec une Canadienne.

Marc-Antoine de Rupellay sieur Desjardins seigneur de Gonneville, enseigne, se maria en 1694 avec une Canadienne.

Je vois, 1687-1689, Camus, Couture, Karesquil, Lesueur, Bourgeois, Lesueur, Chasle, Denis, Morteseigne, soldats de la compagnie Creusel. En 1690 Creusel retourne en France et sa compagnie passe à Lemoine de Longueuil, Canadien.

Le capitaine François Le Verrier de Rousson arrivé en 1686 ou 1687, se maria avec une Canadienne.

Jacques Petit de Verneuilles, trésorier de la marine, se maria avec une Canadienne. Décédé en 1699 dans sa charge. Pas d'enfant.

Guillaume-François de Bourdin sieur Duclos, ou Clos-Percy, lieutenant, était encore dans la colonie en 1691.

Jean-Joseph Maulbaut, chirurgien, compagnie Dumesnil, à Lachine en 1687.

Louis Senéchal chevalier d'Auberville, lieutenant, commande à Lachine en 1687, et paraît être retourné en France (Brest) en 1698.

L'enseigne l'Evetier livre "un beau combat" en 1687. Il est blessé à Laprairie en 1691 par les Mohicans.

Baptême du capitaine Jacques Brouillan de Saint-Ovide qui a compté pour beaucoup ensuite dans l'histoire des provinces maritimes.

Capitaine Gabriel Le Prevost de Saint-Jean, chevalier, se retrouve jusqu'à 1696 dans mes notes.

Jacques-Charles Sabrevois de Bleury, lieutenant, épouse une Canadienne et laisse une descendance militaire.

Claude Drouet de Richerville épouse une Canadienne et laisse une descendance militaire.

Lieutenant Marc-Antoine de Cottentré servit en Canada puis en 1697 obtint un fief à Canceaux. Il se retira alors de la vie militaire.

Sébastien Despéré sieur Delille servit au Détroit en 1687, commanda à Lachine en 1688 et c'est peut-être lui qu'on voit commandant à la baie d'Hudson en 1708.

Un officier du nom de Morric était en Canada en 1687 et 1690. Cette année il passe capitaine.

Le capitaine Bouraillon est mentionné à Québec le 27 juin 1687. Son lieutenant est Nicolas Paris de Rougemont. De 1687 à 1696 je vois des soldats de la compagnie Bouraillon.

Le lieutenant de Boyne cité en 1687 retourna en France en 1699.

Je vois aussi en 1687 le lieutenant Louis Dupin.

Bernard de Persillon, lieutenant, se retrouve de 1687 à 1740.

En 1687, dans l'expédition au lac Ontario, il y avait Dugué, Lavaltrie, Saint-Ours, du régiment ancien de Carignan, et parmi les officiers canadiens, La Vallière, Leber, Lemoine, Denis, Aubert, Hubou. Ce dernier est dit: Jean Hubou de Longchamps sieur de Tourville, âgé de trente-un ans, brigadier du service de M. de Denonville.

L'histoire nous raconte cette expédition qui fut menée gauchement et eut des suites déplorables. On ne fit pas la guerre, mais les chefs iroquois, capturés par un stratagème honteux et envoyés en France pour périr sur les galères ouvrirent la porte à la vengeance des Cinq-Nations. De 1688 à 1700 notre colonie fut sous la hache et le couteau des Sauvages justement outrés de la conduite des autorités françaises à leur égard.

Le présent article ayant pour unique objet de montrer la formation de la prétendue "troupe de la marine," il suffira maintenant de dire que, de 1688 à 1760, rien ne fut changé dans le système et plus le temps s'écoula plus ce corps se composa de Canadiens. En 1760 "la marine" resta ici, chaque homme retournant sur la terre paternelle, et je doute même que les Français qui pouvaient s'y rencontrer aient repris le chemin de la France.

sur Bernard-de [illegible], lieutenant, se retrouve de 1687 à 1740.

En 1687, dans l'expédition au lac Ontario, il y avait Duguay, Lavaltrie, Saint-Ours, du régiment ancien de Carignan, et parmi les officiers canadiens: La Vallière, Hertel, Lanoue, Denis, Aubert, Hubou. Ce dernier est dit: Jean Hubou dit Longchamps natif de Tourville, âgé de trente-un ans, brigadier du service de Monte-Denis-ville.

L'histoire nous raconte cette expédition qui fut menée rondement et eut des suites déplorables. On ne fit pas la guerre, mais les chefs iroquois, capturés par ce stratagème honteux et envoyés en France pour périr sur les galères, ouvrirent la porte à la vengeance des Cinq-Nations. De 1688 à 1700 la colonie fut sous la hache et le couteau des Sauvages [illegible] de la conduite des autorités françaises à leur égard.

Le présent article ayant pour objet de nous faire la connaissance de la prétendue "troupe" [illegible] il suffira simplement de dire que, de 1688 à 1700, rien ne [illegible] le système [illegible] le tems s'écoule plus ce corps se compose [illegible] cette partie [illegible] même que les Français qui [illegible] rement [illegible] déjà le chemin de la France.

Monsieur Georges-Antoine Belcourt
Missionnaire à la Rivière Rouge

Par M. le juge L.-A. PRUD'HOMME, M.S.R.C.

(Lu à la réunion de mai 1920.)

NOTES BIOGRAPHIQUES

M. Belcourt fut le premier prêtre désigné d'une manière spéciale à l'évangélisation des Sauvages de la rivière Rouge. Pendant 17 ans (1831 à 1848) il ne s'épargna guère, fondant des missions à Saint-Paul des Sauteux, à 35 milles à l'ouest de Saint-Boniface, à la Baie des Canards sur le lac Winnipegosis, à Wabassimong, à la décharge de la rivière des Anglais dans la rivière Winnipeg et une dernière au fort Francis. Il accompagna deux fois les chasseurs de bison au Grand-Coteau du Missouri.

Son poste principal était Saint-Paul des Sauteux.

Il se sacrifia à cette tâche sans ménagement. Doué d'une santé robuste, il travailla de ses mains comme un mercenaire pour ériger une chapelle et une résidence à Saint-Paul et à Notre-Dame de Merci à Wabassimong. Convertir les Sauteux devint l'objectif de sa vie.

Pour accomplir cette conquête, il exposa souvent ses jours et connut les privations les plus pénibles. Il s'attacha à ses misères. Parfois, après des courses épuisantes, son courage s'affaisse un instant et de profonds soupirs s'échappent de son âme apostolique devant l'endurcissement et la profonde dégradation de cette nation.

Farouches, cruels, esclaves de honteuses passions, les Sauteux ont été longtemps rebelles à la voix des missionnaires. Nombreux sont encore les païens dans cette tribu, comme on peut le constater au lac des Bois.

Les efforts de M. Belcourt, sans être couronnés des succès qu'il en attendait, ne furent pas vains. Il eut la consolation de gagner à Dieu un certain nombre d'infidèles et de jeter en terre la semence qui sous le souffle de la grâce devait faire germer et produire des fruits de salut.

N'écoutant parfois que les élans généreux de son cœur, il verse dans l'optimisme et ne se rend pas assez compte de l'inconstance de caractère des Sauvages. Il se ménagea ainsi bien des mécomptes et des tristesses.

Il estimait que l'agriculture en fixant les tribus nomades au sol faciliterait leur conversion et transformerait leurs mœurs plus profondément. L'idée au point de vue spéculatif était bonne, mais il ne fallait pas s'attendre à un succès à brève échéance. Monseigneur Provencher prévoyait qu'en donnant trop de leur temps et de leur bourse dans une entreprise qui heurtait de front les habitudes séculaires des Sauvages, les missionnaires s'exposaient à des déboires.

Tant que les aborigènes ont pu gagner leur subsistance au bout du fusil, ils n'ont éprouvé que du mépris pour les travaux des champs. Dès 1732, LaVérendrye, le découvreur du Nord-Ouest, s'efforça de les amener à semer du maïs. Il fut le premier professeur d'agriculture de l'Ouest Canadien.

Quelques petits champs de ce grain, sur l'île Cornfield, au lac des Bois, est le seul souvenir qui soit resté de ces premières tentatives. Voilà 40 ans que le gouvernement fédéral contruit des écoles industrielles sur diverses réserves afin de développer le goût de la culture du sol chez les Sauvages. Des sommes considérables ont été consacrées à un but si louable et pourtant, s'il y a progrès, les résultats sont encore bien loin de ce qu'on était en droit d'espérer.

Pour civiliser les Sauvages, il faut commencer comme l'ont fait partout nos missionnaires, par leur enseigner le décalogue et relever par le sentiment religieux ces âmes avilies et impatientes de tout joug. M. Belcourt tout en se dévouant à ce dernier soin crut y parvenir plus sûrement en s'efforçant de les réunir en bourgade et y prèchant à temps et à contre temps, au prix de sacrifices pécuniaires considérables, l'attachement au sol.

Mgr. Provencher ne caressait pas ces illusions et ne se prêtait qu'à regrets aux pressantes sollicitations de M. Belcourt.

Ces divergences d'opinion en s'accentuant, firent naître un malaise entr'eux, dont nous retrouvons, çà et là, un écho dans leur correspondance. Nous ne saurions trop admirer la sagesse et le sens pratique du premier évêque de Saint-Boniface. Le temps lui a donné raison. Toutes les œuvres de ce prélat sont restées debout et se sont merveilleusement développées, tandis que la plupart des établissements de M. Belcourt n'ont eu qu'une existence éphémère, malgré les sacrifices si pénibles et si admirables qu'il s'imposa pour les maintenir et les animer de son souffle.

Dans ses projets d'avenir qu'il caresse pour ses chers Sauteux, il semble hypnotisé par le but visé et se rendre peu compte des obstacles qui se dressaient sur son chemin.

Peut-être s'appuyait-il trop sur sa volonté tenace et énergique et la fertilité de ses ressources. Les élans de son zèle débordant l'entrainaient parfois dans des entreprises pour lequel le pays n'était pas encore prêt.

Les enthousiastes se ménagent souventes fois des déceptions; c'est ce que ce missionnaire eut le loisir de constater.

Mgr. Provencher le peignait sur le vif lorsqu'il écrivait "c'est un homme tout de feu et il croit que tout est fait lorsqu'il a vu des gens qui lui ont donné de bonnes paroles."

Ce qui convenait davantage à ses talents c'était les courses apostoliques de tribu en tribu. Il se fut trouvé là dans l'élément le plus en harmonie avec son caractère. A vrai dire, dans son ardeur si touchante d'embrasser toutes les brebis d'Israël exposées à leur perte dans nos immenses prairies, il obéissait à l'instinct de la vocation pour laquelle il avait le plus d'aptitude.

Aussi bien, M. Belcourt exprime souvent le désir que la compagnie de la baie d'Hudson favorise une mission ambulante et il sollicite ce poste d'honneur.

Don Benoit dans sa vie de Mgr. Taché, p. 93, porte le jugement suivant sur M. Belcourt: "M. Belcourt était un missionnaire d'une haute intelligence et d'une indomptable énergie qui passa dans le Nord-Ouest avec la puissance du génie; mais faut-il le dire (et pourquoi le ne dirions-nous pas) il manquait de cette soumission d'esprit et de jugement à laquelle est attaché le succès des œuvres de Dieu: aussi toutes ses entreprises malgré son grand talent présentèrent tôt ou tard le spectacle de la maison bâtie sur le sable.

Mgr. Provencher disait de lui en 1838: "Un peu plus de souplesse de caractère lui aurait exempté des mortifications, des chagrins et des pleurs. Il a fallu le laisser faire à sa volonté. Dieu ne pouvait guère bénir des travaux qui n'allaient pas selon l'ordre qu'il a établi. Aussi il y a eu peu de fait à cette mission (St. Paul) si on excepte les bâtisses peu nécessaires pour le moment et qui ne subsisteront plus quand elles deviendront nécessaires. (Bulletin Société Historique vol. 3, p. 172.)

Mgr. Provencher l'avait bien jugé dans le passage suivant: "Dans un poste stable, il a la fureur de faire avant le temps. Il voit déjà fait en imagination ce qui ne se fera pas en 10 ans, en sorte qu'il est toujours en avant, en esprit, et en arrière en réalité." Ces erreurs de jugement ne sauraient cependant nous faire oublier ses labeurs et ses souffrances pour la conversion des Sauvages.

La correspondance de M. Belcourt nous découvre les émotions les plus intimes de son âme. Est-il bien accueilli chez une tribu qu'il tressaille d'allégresse et remercie Dieu avec effusion du bien opéré par son ministère. Quelques jours après, il voile à peine les larmes brûlantes qu'il verse, en voyant les infidèles demeurer sourds à l'appel de la grâce et parfois même tramer des complots contre sa vie. Dans une autre circonstance, le souvenir de ses parents et de ses amis le hante et il sent le besoin d'exhaler sa tristesse dans des pages écrites avec un lyrisme touchant. Sa plume alerte, avec une fine pointe de sel gaulois, se complait surtout dans les descrpitions de sa vie mouvementée.

Son style coloré indique un rare talent d'observation, qui ne néglige ni les légendes ni les menus détails du caractère et des mœurs des Sauvages. Il s'arrêtait souvent sur la rivière Winnipeg pour y relever une croix qui recouvrait les restes d'un voyageur mort au milieu de ce désert. Plus d'une fois il faillit être emporté lui-même au milieu des rapides de cette rivière. Dans ses voyages il amenait avec lui quelques sacs de pemican mais n'écoutant que son bon cœur il en distribuait la plus grande partie à ses Sauvages et souffrait ensuite de la faim.

Il était industrieux et habile ouvrier. Il construisit plusieurs chapelles de ses mains ainsi qu'un moulin à farine et à scie mû par le vent. Il eut beaucoup à souffrir du fanatisme religieux des chefs de tribus. Pour retenir leur autorité, ils inventaient les calomnies les plus absurdes. C'est ainsi qu'on répétait de bouche en bouche que les enfants baptisés mourraient presque toujours peu de temps après leur baptême, que le missionnaire volait les enfants, etc. Au surplus ses jours étaient parfois en danger au milieu de cette tribu perfide. Il ne faut pas s'étonner de cela quand on sait ce qui arriva au P. Lacombe, O. M. I., lors de la construction du Pacifique Canadien. Il voulut profiter de son passage au lac des Bois pour les évangéliser. Les Sauteux le sommèrent de se retirer et comme il ne se pressait pas de les quitter, ils tirèrent sur lui. Un peu plus tard, le P. Allard, O. M. I., ne fut pas mieux reçu. Par contre, M. Belcourt eut la consolation de faire un certain nombre de conversions sérieuses. Quelques-uns de ses néophytes étaient fort édifiants; ils observaient les jours de jeûne avec une rigueur excessive et souvent pendant tout le carême, ils ne prenaient qu'un seul repas par jour. M. Belcourt avait le don des langues. Il parlait l'anglais avec élégance. Les officiers de la compagnie de la baie d'Hudson étaient charmés de la richesse de son langage.

La langue sauteuse n'avait pas de secrets pour lui, à ce point qu'il enrichit cette langue de mots nouveaux en harmonie avec le génie sauteux. Il composa une grammaire et un dictionnaire sauteux indiquant les racines des mots.

Ces travaux rendirent des services inappréciables aux missionnaires de cette époque. Il devint le professeur obligé des prêtres qui arrivèrent après lui dans l'ouest. C'est ainsi qu'il enseigna le sauteux successivement à Messeigneurs Taché, Laflèche, Demers et au P. Lacombe, pour ne citer que les plus illustres de ses élèves.

Un incident qui se produisit pendant l'hiver de 1845-1846 mit fin à sa carrière dans l'ouest canadien.

La population de la rivière Rouge était depuis longtemps fort mécontente du monopole de la traite des fourrures que réclamait la Compagnie. Les décisions du juge Thom à la solde de cette dernière exaspérèrent les gens du pays qui menacèrent de se soulever et de faire un mauvais parti au juge Thom. Une grande assemblée fut tenue à laquelle M. Belcourt fut invité. Pour calmer les esprits et arrêter cette effervescence, il conseilla de présenter une adresse à Sa Majesté la reine et accepta de la rédiger. En attendant l'issue de cette démarche le calme se rétablit.

Les officiers de la Compagnie, mal renseignés, crurent que M. Belcourt avait été l'auteur de ce mouvement, quand il n'avait fait que l'endiguer dans les voies constitutionnelles pour l'empêcher de déborder en émeute.

Sir George Simpson, qui tout d'abord se plaignit de la conduite de M. Belcourt auprès de ses supérieurs ecclésiastiques, finit par comprendre qu'il s'était fourvoyé, et disons-le à sa louange, il n'épargna rien pour rendre hommage à la bonne foi de ce missionnaire et reconnaître les services signalés rendus à la Compagnie en cette occurrence.

Toutefois quelques officiers de cette Compagnie étaient restés mal disposés à l'endroit de M. Belcourt.

Et puis on craignait peut-être que les mécontents s'adresseraient de nouveau à lui et pourraient ainsi le compromettre aux yeux de la Compagnie. Quoiqu'il en soit, on crut qu'il n'était pas désirable qu'il retourne à la rivière Rouge.

M. Belcourt en fut navré et se décida de répondre à l'appel de l'évêque de Dubuque.

En 1848, il alla relever la mission de Pembina fondée par M. Dumoulin, et qui avait été abandonnée à la demande pressante de la Compagnie, parce qu'elle se trouvait au sud de la frontière internationale. C'est là qu'il exerça son ministère pendant 10 ans. Je désire m'attacher en cette étude à ses 17 années d'apostolat dans l'ouest canadien.

Je me suis proposé de dépouiller dans sa volumineuse correspondance tout ce qui pouvait avoir un intérêt historique.

Au lieu de synthétiser en quelques lignes le récit de ses courses, à dessein je souligne les nombreux incidents qui font revivre cette époque, déjà lointaine, et mettent en relief les dures épreuves des premiers missionnaires de l'ouest.

Ses premières années. Il accepte les missions sauteuses de la R. Rouge. Etude de l'Algonquin à Oka. Son départ, avril 1831.

Monsieur Georges-Antoine Belcourt naquit à la Baie du Febvre, province de Québec, le 22 avril 1803 du mariage d'Antoine Belcourt avec Josephte Lemire. Il fit ses études au collège de Nicolet et fut ordonné prêtre le 18 mars 1827. Après deux ans de vicariat aux Trois-Rivières, il fut nommé d'abord curé à Saint-François-du-Lac, et en 1830 il fut transféré à la cure de Sainte-Martine, comté de Chateauguay. Cette même année, monseigneur Provencher descendit en Bas-Canada, pour recueillir des aumônes destinées à la construction de sa cathédrale. Il se proposait également de trouver un missionnaire qui se consacrerait exclusivement à l'instruction des Sauvages et serait prêt à se dévouer pendant de longues années à cette œuvre. Ministère difficile, ingrat, pénible et qui exige des vertus presqu'héroïques et une santé robuste.

Il faut pour le missionnaire qu'il se livre tout d'abord à l'étude d'une langue le plus souvent en rupture de banc avec les règles ordinaires des langues européennes. Il faut qu'il s'incline sur les natures dépravées des aborigènes pour les relever et infiltrer dans leur intelligence et leurs mœurs une vie nouvelle. Pour courir après ces brebis égarées, il doit entreprendre des courses épuisantes, exposé à la chaleur, à la pluie, à la faim, au tourment des moustiques en été, à la bise glaciale en hiver, coucher sur la grève ou sous la neige, exposé sans cesse à périr au milieu des vagues écumantes des rapides ou des violentes tempêtes de la prairie. Telle était la perspective des apôtres de la foi, qui se dévouèrent autrefois à l'évangélisation de ces contrées sauvages.

Tel était l'apostolat que Mgr. Provencher venait offrir à un prêtre de la province de Québec. Il s'adressa à l'épiscopat.

Dès 1827, on avait jeté les yeux sur M. Belcourt qui venait d'être ordonné au séminaire de Nicolet.

M. Boucher ayant consenti à suivre Mgr. Provencher, dans le temps on ne fit pas d'autres démarches auprès de M. Belcourt.

En 1831, Mgr. Panet, évêque de Québec, à la demande de Mgr. Provencher, s'adressa de nouveau à M. Belcourt pour lui offrir les missions de l'ouest. Entre temps, M. Mailloux consentit à suivre Mgr. Provencher et, pour la deuxième fois, on n'insista pas auprès de M. Belcourt, qui d'ailleurs était loin de se montrer enthousiaste pour ce genre de vie.

En janvier, 1831, M. Mailloux annonça à Mgr. Provencher, qu'à son grand regret, il était obligé de renoncer à son premier dessein.

Mgr. Panet revint de nouveau sur son premier choix.

Afin de vaincre les hésitations de M. Belcourt, il lui écrivit le 4 février, de se préparer sans délai pour son départ au printemps suivant. Ce fut un coup bien dur pour lui, et il s'en ouvre à Mgr. Panet, en termes émus. Il lui soumet qu'il est le soutien de sa mère et d'un jeune frère, et le supplie, s'il est possible, de reconsidérer sa décision.

Pour apaiser ces dernières révoltes de la nature, Mgr. Provencher se rendit à Sainte-Martine le 17 février. M. Belcourt avait eu le temps de se ressaisir. Il accueillit cet évêque avec une joie affectueuse et se mit immédiatement à sa disposition. Des arrangements furent conclus au sujet de sa famille et il fut convenu qu'il se rendrait au lac des Deux-Montagnes pour se livrer à l'étude de la langue algonquine.

L'algonquin est la langue mère du Cri, du Sauteux et même de l'Outaouas. Elles sont tellement apparentées que la connaissance de l'algonquin est une excellente préparation pour les autres et qu'à la rigueur, celui qui comprend l'algonquin peut suivre à peu près une conversation en sauteux ou en cri.

M. Belcourt eut pour professeur MM. de Bellefeuille et Durocher. Le 27 avril 1831, il s'embarquait dans un canot d'écorce avec Mgr. Provencher en route pour Saint-Boniface.

M. Belcourt nous a laissé l'itinéraire de son voyage jusqu'à ce dernier endroit. Il a été publié en 1913 dans le Bulletin de la Société Historique de Saint-Boniface. La route des canots fut suivie jusqu'en 1845. Depuis lors, les voyageurs se rendirent dans nos prairies presque toujours par Chicago et Saint-Paul.

1832-1833

Prairie à Fournier. Premiers défrichements. Construction d'une chapelle. Les Gros-Ventres attaquent son établissement. Il les repousse.

Le 17 juin 1831, M. Belcourt arrivait à la rivière Rouge après avoir parcouru en canot 2118 milles. Il se livra aussitôt à l'étude du sauteux, tout en aidant monseigneur à la desserte de Saint-Boniface. Un jeune François Bruneau, qui devint plus tard membre du Conseil d'Assiniboia, faisait l'école à l'évêché. M. Belcourt devait de temps à autres le seconder et le diriger de ses conseils. Il fit de rapides progrès en sauteux. Au mois de juillet 1832, il avait déjà visité l'endroit projeté pour sa mission et fixé le site sur la rive sud de l'Assiniboine à l'ouest de l'endroit occupé aujourd'hui par la paroisse de Saint-Eustache à environ 50 milles à l'ouest de Saint-Boniface.

M. Belcourt lui donna le nom de Prairie à Fournier. Ce choix fut approuvé par Mgr. Provencher et le gouverneur de la colonie.

Ce dernier lui fit don d'une terre de 5 milles de front et de 2 milles de largeur. En 1832 il alla y planter sa tente et se mit à l'œuvre. Il commença les travaux préliminaires d'une chapelle de 20 par 30. Elle devait également lui servir de résidence temporaire. Menuisier habile, il s'entendait assez en construction. Les quelques Sauteux, qui habitaient dans le voisinage, lui aidaient à certains moments, mais le plus souvent, ils flanaient auprès du feu, quand ils n'étaient pas en quête de gibier pour se nourrir.

Mgr. Provencher fit demander à la Compagnie, 50 pioches et les ferrements d'une charrue pour permettre aux Sauvages de défricher quelques arpents. Il lui donna quelques bœufs pour préparer le terrain pour le printemps suivant.

Tout à coup, M. Belcourt vit tout le fruit de ses travaux détruit par une bande de Gros-Ventres venus du territoire américain, pour faire quelques exploits dans la colonie.

Cette attaque eut lieu en septembre 1833, alors que les Sauteux étaient partis pour la chasse d'automne.

Il n'avait autour de lui que deux Sauvages païens et deux chrétiens qui l'aidaient à scier les planches de sa chapelle.

Il se trouvait en ce moment dans un abri entouré de peaux et couvert d'écorce. C'était sa demeure ordinaire.

Il se hâta de se retirer dans le carré de sa chapelle, qui avait été levée quelques jours auparavant.

Les deux Sauteux chrétiens ainsi que quelques femmes et enfants l'y suivirent. Ils firent feu sur les maraudeurs, tandis que les deux Sauteux païens se mirent à *pleurer leur corps*. C'était une habitude dans cette tribu, en face de la mort, de pleurer leur corps. M. Belcourt et ses compagnons continuèrent à tirer, tout en poussant une grande clameur pour effrayer leurs ennemis. Heureusement que les Gros-Ventres étaient peu nombreux. Ils se retirèrent à quelques arpents et pendant plusieurs semaines ils cherchèrent à les surprendre. Cependant M. Belcourt faisait bonne garde, encourageant les Sauteux à ne pas fuir.

Découragés de leur insuccès, les Gros-Ventres abandonnèrent la partie. En 1833, M. Belcourt faisait le catéchisme à 20 élèves. Il baptisa 5 adultes et 10 enfants. L'un des adultes avant son baptême était tellement malade, que les forts en médecine l'avaient abandonné. A peine l'eau régénératrice du baptême eut-elle coulé sur son front, qu'il fut guéri et partit pour la chasse.

Mgr. Provencher crut qu'il était plus prudent de rapprocher cette mission de celle de la prairie du Cheval-Blanc (St. François-Xavier). M. Belcourt vint hiverner à Saint-Boniface et au printemps de 1834, il alla fonder une nouvelle mission à la baie St-Paul.

1834-1838

St. Paul des Sauteux. Progrès lents. Extrême sensibilité de M. Belcourt. Les Sauteux rebelles à la foi. Les forts en médecine' Delle Nolin institutrice. Travaux agricoles. Construction d'une chapelle. Ambassade des Sauteux de la prairie. Projet des grandes missions jusqu'aux Rocheuses. Missions de la Colombie.

Ce dernier poste fut le pied à terre de M. Belcourt jusqu'à son départ de la rivière Rouge. De là, il allait de temps à autres desservir St. François-Xavier à environ 12 milles de distance. Mgr. Provencher écrivait à ce sujet à Mgr. Signay: "M. Belcourt a changé le lieu de sa mission. Il n'est plus qu'à 9 lieues et à 4 lieues de la prairie du Cheval-Blanc. On a craint le danger de la part des ennemis à l'autre poste beaucoup plus éloigné, mais le dernier est moins bien situé pour les Sauvages. Ils y trouveront moins facilement à vivre. J'avais bâti l'an dernier et il a fallu recommencer cette année. Il y a peu de Sauvages. Ils n'ont point semé cette année. Ils disent toujours qu'ils veulent se faire instruire et diffèrent sans cesse à dire: Je le veux hic et nunc. M. Belcourt en instruit quelques-uns cette année. Il a peut-être trop différé l'année dernière à leur parler de Dieu sous prétexte qu'il lui fallait une maison pour les assembler. Je l'ai poussé à parler en public; tout le monde entendrait. Il pense qu'on ne réussira pas de même. Il a un peu peur que les Sauvages rient de lui. Il convient qu'ils sont effrayés des vérités terribles de la religion. Il me semble qu'il faudrait les leur faire retentir aux oreilles, le plus souvent possible. C'est une semence qui germerait avec le temps. Il fait l'école; c'est bien une bonne chose mais qui ne pourra pas probablement être continuée faute de moyens. Où prendre des livres dans leur langue? Il faudrait nourrir des gens qui ne lui feraient pas même la grâce de l'écouter. Où prendre pour subvenir à cette dépense. . . . Je ne vois pas toujours comme lui sur cette partie de sa besogne, mais il n'est pas aisé de le faire changer de sentiment, ni même de lui dire qu'il faudrait faire autrement." M. Belcourt comptait, en 1834, environ 150 catéchumènes et avait baptisé 72 infidèles. Le gouverneur vint lui rendre visite et l'assura qu'il comptait beaucoup sur l'avenir de cette mission pour civiliser les Sauvages. Une trentaine de Sauvages avaient semé quelques grains soit en tout 100 minots de patate, 3 de blé d'inde et un peu d'orge. Mgr. Provencher le visita deux fois en 1834 et lui envoya des bœufs pour casser la prairie. M. Belcourt était obligé d'écrire lui-même les livres de classe de ses élèves. C'était un travail fort long. Il avait pensé à faire venir de Québec une presse à main avec les caractères voulus. Le tout devait peser mille livres et coûter 50 louis. Ce n'était pas commode à cette époque de faire venir de Montréal en canot d'écorce un article aussi pesant. M. Belcourt dût renoncer à ce projet sur lequel il revint pour la composition de son dictionnaire. En attendant Delle Angélique Nolin lui aida à copier ses livres de classe et à préparer son dictionnaire sauteux.

A l'automne de 1834, M. Thomas Simpson était commis à la Fourche. M. Belcourt se trouvait un jour de passage à Saint-Boniface lorsque le gouverneur envoya prier Mgr. Provencher ainsi que M. Belcourt de venir au plutôt pour calmer les Métis qui voulaient faire un mauvais parti à Simpson. Ce dernier dans un moment d'impatience avait fendu la tête à un Métis du nom de Larocque qui réclamait impérieusement ses gages. Il se présenta devant les siens baignant dans son sang. Le gouverneur essaya en vain d'intervenir pour contenir les Métis indignés d'un tel traitement.

Mgr. Provencher ainsi que M. Belcourt accoururent aussitôt et réussirent à apaiser les Métis et à les faire accepter une somme d'argent pour indemniser leur compatriote.

M. Belcourt avait une âme sensible et trop impressionable. Il l'avoue ingénument dans une lettre du 25 juin 1835 adressée à Mgr. de Québec: "Mgr. Provencher s'est rendu à mes désirs pour l'avancement de ma mission beaucoup plus qu'à l'ordinaire. J'ai cependant reçu de lui des lettres qui m'ont fait désirer de m'en retourner en Canada, comme il a pu le voir par mes réponses qui, je l'avoue, ont quelquefois renfermé des expressions trop vives.

"Je ne puis me persuader que Mgr. n'ait pas d'antipathie contre moi. Il est vrai qu'il m'a marqué quelquefois beaucoup trop de bonté pour mon mérite, mais en revanche, il m'a fait quelquefois beaucoup trop de chagrin pour ma capacité. Si je ne verse pas mon sang pour le salut des infidèles, j'aurai bien versé des larmes. S'il plaît à Votre Grandeur de les essuyer en me rappelant vers elle, je lui baiserais la main avec action de grâces. J'avoue que quand on est au milieu d'un peuple barbare, où l'on n'a devant les yeux que de la brutalité sans aucun bon exemple, on éprouve souvent des ennuis et des dégoûts. Alors, s'il survient quelques mots d'un supérieur, il n'est pas nécessaire qu'ils soient bien désagréables pour faire verser des larmes. Du moins, je suis ainsi bâti."

M. Belcourt se peint sur le vif dans ces quelques lignes.

Ce qui l'affligeait plus profondément c'était la dégradation de ses Sauteux. A peine venaient-ils d'être baptisés qu'ils retournaient à leurs anciens désordres. La plupart n'étaient chrétiens que de nom. Dans l'état d'abaissement moral dans lequel ils étaient plongés, il aurait fallu presqu'un miracle pour briser les chaînes rivées par des siècles de désordre. Un torrent d'iniquité avait avilé ces caractères. Les appétits grossiers endormis un instant se réveillaient avec fureur et les entraînaient de nouveau dans le vice. Mgr. Provencher se rendait bien compte de la difficulté de cette mission et encourageait son missionnaire à persévérer. "Il parait gagner du terrain," dit-il, "mais ces pauvres Sauvages sont si abrutis qu'il faudra un miracle de la grâce pour leur ouvrir les yeux. Que Dieu daigne le faire bien vite pour donner du courage à M. Belcourt qui trouve que le temps de sa prédication passe et que les fruits ne sont pas encore en fleurs." Mgr. aurait préféré, avant de construire une chapelle, attendre qu'un certain nombre de Sauteux se fussent sérieusement convertis. Pour ne pas trop contrarier M. Belcourt, il se rendit à ses désirs. Quelques Sauteux se construisirent des cabanes près du site de la chapelle et assistaient fidèlement aux instructions. A l'automne de 1835, il se mit en frais de recueillir sa récolte. Elle ne devait pas être considérable puisqu'il put la terminer en trois jours avec une faucille, aidé de quelques Sauvages armés de couteaux. Pendant l'hiver il s'employa à préparer la charpente de sa chapelle, dont il termina le carré à l'été de 1836.

Ses ressources ne lui permirent pas de la couvrir la même année. Il reçut, en 1836, la visite d'un groupe de Sauteux venus du voisinage des Montagnes-Rocheuses. Ils avaient été députés par leurs parents, pour s'assurer s'il était vrai qu'un prêtre faisait une ville de Sauteux où plusieurs se mettaient de la prière. On leur avait dit que ce prêtre parlait comme eux et qu'il disait des choses d'une sagesse admirable et que c'était le Grand Esprit qui avait fait son cœur. Partis de leur contrée le 20 février, ils n'étaient arrivés à Saint-Paul des Sauteux que le 2 juin. Ils regardèrent attentivement des pieds à la tête M. Belcourt qui les fit fumer et flatta le manche de leur calumet en signe d'affection. Ces Sauvages se montrèrent bien disposés envers M. Belcourt et promirent de revenir avec leurs parents, au printemps, pour se fixer près de lui. Près de Saint-Paul se trouvaient des petits lacs couverts de gibier. La rivière Assiniboine regorgeait de poissons. A certaines époques, les Sauvages y prenaient jusqu'à 30 éturgeons par jour. Ce n'était pas un endroit à dédaigner pour les Sauvages. Au jour de Pâques, cinq jeunes Sauteux firent leur première communion. Malgré les heureuses dispositions d'un petit groupe, le plus grand nombre, tout en assistant à ses sermons, restait attaché au paganisme.

Les forts en médecine s'efforçaient d'aigrir les esprits contre le missionnaire. Ils s'assemblèrent un jour pour déterminer les autres Sauteux à le chasser. Ils en furent quittes pour leur peine. Quelque temps après, un jeune chasseur ne pouvant retrouver ses chevaux dans la prairie eut recours à l'un de ces forts en médecine. Un Sauteux qui avait aperçu ces chevaux au coin d'un bois vint l'avertir secrètement. Ce dernier fit solennellement ses incantations et après avoir reçu des présents du propriétaire, il lui déclara que le manitou lui avait révélé l'endroit précis où étaient ses chevaux et il le lui indiqua sur l'heure. M. Belcourt réussit à découvrir cette fourberie et la dévoila publiquement. Cet incident augmenta son crédit. Mgr. Provencher voyant les travaux considérables de M. Belcourt lui donna Delle Nolin pour institutrice. Elle parlait parfaitement le sauteux. Quoique très attaché à sa mission naissante, M. Belcourt souffrait de la vie sédentaire qu'il menait à Saint-Paul.

Il forma le dessein de se lancer dans la prairie pour visiter les serviteurs catholiques de la compagnie de la Baie d'Hudson dans les diverses postes échelonnés jusqu'aux Montagnes-Rocheuses.

Mgr. Provencher favorisait cette mission ambulante, et désirait la lui offrir, ajoutant: "C'est un homme sur lequel on peut compter." M. Belcourt fit part de ce projet au gouverneur Christie qui abonda dans son sens et lui promit de demander à la Compagnie un passage gratis et l'hospitalité dans ses forts. Mgr. Provencher s'adressa à Sir Geo. Simpson à ce sujet. Il se montra très sympathique et l'assura qu'il écrirait aux membres du comité à Londres pour appuyer cette demande. Mgr. aurait bien désiré envoyer M. Belcourt jusqu'au fort des Prairies (Edmonton) mais il croyait qu'il était de la plus haute importance, pour le succès de ces lointaines missions, de s'assurer l'appui de la Compagnie. Il est bien probable que si Mgr. se fut lancé de l'avant, en négligeant ce point d'appui, les dépenses de voyage auraient fait de telles entailles à son budget, que ses efforts auraient été bientôt paralysés.

La Compagnie eut le bon esprit de comprendre que la présence des missionnaires dans l'ouest serait une garantie d'ordre, de respect de l'autorité et favoriserait ainsi les affaires de la compagnie.

Disons-le à la louange de cette compagnie, elle accorda presque partout une généreuse hospitalité aux missionnaires et favorisa l'exercice de leur ministère.

M. Belcourt, toujours pressé d'aller de l'avant, s'impatientait de ces retards et aurait voulu partir avant la réponse de la Compagnie. Il tourna alors ses regards vers la Colombie Anglaise. Sans s'opposer à ce dessein, Mgr. Provencher préférait le retenir à son poste. Il écrivit le 4 juillet 1837: "L'établissement de M. Belcourt coûte passablement. Sa chapelle est couverte, mais elle sera grande longtemps, car il parait que son troupeau n'a guère augmenté. . . .

J'ai dessein d'envoyer M. Belcourt du côté du lac La Pluie. Ce projet n'aura probablement pas lieu avant l'année prochaine faute de moyens pour cette année. Il manque surtout d'un canot d'écorce qu'il n'est pas aisé de se procurer ici."

Tous ces retards contrariaient M. Belcourt. Pourtant Mgr. Provencher était tout aussi soucieux du salut des âmes que son missionnaire, mais il manquait de tout. Plus d'une fois, n'ayant plus rien à manger, il s'adressait aux enfants qu'il catéchisait les priant de demander à leurs parents un peu de galette et de pemmican, pour maintenir son existence. M. Belcourt évidemment ne se rendait pas un compte exact de la situation. Il écrivit à Mgr. Signay demandant son rappel.

Durant l'hiver de 1837-1838, M. Modeste Demers, vicaire général de la Colombie, se trouvait à la rivière Rouge. Il devait repartir le printemps suivant pour les côtes du Pacifique. Il fut l'hôte de M. Belcourt à Saint-Paul des Sauteux. Ce dernier fut son professeur de sauteux. Au printemps M. Blanchet vint rejoindre son compagnon qui l'avait dévancé de quelques mois et tous deux, le 10 juillet 1838, s'embarquèrent à bord des barges de la Compagnie pour leur lointaine mission.

Depuis six ans (1832-1838) M. Belcourt était demeuré stationnaire à Saint-Paul des Sauteux. Il avait eu le temps de se former à la langue et aux coutumes des Sauteux. De ce jour il ne sera plus que coutumier à St. Paul pendant l'hiver et pendant le reste de l'année on le verra en courses presque continuelles.

1838-1840

Il descend en Bas-Canada. De retour en 1839. Missions au fort Francis et Baie des Canards. Portage des Français. Conférence avec un chef sauteux, Saline. Légende. Wabassimong. Chasseurs Sioux. Anecdote amusante. La cave du Portage du Rat. Notes sur Wabassimong.

Au printemps de 1838. M. Belcourt se rendit en canot, au fort Francis, s'arrêtant çà et là sur la rivière Winnipeg et le lac des Bois, partout où il rencontrait un campement de Sauvages, pour les exhorter à se convertir. Malgré tout le zèle qu'il déploya, ses succès furent bien maigres. A cette époque la compagnie distribuait du rhum aux Sauvages qui sous l'influence de la boisson devenaient des bêtes fauves.

Il fit rapport à Mgr. Provencher, que dans de telles conditions, cette mission donnait peu d'espérance. A peine était-il de retour du lac La Pluie qu'il se décida à visiter la province de Québec, avec l'entente qu'il reviendrait bientôt. Il partit au mois d'août 1838. Mgr. de Québec lui confia en arrivant la desserte de la paroisse de Saint-Joseph de Lévis. Il retourna dans l'ouest au printemps suivant en compagnie de M. Keith, bourgeois de la Compagnie. Ce dernier se montra charmant pour M. Belcourt. Le soir il récitait la prière avec lui. Pendant le voyage six employés désertèrent. Pour éviter ces pertes, les voyageurs campaient dans une île, lorsque la chose était possible. A la fin de juin 1839, il était de retour à St. Paul des Sauteux. Pendant son absence, sa chapelle avait ouvert d'un pouce parcequ'on avait négligé, dit-il, de creuser autour un fossé pour écouler les eaux de la toiture, tel qu'il l'avait demandé.

Il répara lui-même ces dommages. Peu de temps après, il reçut $100 de Sir Geo. Simpson pour l'aider à terminer son dictionnaire sauteux. Il espérait qu'après avoir complété cet ouvrage et enseigné le sauteux à deux ou trois missionnaires, il pourrait retourner en Bas Canada pour s'y fixer. Il se faisait illusion sur ses propres sentiments. Autant il avait senti de répugnance à se faire missionnaire, autant il lui en coûtait de quitter le théâtre de ses pénibles travaux.

Il avait arrosé ce champ de trop de ses sueurs et de ses larmes pour s'en détacher aussi facilement. A l'automne de 1839, il visita la baie des Canards. Il partit le 13 septembre. Rendu au lac Winnipegosis il aperçut un gros camp de Sauvages, qui avertis par un messager l'attendaient. Ils avaient presque tous le corps tatoué. Ils vinrent en canot à sa rencontre. On le fit entrer dans une immense loge où tous les hommes s'assemblèrent. Il y avait là un vieillard de 80 ans, d'une figure et d'une contenance vénérables, en quelque sorte le dieu de la bande. Il avait entendu parler de la venue du prêtre et avait répondu aux gens de sa tribu: "Qu'il ne se donne donc pas cette peine, qu'il prêche les Bois-Brûlés et qu'il me laisse prêcher les Sauvages. C'est moi qui suis leur ministre." On avait étendu par terre une couverte près de ce chef, car c'était à lui que M. Belcourt devait adresser la parole. Après qu'il eut jeté au milieu de la place quelques verges de tabac, à la grande satisfaction de tout le monde, on fit silence. C'était dire qu'on était prêt à écouter le missionnaire. "Dans de pareilles circonstances," dit M. Belcourt, "on ne manque ni de pensées ni de paroles. Dieu fait tout et il me semble que ce que je leur disais était irrésistible. Quand je dis que c'était tout ce que j'avais à leur annoncer, on fit le signe d'assentiment, et le vieillard parla à son tour avec une sagesse qui m'étonna. Je lui avais parlé de la charité que se doivent les hommes entr'eux, comme descendants du même père et ouvrage du même Dieu. De là cette apostrophe: "Mon parent, mes oreilles t'ont entendu avec plaisir et je t'ai parfaitement compris. Ta bouche a prononcé des choses sages et qui m'ont réjoui l'esprit. Plût à Dieu qu'on agit comme tu le désires. Il ferait bon de vivre comme tu viens de nous le dire. On verrait se tarir bien des sources de chagrin. Mais, mon parent, tu ne sais pas à qui tu t'adresses, en parlant à ces hommes-ci, gens qui n'écoutent rien de ce qui est sage. Je m'épuise en vain à défendre aux femmes de s'entre-voler, aux jeunes gens de vivre dans l'impudicité, aux hommes d'aimer d'autres que leurs femmes ou de se faire des injustices. Mais faut-il s'étonner qu'ils ne m'écoutent pas, moi qui suis aussi malheureux qu'eux. Si tu pouvais leur ôter les oreilles pour en mettre d'autres, si tu pouvais leur donner un nouveau cœur, peut-être pourrais-tu en être écouté. Pour moi je désespère de leur changement parce qu'ils sont trop donnés à l'impudicité. Je ne vois que les jeunes enfants qui n'ont pas encore d'idée des femmes avec lesquels tu pourrais faire quelque chose de bien. Au reste je souhaite que tous t'écoutent et je le leur conseille."

Après ce discours l'assemblée se dispersa en deux camps, les uns désirant se faire instruire et les autres s'y opposant.

M. Belcourt fixa un nouveau rendez-vous pour l'année suivante pour ceux qui désiraient l'entendre.

Quelques jours après, il arrivait à la baie des Canards. Il y reçut le meilleur acceuil. On se hâta de lui préparer une loge et tous s'empressèrent autour de lui, pour entendre sa prédication. Il y baptisa 15 enfants et apprit les prières à 41 adultes qu'il confessa. Des vieillards se jetaient à ses genous pour apprendre à faire le signe de la croix. Il leur promit de revenir l'année suivante. Il se proposait de faire construire une petite chapelle par les hommes qui l'accompagneraient dans ce voyage.

Tout près de cette mission se trouvait une saline où l'on venait de partout pour chercher du sel. L'hiver pendant les gros froids, les Sauvages puisaient dans une source d'eau très salée et en peu de temps par l'ébullition, ils réduisaient cette eau en sel. Un seul Sauvage parfois faisait jusqu'à cent minots de sel pendant l'hiver, qu'il vendait à 10 chelins le baril. Comme la seule chaussure portée alors était faite en cuir mou qui se brûlait en marchant aux abords de la saline, ceux qui se livraient à cette industrie, attachaient des semelles en bois à leurs souliers.

De 1840 à 1841 M. Belcourt visita de nouveau le fort Francis et la baie des Canards. Il avait pour guide Antoine Lafrenière, natif de Berthier, et était accompagné de trois Sauvages chrétiens. Je relève ici deux anciens noms géographiques que je trouve dans les lettres de M. Belcourt. Le rapide de Saint-André s'appelait "Saut de la Biche," tandis que l'île à la Biche, à l'entrée de la rivière Winnipeg, portait le nom de "Portage des Français." Le passage entre la terre ferme et cette île était si peu profond que les Français, lors de la découverte du pays, étaient obligés souvent de faire portage sur l'île, de là le nom de Portage des Français. Il s'arrêta quelque temps au lac du Bonnet pour prêcher à un groupe de Sauvages. Un vieillard, s'avançant vers lui, lui répondit: "Un Sauvage du lac Supérieur mourut peu de temps après son baptême et en conséquence il parut devant Dieu, pour être placé dans le domaine des baptisés, mais à sa grande surprise, une main puissante lui en défendit l'entrée parce qu'il était Sauvage et que les Sauvages n'entraient pas là. Il s'en retourna donc trouver les Sauvages non baptisés qui étaient dans un lieu séparé, mais ceux-ci le repoussèrent avec mépris et ne sachant où aller, il revint sur la terre, pour vivre encore et raconter, après sa résurrection, l'histoire qu'ils faisaient circuler partout." M. Belcourt pour se moquer d'eux leur répliqua: "Mais alors faites-vous donc baptiser pour vivre deux vies" et les Sauvages ne savaient quoi lui répondre. Cette histoire grossière ne manqua pas de faire des dupes. Elle se répandit de tribu en tribu avec des variantes. Un jour le P. Lacombe O. M. I., étai tà évangéliser un gros camp de Cris, aux pieds des Montagnes Rocheuses, lorsqu'un chef lui posa la même objection.

Cette fois, afin d'empêcher le P. Lacombe de le confondre, ils prétendirent que ce chef habitait les côtes du Pacifique. Le P. Lacombe eut beau leur démontrer l'absurdité de cette fable, les Sauvages refusèrent de l'entendre lui répétant sans cesse: "Prouve le—Prouve le." Rentré dans sa loge, le missionnaire fit partir son guide pour aller chercher ce chef. Quelques semaines après, il revenait accompagné du chef en question. Il n'eut pas de peine alors à les convaincre que cette histoire n'était qu'un odieux mensonge. Ce fut le coup de mort à cette légende.

M. Belcourt trouva un gros camp de Sauteux à Wabassimong (Chien Blanc). Il s'arrêta trois jours pour les décider à se faire instruire. Il fut reçu froidement. Un Sauvage avait remonté la rivière avant lui, calomninant les prêtres catholiques et indisposant les Sauvages contre lui. Sans se laisser déconcerter, il leur adressa la parole. Après l'avoir entendu, ils se retirèrent pour délibérer et finalement ils consentirent à se faire chrétiens, pourvu qu'un prêtre vint demeurer chez eux, l'été suivant.

Il rencontra au lac des Bois des guerriers sauteux qui venaient de poursuivre des chasseurs sioux qui s'étaient aventurés jusque là. A cette époque, les Sioux n'osaient plus fréquenter le lac des Bois par crainte des Sauteux. Avant de partir de Saint-Boniface, Mgr.

Provencher avait chargé son canot de pemmican, tabac, etc., afin que M. Belcourt put faire quelques présents aux Sauvages. Ces derniers toujours imprévoyants ne pouvaient demeurer longtemps auprès du missionnaire sans être à bout de vivres. Pour les retenir M. Belcourt faisait chaudière, pour me servir d'une expression du pays.

Au fort Francis, il comptait une cinquantaine de chrétiens comprenant des Canadiens-Français, des Métis et des Sauvages. M. Belcourt estime qu'il y avait entre les lacs Winnipeg et La Pluie environ 800 chasseurs presque tous hautains, cruels et idolâtres.

Un ministre méthodiste ainsi que sa famille résidaient au fort Francis. La Compagnie lui permettait de loger dans le fort et cherchait à lui gagner les faveurs des Sauvages. Ces derniers répétaient partout: On ne veut prier qu'avec le ministre non-marié, l'autre n'est pas un véritable prêtre. Le gouverneur Allan McDonnell était catholique mais obéissant à des ordres supérieurs, il voulait réserver le lac La Pluie aux méthodistes. Il est vrai que Sir Geo. Simpson était bien disposé envers le clergé catholique, mais il y avait dans le bureau de Londres un directeur mal disposé qui poussait le clergé protestant vers la rivière Rouge. Néanmoins, M. Belcourt fut beaucoup plus satisfait de cette mission que de la précédente. Les Sauvages se montrèrent mieux disposés parce que la Compagnie avait cessé de leur donner de la boisson.

En descendant la rivière La Pluie il rencontra un canot monté par un Sauvage et sa femme. Il demanda à l'homme où il allait. Il répondit, je retourne dans mon pays, je suis étranger ici. D'où viens-tu donc, lui demanda M. Belcourt? Il répondit du lac des Sables. Priez-vous par là, dit-il? Quelques-uns prient, répliqua le Sauvage. Le missionnaire reprit: vous faites bien, faites vous instruire et devenez sages, mais comment s'appelle le prêtre qui est là. Le Sauvage se mit à rire aux éclats ainsi que sa femme. C'est un de ces soi-disant prêtres qui sont mariés; voilà pourquoi je ne l'écoute pas, dit le Sauvage.

M. Belcourt ne put s'empêcher de rire de sa méprise.

Il fut également bien acceuilli au portage du Rat mais il fallit y perdre son guide à la *Cave de la Chute*. Ce dernier hélait le canot le long d'un rocher lorsque le pied lui glissa et l'instant d'après il disparaissait dans un remou. Au moment où il revint à la surface, M. Belcourt, qui avait saisi à temps la corde du canot, le poussa vers lui. Il le saisit et put ainsi le sauver. A ce même endroit, en 1835, Jean-Baptiste Laplante s'était noyé. Quelques jours après il se trouvait à Wabassimong. Ce poste était situé sur la rive nord de la rivière

Winnipeg, sur une pointe fort haute, formée par la rivière des Anglais, qui prend sa source dans le lac Seul et descend dans la rivière Winnipeg. Il y planta une croix, en attendant d'y ériger une chapelle. Malgré les bonnes dispositions d'un groupe de Sauteux, en voyant leur attachement au paganisme, M. Belcourt s'écriait: Convertir les Sauteux que je viens de visiter c'est transporter des montagnes. Ce miracle je l'espère des saintes âmes qui tous les jours supplient le Seigneur à cette intention. M. Belcourt estimait que dans le district avoisinant, Wabassimong, se trouvaient un millier de Sauvages et que la chapelle coûterait $150. Il croyait qu'un missionnaire pourrait subsister avec quelques secours parce que le sol était fertile et la rivière poissonneuse. Il prépara une carte de cette rivière qu'il adressa à Mgr. de Québec.

FOLLE-AVOINE—NOTES DE M. BELCOURT

La folle-avoine croit en abondance dans les baies des rivières et des lacs, surtout lorsque l'eau y est basse. Cette plante dont la tige est d'environ six pieds de hauteur croît dans l'eau. Elle porte un épi semblable à celui de l'avoine mais plus abondant en grains et chaque grain est presque moitié plus long. Sa pesanteur surpasse celle du blé. Une once de graisse ou de suif et une pinte de cette folle avoine font 2 ou 3 gallons d'une soupe épaisse que celui qui a faim trouve bonne mais fort peu soutenante. Cette récolte se fait par les Sauvages depuis la fin d'août jusque vers le 30 septembre, de la manière suivante: Ils entrent avec leurs petits canots à travers un champ de folle avoine. La tige dépassant de 3 à 4 pieds pardessus leurs canots, ils la courbent sur le maitre, frappant avec un bâton le grain qui tombe dans le fond du canot. Lorsqu'ils le trouvent assez chargé, ils vont le déposer sur des nattes pour l'y faire sécher, puis le piler ensuite pour en faire partir la balle. Ils la mettent ensuite dans de petits sacs de jonc, contenant environ 3 à 4 gallons.

1840-1843

Mission à la baie des Canards. Le poste Manitoba. Loge de Médecine. Le Mitewi. Discours d'un chef sauteux. La crainte de l'enfer. Ile Kistche Wigwam. Agask-O-Kat. Forts Pelly et Ellice. Chapelle de Wabassimong.

Après s'être reposé de son voyage au fort Francis, M. Belcourt partit le 18 septembre pour la baie des Canards. Il dut fabriquer lui même son canot avec l'écorce de bouleau qu'il avait apportée du lac des Bois. Le premier jour de son départ, il atteignit le lac Manitoba, soit à environ 30 milles de Saint-Paul. Il eut le temps d'administrer un jeune Sauvage qui expira pendant la nuit.

A cette époque ce lac abondait en poissons blancs pesant jusqu'à 8 livres. Cà et là sur ses rives on apercevait des érables que les Sauvages entaillaient au printemps pour faire du sirop.

Au détroit se trouvait le poste Manitoba, qui ne comprenait qu'une maison et quelques petits bâtiments couverts d'écorce. Il n'y avait ni pieux debout ni palissade autour du fort. Le traiteur était un homme de confiance mais qui ne sachant ni lire ni écrire avait sous lui un commis qui tenait ses comptes. Les fenêtres de la maison étaient fermées avec des peaux. Il y fit cinq baptêmes. Non loin du poste de Manitoba, sur une pointe qui s'avançait dans le lac, se trouvait un gros camp. Un Sauvage vint le supplier d'arrêter à cet endroit pour voir son fils qui perdait souvent connaissance. Un jour, dit-il, qu'il était dans cet état, il eut une vision. "Prends la prière, lui dit le maître de la vie, et tu seras guéri." M. Belcourt accéda à sa demande et il y trouva 200 Sauvages assemblés de partout. Quelques uns même étaient venus de la rivière au Brochet (Norway House). On le fit entrer dans une vaste enceinte formée par de petites bottes de grands roseaux, debout l'un contre l'autre, retenues par une perche de travers, fixée sur des fourches plantées en terre de distance en distance. Cette enceinte avait environ 80 pieds de longueur et 30 de largeur. Au milieu se trouvait une loge, qui traversait cette enceinte dans toute sa largeur, recouverte à 7 à 8 pieds de hauteur.

Cette loge était chargée d'effets de toutes espèces, qu'on avait livrés les uns par voeux dans des temps de maladie et d'autres enfin pour qu'on leur donne en échange des médecines. Au milieu sur le sol, était une pierre ronde vermillonnée avec une base en terre blanche. Au-dessus s'élevait une petite perche au haut de laquelle était fixée une tête de pipe en porcelaine. Déjà on était sur le point de commencer le *Mitewi* (jonglerie). Les jeunes gens se vermillonnaient le corps, chacun suivant son goût. Les femmes peignaient leurs enfants. Les hommes se partageaient le tabac et après que chacun avait reçu sa part, il répondait: Kanakekana (Deo Gratias).

Ces pauvres idolâtres sentaient le besoin d'une religion et de rendre hommage à la Divinité. Dans leur profonde ignorance, ils se livraient à des cérémonies ridicules.

En apercevant M. Belcourt, les Sauvages étendirent dans la loge une peau d'ours et l'invitèrent à leur parler. Il leur fit un chaleureux appel à prendre la prière, afin de plaire à Dieu dont il était le ministre. Le chef Agask-O-Kat, lui répondit: "Je suis convaincu que tu veux notre bonheur. Tes paroles sont sages. Ta bouche est bonne. Le Manitou qui a fait les Français a fait ton cœur. Mais je te l'ai déjà dit l'an dernier ce que je pensais. J'ai vu depuis notre Manitou. Voici ce qu'il m'a dit: Le Grand Esprit est dans le ciel. C'est lui qui a fait les blancs avec de la terre blanche. Notre Manitou, celui qui nous a fait misérables comme nous sommes est dans la terre et non pas dans le ciel. Il nous a fait avec de la terre noire et voilà pourquoi nous ne sommes pas blancs comme les Français. Oui, notre Manitou, notre père est dans la terre et la terre est notre mère. Le soleil est son fils et la terre est sa fille. Les étoiles sont leur nombreux enfants. Je l'ai vu notre Manitou. Regarde là (montrant du doigt la pierre ronde) voilà comment il m'est apparu. Il finit par dire qu'il ne voulait pas changer de religion mais qu'il laissait les membres de sa tribu libres de faire ce qu'ils voudraient. M. Belcourt lui répondit que puisqu'il refusait de se convertir, il risquait fort de brûler en enfer dans des tourments indicibles. Cette menace produisit de l'effet chez plusieurs Sauvages qui promirent d'aller se faire instruire à Saint-Paul des Sauteux."

Dans la partie nord du lac Manitoba, M. Belcourt dit qu'il se trouvait une île appelée "Kistche Wigwam" c'est-à-dire la grosse loge, parce qu'à tous les ans, les Sauteux se réunissaient dans cette île, dans une grande cabane qu'ils avaient construit pour y faire la médecine.

A la baie des Canards une centaine de personnes assistèrent au catéchisme. Il y fit 18 baptêmes et confessa 70 personnes. La compagnie n'avait pas de fort à cet endroit, mais les Sauvages y étaient attachés surtout parce que leurs morts depuis nombre d'années y avaient été enterrés.

De là, M. Belcourt se rendit au "Coude de l'homme" (fort Pelly) et à la rivière du Cygne. Le Dr. Todd était en charge de ce fort et M. McKay du fort Ellice. Il fut reçu partout avec la plus grande hospitalité. Ces deux forts étaient entourés de murs et de bastions pour inspirer le respect aux Sauvages.

Les Sioux venaient enlever des chevelures jusqu'aux portes de ces forts. Pendant cet été plus de 2,000 Sauvages visitèrent le fort Ellice. M. McKay avait semé un champ de blé mais les Sauvages le cueillirent avant qu'il ne fut mûr. M. Belcourt, épuisé de fatigue, après avoir parcouru 300 lieues, arriva à Saint-Paul le lendemain de la Toussaint. Mgr. Provencher était très inquiet à son sujet, car une rumeur s'était répandue qu'il avait été assassiné à la rivière du Cygne. Pendant l'année 1840, l'ouest fut exposé à de violentes tempêtes. La foudre éclatait souvent. Un jour, un parti de chasseurs fut frappé. Dix-neuf d'entr'eux perdirent connaissance parmi lesquels se trouvait François Courchène de St. François, lac Saint Pierre, P.Q. Trois autres expirèrent sur le champ.

L'année suivante (1841) les Sauteux entrèrent en campagne contre les Sioux et les Pieds-Noirs et la prairie devint en feu.

M. Belcourt réussit à semer cette même année 15 barils de patates, 7 d'orge, 5 de blé et une petite quantité de pois et de fèves. Il possédait de plus 8 vaches et une basse-cour. Il se servait en général du produit de sa ferme, pour obtenir en échange des quartiers de bœuf sauvage. Au printemps il recommença ses missions. Les Sauvages du lac Seul descendirent le rencontrer à Wabassimong, tandis qu'au fort Francis, les Sauteux se groupèrent autour de la croix plantée par MM. Tabeau et Crevier. Mgr. Provencher avait donné plein pouvoir à M. Belcourt d'aller partout où il croirait pouvoir faire des conversions sans se mettre en peine de son poste à Saint-Paul dont il se chargerait. Parlant des Sauteux de la rivière Winnipeg, Mgr. Provencher écrivait: "Les Sauvages sont méchants de ce côté-là, mais Dieu peut faire avec des pierres des enfants d'Abraham."

Toutefois à Saint-Paul, M. Belcourt avait réussi à bannir la boisson. Un jour trois Sauteux tentés par un blanc de passage à cette mission s'enivrèrent. Il leur imposa comme pénitence de se tenir debout près de la porte de la chapelle pendant trois dimanches consécutifs. Ils se soumirent en toute humilité à cette discipline qui rappelait les temps apostoliques.

Au printemps de 1842, il put se procurer une institutrice du nom d'Isabelle Gladu. Elle avait été formée à l'enseignement par M. Poiré, à la prairie du Cheval Blanc.

Sur la rivière Winnipeg, les Sauteux pressés par les exhortations de M. Belcourt finissaient parfois par révéler le motif véritable et la raison ultime qui les retenaient dans le paganisme.

Nous consentirons, disaient ils, à nous faire baptiser, pourvu que tu n'exiges pas qu'on soit chaste. Nous ne pouvons pas nous soumettre à ce précepte.

A Wabassimong, les Sauvages firent chantier à un mille ou deux en amont de l'endroit où la croix avait été plantée en 1840 et après avoir mis le bois en cajeu, ils le descendirent, et le montèrent ensuite sur leur dos jusqu'au haut de la colline. Le carré de la chappelle fut construit. M. Belcourt réussit également à scier le bois du plancher, mais l'ouvrage dut être abandonné le 22 juillet (1842) parce que les Sauvages manquaient de provisions. Cette chapelle avait 40 pieds de longueur et 25 de largeur. En 1842, il y baptisa 64 personnes, parmi lesquelles se trouvaient les enfants de trois chefs du lac Seul, qui se firent instruire eux-mêmes. Il fondait de grandes espérances sur cette mission dont il rêvait faire un poste central, pour de là rayonner tout autour. Afin de fixer les Sauvages au sol, il se proposait de leur prêter quelques vaches et moutons. Il se laissait trop facilement entraîner par des espérances d'avenir, sur de simples promesses de conversion. Ces chrétiens de quelques jours qui suintaient le paganisme le plus abject par tous les pores ne valaient pas cher. Wabassimong devait lui ménager plus tard une amère déception. Mgr. Provencher aurait préféré qu'il amenât des ouvriers pour construire, pendant qu'il se consacrerait exclusivement à l'instruction des Sauvages. Il croyait que pour obtenir quelques progrès, il devrait séjourner plusieurs mois au milieu d'eux. Entre temps la chapelle de Saint-Paul était en mauvais état. Les chevrons menaçaient d'échapper de dessous les sablières.

A cette époque M. Belcourt recevait $500 par année de Mgr. de Québec, mais il avait bien du mal à équilibrer son budget.

A Saint-Paul le nombre des chrétiens diminuait et les Sauvages ne semaient plus aucun grain.

1843-1844

Projets industriels. Légende. Portage de l'Enfant perdu. Possédé converti. Tumulus sur l'Ile au Massacre. Etablissement de Notre-Dame de Merci (Wabassimong.) Ses progrès. Course à la Falle de la Perdrix. Démons chassés par l'invocation de la Sainte-Vierge. Sir Geo. Simpson. Dictionnaire sauteux.

En 1843, la chapelle de Saint-Paul n'était pas encore toute crépie et déjà elle menaçait ruine. M. Belcourt se proposait de convertir une partie de sa chapelle en atelier. Il voulait y monter des rouets et métiers pour y fabriquer de l'étoffe et de la toile. Il se disposait à faire du fil avec une espèce d'ortie qui poussait en abondance dans la baie. Bien plus, il avait l'intention de préparer un tissu avec le poil de bison.

En attendant, le plancher de sa chapelle qui avait été construit avec des croutes de bois blanc était en partie pourri.

La chapelle n'était recouverte que d'écorce et de terre. A tous les automnes il fallait réparer la couverture. Il aurait bien voulu y substituer du bardeau mais un baril de clous coûtait $35 et sa bourse criait famine. Delle Angélique Nolin était retournée à Saint-Boniface et il se trouvait seul dans une nouvelle maison de 30 par 25 qu'il avait terminée à l'automne de 1843. Il s'était hâté de finir sa résidence, parce qu'il était rumeur à la rivière Rouge que les PP. Jésuites devaient se charger des missions. Il devait être leur instituteur de

Sauteux. Ce projet n'eut pas de suite. Durant l'été les moustiques devinrent tellement insupportables que les voyageurs en étaient affolés. "Dans les campements, dit M. Belcourt, au souper nous étions actifs et passifs, mangeant et mangés. Nous passions la nuit à défendre notre sang." Un jour qu'il faisait du feu, un Sauvage infidèle qui le regardait s'étant aperçu qu'en passant une allumette sur sa manche de soutane, elle s'enflammait, crut que cette vertu venait de son habit. Il lui offrit ce qu'il avait pour avoir un petit morceau de sa soutane.

Le 2 juin 1843, lorsqu'il partit pour le lac La Pluie, M. Thibault était de retour de la prairie et M. Darveau était en route pour la baie des Canards. M. Belcourt avait construit un abri à l'entrée de la rivière Tête-Ouverte pour catéchiser les Sauvages. La vénalité du chef rendit son ministère infructueux. Il demandait un habit complet pour se faire chrétien. M. Belcourt lui représenta tout l'odieux d'une telle proposition, mais sans le faire changer. Le fils de ce chef avoua qu'il avait honte de son père.

De prétendus prédicants méthodistes faisaient appel à des moyens sordides pour attirer à eux les Sauvages. M. Belcourt leur décoche le trait suivant: "En voulant donner la foi, à un peuple tout de chair, des hommes qui se disent chrétiens prennent tous les moyens propres à rendre ces pauvres gens plus sensuels encore, en alimentant par l'argent, leur attache exclusive aux biens de la terre."

Au fort Alexandre, il rencontra les barges du lac La Pluie. La plupart des employés qui faisaient ce service pour la Compagnie étaient catholiques. Le chef d'équipage leur donna le temps de s'acquitter de leurs devoirs religieux et M. Belcourt en confessa trente trois.

Au lac du Bonnet, les Sauvages l'accueillirent avec joie. Un vieillard demanda à être baptisé. Plusieurs autres l'imitèrent et le supplièrent de construire une chapelle à cet endroit. Il promit de se rendre à leur demande l'année suivante, s'ils persévéraient dans leur bonne disposition.

Sur la rivière *Tabinawa* (à l'abri du vent) les Sauvages avaient donné à un portage le nom de "L'enfant perdu" à cause de la mort tragique d'un jeune enfant sous les yeux de ses parents. Au cours de ce portage se trouve une crevasse d'environ 14 pouces de largeur, à une profondeur énorme. Au fond de ce précipice flotte une mousse épaisse. Un enfant de trois ans eut le malheur de glisser dans cette crevasse et de tomber au fond. Il appelait à son secours son père et sa mère au désespoir dont il était aperçu du haut de cet abîme. Il se soutint longtemps au-dessus de l'eau à l'aide de cette mousse, jusqu'à ce qu'enfin, épuisé de fatigue, il disparut.

L'hiver précédent les Sauvages avaient cruellement souffert de la faim parce qùe la récolte de la folle avoine avait manqué.

Un père tua son enfant et le dévora, tandis que la mère redoutant le même sort, réussit à se traîner à un poste de la Compagnie.

Au lac La Pluie douze personnes moururent de faim.

M. Belcourt rencontra une foule considérable de Sauvages qui l'attendaient au Portage du Rat. Pendant qu'il expliquait la nature et les effets du baptême, un jeune homme se détachant du groupe, s'élança vers la rivière. Il se serait précipité à l'eau, si son père ne l'eut retenu. M. Belcourt croit qu'il était possédé du démon. Depuis plusieurs années, il était souvent agité par le mauvais esprit.

Lorsqu'il fut revenu à lui, M. Belcourt l'instruisit et le baptisa. Depuis lors il devint calme et fervent chrétien.

Il eut également la consolation de rencontrer un vieux Canadien Français du nom de Jourdain qui depuis nombre d'années vivait à la manière des Sauvages.

En voyant M. Belcourt, le souvenir de sa première communion se présenta à son esprit et toucha son cœur. Il se confessa avec une vive émotion et mourut réconcilié avec le Dieu de sa jeunesse.

M. Belcourt avait souvent entendu parler d'une île où un prêtre et des Français avaient été tués autrefois par les Sioux.

En revenant du fort Francis, durant l'été de 1843, il résolut d'aller visiter cet endroit. Il convient de citer textuellement ce qu'il écrit à ce sujet car il touche à un fait historique important. "Je pris ici, (Rapide Manitou, sur la rivière La Pluie) des informations sur le lieu de la sépulture d'un missionnaire français tué par les Sioux dans le lac des Bois, et je détournai ma course pour voir s'il serait possible d'en reconnaître quelques vestiges. On y remarque un énorme chêne, qu'un vieillard me dit avoir vu déjà vieux, lorsqu'il était enfant. On y voit un monceau de pierres que les Sauvages disent avoir servi à inhumer le missionnaire ainsi que quatre hommes de l'équipage tués dans ce massacre. Je n'ai pu remarquer ni os ni dents, quoique tout indique une sépulture. D'après le calcul de plusieurs vieillards, il y aurait de 90 à 100 ans, qu'un prêtre venu comme chapelin de l'équipage des canots français, mit pied à terre sur cette petite île au côté nord-ouest. Pendant qu'ils déjeunaient la fumée de leur feu fut aperçu par un parti de guerre Sioux, qui descendus par une petite rivière qui se décharge dans celle de La Pluie appelée chemin de guerre, étaient descendus jusqu'au lac où ils cherchaient à surprendre les Sauteux. Arrivés sur ces hommes sans défense ils les massacrèrent impitoyablement, à l'exception de trois ou quatre qui s'étant jetés à l'eau, s'y noyèrent. On ajoute que le chef sioux a conservé longtemps le calice du missionnaire sans le briser."

J'ajouterai que la partie nord-ouest de l'île au Massacre est plus élevée que le reste de l'île et la plus commode pour un campement. C est à cet endroit que Mgr. Langevin a fait construire une chapelle sous le vocable de "Reine des Martyrs."

M. Belcourt s'arrêta à Wabassimong et y fit le catéchisme à 78 sauvages parmi lesquels se trouvaient des vieillards de 70 ans.

Sir Geo. Simpson vint le trouver à ce poste et le félicita de son entreprise. Sa chapelle était alors couverte en planches et il espérait pendant l'hiver préparer le bardeau et le poser au printemps suivant.

Il se proposait également d'y envoyer des charrues, des bœufs, des vaches et des moutons pour inviter les Sauvages à la culture. Sir Geo. Simpson lui offrit des provisions et lui prodigua des témoignages d'estime.

M. Belcourt dans une lettre qu'il adresse à Mgr. de Québec dit que Mgr. Provencher le laissait libre de faire tout le bien qu'il pouvait parmi ces nations mais qu'il était souvent fort embarrassé sur ce qu'il convenait de faire. Il était un peu effrayé des dépenses de cette entreprise. Il ne recevait que $500 de traitement annuel de la propagation de la foi de Québec et ce seul établissement avait fait à sa bourse une saignée de $420, à part des frais de transport.

Quoiqu'il en soit, il résolut de pousser cet établissement jusqu'au bout. De retour à Saint-Paul, il dépêcha Wm. Pritchard avec sa femme et trois engagés à Wabassimong, pour préparer la terre, faire les semailles, etc. Il donnait à Pritchard $100 par année. Pendant l'hiver il envoya au même endroit, à travers les terres, des traîneaux chargés d'instruments agricoles et d'outils.

Au mois de février 1844, à la demande des Sauvages de la Falle de la Perdrix, il partit avec deux traînes à chien et deux Métis qui avaient des parents à cet endroit. En se rendant à la baie des Canards, il s'était déjà arrêté deux fois à la Falle de la Perdrix.

Le chef fut touché de le voir à cette époque de l'année mais il finit par lui dire que ses superstitions et la prière étaient d'égales forces. C'était disait-il, comme un fusil à deux coups, dont tous deux portaient avec la même justesse, au même but.

M. Belcourt nous rapporte ici un événement bien émouvant qui venait de se passer dans les territoires de chasse. Je lui donne la parole: "Il y eut cet hiver dans un camp d'infidèles qui suivaient les bandes de bœufs sauvages dans la prairie, une alarme qui les effraya beaucoup. Quelquesuns d'entr'eux avaient aperçu, à plusieurs reprises des spectres horribles rodant autour des loges.

"Il se trouvait là un Sauvage chrétien qui n'avait eu connaissance de rien et qui dormait tranquille. On accourut à sa loge, on le réveilla puis on lui dit: Les démons sont ici. Toi qui parles au Grand

Esprit dans la prière, lève-toi vite. Demande au Grand Esprit qu'il ait pitié de nous, car sûrement ils viennent ici, à la chasse aux Sauvages. Mon Sauteux chrétien se leva, prend son chapelet puis sort de sa loge et leur dit: Mes parents, voyez donc comme vous faites pitié. Vous avez peur des démons et vous voulez toujours les servir et vous craignez de servir le Grand Esprit qui est plus fort qu'eux. Apprenez donc qu'un priant n'a pas peur des mauvais Manitoux, quand même ils seraient par centaines. Puis levant les yeux au ciel: Marie, dit-il, la bonne mère des chrétiens, garde ce camp, garde mes parents. Peut-être quelqu'un d'entr'eux cessera d'être bête et priera bientôt. Allez, dit-il alors, à ses confrères tremblant de frayeur, retournez dans vos loges et dormez tranquilles. Pas un démon n'approchera d'ici. Notre Grande mère les a chassés. Il se mit alors à genoux, dit un chapelet, puis après il alla se coucher et tout le monde dormit tranquille."

Au printemps de 1844, M. Belcourt retourna à Wabassimong apportant avec lui des grains de semence, des ustensiles de cuisine et 6 moutons. Il avait mis à part dans une caisse, des vitres pour sa chapelle. C'était un objet de luxe à cette époque. Une partie considérable de ces vitres se brisa dans un portage et il en fut quitte pour sa peine.

Au bas de la chute aux Esclaves, sur la rivière Winnipeg, il éprouva une agréable surprise. Il entendit tout à coup des cris de joie. C'était des Iroquois qui guidaient les canots partis de Lachine. Ils avaient à bord MM. Laflèche et Bourassa et quatre Sœurs de la Charité. L'une de ces dernières (Sœur Lagrave) était assise sur un brancard souffrant encore d'une entorse qu'elle s'était donnée en descendant de canot, sur le lac Supérieur. La brigade était en charge de M. McPherson, bourgeois de la Compagnie. Ils étaient si pressés de part et d'autre de terminer leur voyage, qu'ils n'eurent que le temps d'échanger quelques saluts. M. Belcourt fit 26 portages, transportant lui-même son canot. Il en eut l'épaule si meurtrie, qu'il pouvait à peine lever le bras. Au portage du Rat, il était toujours bien accueilli par le commis en chef, M. McKenzie. Ce dernier l'invitait à loger au fort. Il n'en était pas ainsi au fort Francis. Or, en 1844, Sir Geo. Simpson arriva à ce dernier poste, quelques jours après M. Belcourt. Il retournait en Canada. Il se montra fort mécontent lorsqu'il apprit que le missionnaire catholique n'avait pas été reçu au fort. Il ordonna à l'instant au commis en charge de lui préparer une chambre. Il alla lui-même trouver M. Belcourt et lui dit: J'ai ici une maison qui m'est destinée. Elle est vaste et commode. Emparez-vous en et ne vous regardez plus comme un étranger dans aucun des postes où il vous plaira d'aller.

Après le départ de Sir Geo. Simpson, le commis vint lui présenter ses excuses et l'assura qu'à l'avenir il trouverait des chambres prêtes à le recevoir à son arrivée.

M. Belcourt croyait que s'il eut pu demeurer à tous les ans trois semaines au lac La Pluie, la moitié des Sauteux se serait convertie. La proximité des Sauvages convertis par M. Peers, missionnaire au Grand Portage, disposait favorablement les Sauteux du fort Francis à prendre la prière. Il s'arrêta au retour à Wabassimong pendant un mois. Il y reçut la visite du gouverneur Finlayson et du bourgeois P. Ogden. Il y baptisa 32 Sauvages et en confessa 62.

En traversant le lac des Bois, il avait aperçu un énorme rocher présentant une façade plane et perpendiculaire, couvert d'une mousse noire connue vulgairement sous le nom de tripe de roche.

Il s'y arrêta, gravit cette éminence et y traça les monogrammes J. H. S.—M en gros caractères couvrant une étendue de 20 pieds. Pendant de nombreuses années, les voyageurs, qui visitaient ces parages, purent admirer ces signes si touchants de la piété de ce missionnaire. Ils constituaient pour ainsi dire une prise de possession de ce lac au nom du Sauveur et de sa Divine Mère.

De retour à Saint-Paul, Mgr. Provencher vint y donner la confirmation. Une troupe de 150 cavaliers se porta à sa rencontre et lui fit escorte. La cloche de la chapelle qui pesait 20 livres se mit en branle. Les Sauvages furent électrisés par cette démonstration dont ils n'étaient pas coutumiers.

A cette époque M. Belcourt avait à peu près terminé son dictionnaire sauteux. Sir Geo. Simpson lui offrit de défrayer une partie des frais d'impression, et un passage gratis en Angleterre, via la baie d'Hudson, afin de surveiller ce travail.

Pendant l'hiver, il fit transporter 6 vaches et 3 bœufs de travail à Wabassimong. La récolte avait été bonne, mais les sauterelles et les souris en avaient détruit une grande partie.

1845

Meurtre de M. l'abbé Darveau ainsi que d'un Sioux et d'un Sauteux. Le coupable expire sur l'échafaud. La chasse au bison.

En 1844, Mgr. Provencher avait eu la douleur de perdre l'un de ses auxiliaires dans la personne de M. Darveau.

"J'ai appris, dit ce prélat, en juillet 1844 qu'il était parti de la baie des Canards le soir et avait campé à une petite distance. Il est probable qu'il a péri en partant le lendemain parce qu'on a trouvé son canot, ses autres effets et son corps ainsi que celui de J.-B. Boyer, Métis de la prairie du Cheval Blanc, à peu de distance de son campement. On m'a annoncé qu'il s'était noyé ainsi que les deux hommes qu'il avait avec lui."

Toutefois il ajoute un peu plus bas qu'un Sauvage qui était aussi avec lui n'avait pas été trouvé. Déjà une certaine rumeur circulait accusant les Sauvages de l'avoir assassiné. Au mois d'août 1845, écrivant à son ami de cœur, M. C.-F. Cazeau, secrétaire de Mgr. de Québec, M. Belcourt fait allusion à ce bruit qu'on répand et lui dit de n'en rien croire. "Je connais très bien, dit-il, les Sauvages de ces cantons, avec lesquels j'ai conversé longtemps sur ce sujet. J'ai vu le lieu où la scène de ce funeste accident s'est passé, et je puis t'assurer que ce rapport n'a pas de vraisemblance." Tel fut le verdict des hommes les plus en vue de cette époque. Mgr. Taché recueillit cette tradition et s'y attacha.

Enfin la lumière a fini par éclaircir ce sinistre drame et un jour le P. Camper, O. M. I., put produire une preuve irréfutable que M. Darveau avait bien été tué et d'une manière bien cruelle.

Habemus reum confitentem. L'un des meurtriers même confessa son crime peu de temps avant sa mort ajoutant, je vais bientôt brûler parce que j'ai tué le prêtre. Les meurtriers étaient trois Muskegons du nom de Chetakonn, Tchimekatis et Witchina.

En 1845, un parti de Sioux se rendit à la Fourche (Winnipeg) pour faire la paix avec les Sauteux et les Métis.

Un jeune guerrier sauteux infidèle, dont le père avait été tué en guerre, par ces mêmes Sioux, parvint à fendre la foule et à pénétrer jusqu'à l'un d'eux. Il le tua presqu'à bout touchant. La balle perça deux cœurs à la fois, celui du Sioux et celui d'un Sauteux qui se trouvait en arrière et alla tomber dans la jupe d'une femme à quelques pas de lui. Ce meurtre eut lieu un dimanche vers 6.30 p.m. Le procès ne fut pas long. La même semaine (6 septembre 1845) M. Belcourt accompagnait cet infortuné à l'échafaud, où il fut pendu, après avoir demandé et reçu la grâce du baptême, la veille de son exécution.

A tous les ans, les Métis allaient chasser dans le haut du Missouri. Les Américains les avertirent en 1845 que c'était la dernière fois qu'il leur permettait de chasser chez eux.

Venez résider aux États-Unis, leur disaient-ils, et vous chasserez tant que vous voudrez, pourvu que vous vendiez le produit de votre chasse, dont vous n'avez pas besoin pour votre famille, au gouvernement Américain. Les Métis s'adressèrent à M. Belcourt pour lui demander de préparer une requête au Congrès, prétendant que le droit de chasse leur appartenait autant qu'aux Sauvages depuis plus de soixante ans. M. Belcourt se rendit à leur demande et fit signer la requête à Saint-Paul des Sauteux après la messe. Il ajoute dans sa correspondance que les Métis jetaient les yeux sur Pembina qu'ils n'avaient quitté qu'à regret. M. Laflèche partit au printemps pour Le Pas où le P. Taché devait le rejoindre un peu plus tard pour aller fonder ensemble la mission de l'île à la Crosse.

M. Belcourt de son côté se rendit à la baie des Canards et à son retour accompagna le P. Aubert à Wabassimong. Il le laissa à ce poste et continua seul jusqu'au lac La Pluie.

A l'automne de 1845, pour la première fois il fut appelé à prendre part aux grandes chasses des bœufs sauvages.

Le rapport qu'il nous donne de cette expédition est si circonstancié, qu'il ressemble à un croquis pris sur le vif.

Le tour de chasse qui se fait à l'automne, dit-il, est toujours celui où l'on est en plus petit nombre pour les raisons suivantes: Une partie des Métis qui ne se sentent pas les moyens de pouvoir hiverner dans la colonie se dispersent de côté et d'autre se reposant sur la chasse de la biche, de l'orignal et de l'ours pour leur subsistance, durant l'hiver. D'autres espérant plus gagner à la chasse de la pelleterie qu'à celle du bison, suivent le cours des rivières et les bords des lacs, à cet effet, de manière qu'un tiers environ forme le parti de la chasse d'automne. Le retour de la chasse d'été avait été pitoyable. Après une marche très longue et des chaleurs excessives, ils étaient revenus, n'ayant pas le quart de leurs charges et cela beaucoup plus à cause du manque d'union que du manque d'animaux. Les chasseurs reprirent courage aussitôt qu'ils apprirent qu'un prêtre devait les accompagner avec l'espoir d'un meilleur accord. Les préparatifs se firent de part et d'autre, tant à Saint-Boniface qu'à Saint-François-Xavier et ils se mirent en marche les uns après les autres jusqu'au 9 septembre, date où M. Belcourt partit le dernier. Le rendez-vous était donné sur la rivière Pembina non pas à l'ancien établissement mais à environ une journée de marche plus haut. Il y arriva la troisième journée après son départ. Du haut de la côte, qui est à plus de 200 pieds du niveau de la rivière, il découvrit le camp comprenant environ 60 loges, 300 chevaux et 100 bœufs. Les Métis apportaient au camp du gibier, du poisson, du bois de chauffage, des essieux de relai et des perches de loge.

Le 14 septembre le camp s'élança à travers la prairie.

Les chasseurs de la rivière Rouge ne s'étaient pas réunis à ceux de la rivière Assiniboine. Pour ne pas leur faire dommage en levant devant eux les animaux et éviter de rencontrer les Métis établis dans leur quartier d'hiver, à la montagne Tortue et à la rivière Souris, ils prirent une direction sud, sud-ouest.

Ils côtoyèrent les lacs des Branches, des Buttes, des Trous, du Diable, du Bois Blanc jusqu'à la maison du Chien.

Les guides nommés publiquement avant le départ dirigeaient la caravane. Les charettes au nombre de 213 s'avançaient en trois colonnes trainées par des chevaux ou des bœufs.

A tous les matins des cavaliers se dispersaient de chaque côté et ne revenaient que le soir au lieu du campement indiqué d'avance. Au premier jour de marche, ils campèrent de bonne heure, attendant avec anxiété le rapport des découvreurs. Le premier qui apparut apportait deux grues, dont l'une mesurait plus de huit pieds d'envergure. Ce gibier dont la chaire est médiocre était alors commun. Il se nourrit de racines qu'il déterre avec son bec. Lorsqu'il est blessé, il attaque son agresseur et s'efforce de lui arracher les yeux. Des jeunes Sauvages ont eu parfois les intestins arrachés du corps par ces oiseaux furieux.

Deux des cavaliers n'arrivèrent que le lendemain chargés de viande de bison. Le lendemain matin ils aperçurent une bande de bœufs. Les chasseurs partirent au petit galop et s'arrêtèrent à 7 ou 8 arpents de ces animaux qui paisaient librement.

"Alors, dit M. Belcourt, nous arrêtâmes au pas; car si l'on y va doucement, ils ne fuient que lorsqu'on est tout près d'eux. Quelques-uns des buffalos commencèrent à faire voler en l'air des tourbillons de poussière avec les pattes de devant. D'autres se jetant par terre se roulaient à la façon des chevaux, puis avec la légèreté d'un lièvre se trouvaient tout à coup sur leurs pattes. D'autres enfin, nous regardant fixement, laissaient échapper un son sourd, semblable à celui que fait d'ordinaire entendre un cochon qui broute paisiblement, nous signifiant d'ailleurs, par le mouvement de leur queue, combien notre présence leur était désagréable. Enfin on lâcha tout à coup nos coursiers et c'était plaisant de voir la légèreté avec laquelle ces lourdes masses fuyaient devant nous. Quelques-uns furent renversés du premier coup, mais d'autres se sentant mortellement blessés, s'arrêtaient furieux, déchiraient du pied la terre, ou la frappaient des deux pieds de devant à la façon des béliers. Leurs yeux étincellaient de fureur à travers une masse de poil. La chasse avait duré à peine un quart d'heure."

Ce troupeau n'était composé que de bœufs. A peine cette chasse était-elle finie que des chasseurs s'écrièrent: "La vache, la vache."

A 10 ou 12 milles en effet, on apercevait des points noirs qu'au premier abord on eut pris pour des arbres. Cinquante-cinq chasseurs s'élancèrent dans cette direction. Il est très important que le chasseur ménage l'ardeur de son coursier jusqu'à la distance d'environ deux portées de fusil. Quelquefois il arrivait qu'un cavalier, qui avait un cheval plus rapide que les autres, prenait les devants et que ceux qui le suivaient arrivaient trop tard; de là des querelles et des haines.

D'ordinaire les bœufs et les vaches vivent en deux groupes séparés. Les bœufs se tiennent en arrière, pour protéger les vaches.

Les chasseurs naturellement désirent se procurer de préférence la chair de la vache qui est beaucoup plus tendre.

Il leur faut donc traverser le troupeau des bœufs pour atteindre les vaches et c'est ce qu'il y a de dangereux et de redoutable.

L'été précédent, un Sauvage démonté parmi les bœufs, fut lancé en l'air par leurs cornes nombre de fois jusqu'à ce que son corps eut été lacéré de toutes parts et en lambeaux.

Pour se faire une idée de la force des taureaux, il est arrivé quelquefois que l'un d'eux se jetant sur une charette chargée de mille livres, la renversait d'un seul coup de corne.

Les chasseurs, avant de se précipiter dans cette course vertigineuse sont émus et parfois palissent. Des balles lancées dans toute direction, au milieu d'un nuage de poussière, qui empêche de se voir de loin, atteignent des chasseurs et les blessent ou les tuent.

Cependant ces accidents sont rares.

La rapidité avec laquelle ils tiraient du fusil était étonnante. Il n'était pas rare de voir trois animaux abattus dans l'espace d'un arpent par le même chasseur.

Leur premier coup seul est bourré; pour les suivants, ils amorcent, chargent la poudre, puis ayant la bouche pleine de balles, ils en crachent une dans le fusil. La salive fait attacher la poudre, de manière qu'elle demeure au fond du calibre.

Après cette course, M. Belcourt compta 169 vaches abattues.

Le lendemain, ils en tuèrent 177. Le quatrième jour, ils chargèrent 520 vaches. La course finie, le chasseur place l'animal sur les deux genoux et puis lui étend les pattes de derrière.

Il lui enlève la petite bosse. C'est une éminence de chair d'environ trois livres qui se trouve au haut du cou et tient à la grosse bosse. Il ouvre ensuite la peau sur le dos et la lève. Après quoi il sépare l'animal en 17 parties: les deux dépouilles sur les côtés depuis les épaules jusqu'aux hanches, les filets, les bricoles, les petits filets du cou, le dessus de la croupe, les deux épaules, les dessous d'épaule, les rotis, le ventre, la panse, la grosse bosse, le suif, les plats côtés, la croupe, le brochet et la langue qui est la partie la plus délicate. Cette opération se fait rapidement. Les chasseurs transpirent abondamment dans ce travail et pour apaiser la soif qui les tourmente ils mangent la partie cartilagineuse de la narine.

Ces viandes sont tranchées par les femmes d'un quart de pouce d'épaisseur, en les déroulant toujours dans la main, sans les couper tout à fait. On les étend ensuite comme des pièces de linge sur des grilles faites de petites perches attachées horizontalement à 2 ou 3 rangs à des trépieds de bois. Au bout de 3 à 4 jours, ces viandes sont sèches. On les plie alors et on attache en ballots, pesant de 60 à 70 lbs., les dessus de croupe, les dépouilles, les dessous d'épaule, la viande des grosses bosses et les ventres. Le reste est pilé à coup de fléaux. Les peaux servent d'aire.

Cette viande ayant été préalablement exposée sur une grille horizontale faite de bois vert, à une forte chaleur, la rend cassante et facile à réduire en poudre. Le gras de l'intérieur est haché et fondu dans de grandes chaudières et on le verse ensuite sur la viande pilée. On tourne le tout en sous sens avec une pelle. On vide ensuite dans des sacs de peau. Ces sacs s'appellent taureau ou pimikehigan. Quelquefois on y mêle des fruits secs tels que poires, cerises, etc., et alors on les appelle taureaux à graine. Une vache d'ordinaire ne donne qu'un demi sac de pemican et les trois quarts d'un ballot de viande.

Les peaux sont tendues sur des cadres pour les mettre en parchemin, c'est-à-dire, pour les gratter en dedans avec un os aiguisé et en dehors avec une espèce de petite gratte coupante pour enlever le poil. Les os de l'animal sont broyés et bouillis pour en extraire la graisse de moëlle, qu'on conserve dans les vessies de ces animaux. Les os de deux vaches suffisent à peine à emplir une vessie.

Un jour, un chasseur ayant deux coursiers, en attacha un à la porte de sa loge et montant sur l'autre, s'élança sur les buffalos. Le cheval captif réussit à briser la corde qui le retenait, vint rejoindre son maître au milieu des buffalos et ne le quitta qu'après que la chasse fut terminée, tant il est vrai que les chevaux semblaient se passionner pour cette chasse autant que les hommes. A la chasse du printemps les métis parfois amenaient avec eux de petits veaux sauvages. L'un de ces chasseurs réussit même à labourer avec ce jeune buffalo.

Il fut plus heureux que Mgr. Taché qui fit la même expérience. Ce jeune buffalo devenu gros fit le désespoir de son propriétaire. De guerre lasse, Mgr. Taché le fit assommer.

Le camp atteignit le Grand-Coteau qui s'étend le long du Missouri; ils n'étaient qu'à 75 milles de cette rivière.

Le 16 octobre les chasseurs reprirent le chemin de la rivière Rouge, emportant dans leurs charettes la chair de 1,776 vaches.

Le camp comprenait 309 âmes. A tous les jours M. Belcourt faisait le catéchisme à 68 enfants. Il disait la messe dans le camp à tous les matins. A deux reprises les feux de prairie avaient failli les atteindre. Un point capital à retenir dans ces expéditions c'est le maintien d'une discipline sévère. C'est ainsi qu'il est absolument défendu de courir après le buffalo sans la permission du chef de camp. L'infraction de cette ordonnance peut éloigner les animaux avant que les chasseurs soient prêts à fondre sur eux. Le 24 octobre, M. Belcourt était de retour à Saint-Paul des Sauteux. Il passa l'hiver à Saint-Boniface à enseigner le sauteux aux PP. Aubert et Taché et à M. Laflèche.

1846-1847

Dyssenterie et rougeole dans la colonie. Il part de nouveau pour la chasse. Défaite des Assiniboines. Les chasseurs leur sauvent la vie. Gros Ventres, Mandans, Corbeaux et Sioux. Récolte de maïs et citrouille chez les Gros Ventres. La bosse du bison. Arrivée de nouvelles troupes. Requête des colons. Sir Geo. Simpson mal renseigné écrit à Mgr. de Québec se plaignant de M. Belcourt. En 1847 M. Belcourt descend à Québec; revient en octobre 1847. Il apprend le mécontentement de Simpson; retourne à Québec via Saint-Paul même automne. Simpson lui rend justice.

Depuis deux ans M. Belcourt avait manifesté à Mgr. de Québec le désir de retourner dans sa patrie. Il fit part de ce dessein à Mgr. Provencher. Il avait fixé la date au printemps de 1847. Toutefois M. Belcourt ne souhaitait nullement d'abandonner pour toujours ses missions sauvages, pour lesquelles il était prêt à faire le sacrifice de sa vie. Il ne demandait pas son rappel mais un simple congé d'absence.

Au printemps de 1846 la dyssenterie et la rougeole firent de tels ravages dans la colonie qu'il dut renoncer à visiter ses missions.

Les métis et les sauvages implorèrent M. Belcourt de les accompagner à la chasse, afin de ne pas mourrir sans confession.

Mgr. Provencher se rendit à leur prière et M. Belcourt partit pour rejoindre la caravane qui le précédait déjà de quelques jours. Dès qu'on apprit qu'ils les suivait, les chasseurs envoyèrent un détachement de cavaliers qui l'escortèrent jusqu'au camp où régnait la plus grande joie.

Il se mit à visiter les malades jour et nuit. A peine lui laissait-on deux-heures de sommeil par nuit. Il était tellement accablé de lassitude qu'il dormait à cheval. Pendant le jour, lorsque les malades ne réclamaient pas son ministère, il faisait le catéchisme à une centaine d'enfants. La famine se mit de la partie. Il y avait environ mille personnes à nourrir dans le camp. Or, on ne tuait que 7 à 8 gazelles et une centaine de canards par jour. Il en aurait fallu quatre fois autant. On fut réduit à tuer des bœufs de travail. Heureusement qu'ils tombèrent bientôt sur un troupeau de bisons et l'abondance revint dans le camp. Il eut la consolation de baptiser 14 Sauvages qui expirèrent presqu'aussitôt. En un seul jour, huit chasseurs moururent. Il eut bientôt dépensé tous les remèdes qu'il avait apportés avec lui pour combattre ce fléau. Il résolut alors d'atteindre au plus tôt le fort des Gros-Ventres afin d'obtenir du bourgeois de ce poste une nouvelle quantité de remèdes. Le 12 juillet la caravane gravissait le Grand-Coteau. Ils se trouvaient au milieu d'une foule innombrable de bisons et en même temps de leurs ennemis, les Sioux. De la Maison du Chien, qui se trouve sur une éminence, ces derniers faisaient le guet, afin de surveiller les autres nations sauvages et les surprendre quand l'occasion favorable se présentait.

"A tous les soirs, dit M. Belcourt, nous formions avec les charettes un retranchement d'environ 1,500 pas de circuit où nous enfermions nos chevaux pendant la nuit. Nous eûmes là la visite d'un parti de guerre d'assiniboines, nos alliés, qui marchant contre les Sioux, eurent le malheur d'être découverts les premiers et en furent poursuivis vigoureusement. Ce fut un bonheur pour eux de nous trouver sur leur route, car ils eussent été entièrement défaits et littéralement hachés en pièces. Il y avait 132 chasseurs dans le camp, qui, à tous les jours abattaient des buffalos. Quand M. Belcourt parle de *foule de bisons*, d'après le langage du temps, cette expression signifiait au moins un *million d'animaux*. M. Belcourt profita du temps que les chasseurs restaient en place pour se rendre au fort des Gros Ventres, sur la rive gauche du Missouri à huit heures de marche du camp. Les Gros-Ventres avaient été longtemps les ennemis des Cris et des Sauteux. Depuis cinq ans ils avaient fait alliance avec eux, forcés plutôt par leur intérêt que par un sentiment d'amitié. Cette tribu avait été décimée par la petite vérole. Il ne restait plus de vivant qu'un dixième de la population. Dans l'impossibilité où ils se trouvaient de résister à leurs ennemis, ils s'unirent avec les Mandans et formaient un village de 133 loges. Ces loges, enfoncées à environ un pied dans la terre, se composent d'une charpente dont le sommet est soutenu par quatre pilliers et le tout est recouvert de terre à l'épreuve de la balle. Au haut est pratiquée une ouverture d'environ deux pieds et demi carrés, par où s'échappe la fumée du foyer qui est au milieu de la loge et laisse introduire la lumière. A l'entrée est une espèce de vestibule formé par une cloison. C'est là qu'on fait entrer les chevaux en hiver. L'enceinte est d'environ 50 pieds de diamètre et contient 4 à 5 lits élevés de terre à la hauteur de sièges dont ils servent également. On compte de 4 à 5 familles par loge. Ce village contenait à peu près 2,000 âmes.

Il y avait peu d'hommes comparés au nombre d'enfants, parce qu'à tous les jours, quelques uns des guerriers étaient tués autour de leur demeure, soit par trahison, soit par les Sioux.

Généralement, dit M. Belcourt, les Gros-Ventres sont forts et robustes. Plusieurs ont audessus de six pieds et se présentent avantageusement. Ils sont alliés aux Corbeaux, dont je vis quelques-uns qui étaient venus les visiter. Ils cultivent la terre dont ils retirent des récoltes de maïs, ainsi que de petites citrouilles, qu'à cette saison les femmes étaient occupées à fendre par tranches pour les enfiler dans de petites perches et les faire sécher au soleil. C'est la nation la plus reconnue pour sa propreté. Ils ont l'habitude de se baigner tous les jours, les hommes d'un côté et les femmes de l'autre. Cet amour de la propreté s'étend à leurs habits et à leur demeure où tout est bien rangé. On donna à boire au missionnaire dans une corne de bélier sauvage très bien ouvragé et soigneusement lavée. Il leur fit un sermon de deux heures à l'aide d'un interprète. Ils l'écoutèrent avec un silence religieux et l'applaudirent à la fin. Ces nations n'avaient pas abusé de la grâce; aussi bien la vérité produisait un effet merveilleux dans leur âme. Nous avions cru jusqu'à présent, disaient-ils, que le soleil était le maître de la vie. Nous n'avions jamais entendu parler avant ce jour d'un Dieu mort pour nous racheter. Ce que tu nous dis nous paraît si vrai et si sage que nous en sommes persuadés. Nous savons que les Français sont supérieurs à nous et nous donnent de bons conseils. Si tu veux nous faire venir un prêtre, nous lui donnerons chacun un cheval et il aura part à toutes nos chasses. Nous lui ferons un généreux partage de nos recettes. Ils demandaient à être instruits afin d'avoir part au bonheur de l'autre vie dont le missionnaire leur avait parlé.

Ils s'engageaient à lui construire une grande cabane pour sa résidence et à faire tout ce qu'il leur dirait. Ils offrirent à M. Belcourt comme présent un casque de guerre, une chemise en cuir garnie de porc épic, une chaudière de leur façon dont la solidité répondait à celle de nos marmites et un peu de farine. Le casque de guerre portait une longue queue, ornée de cornes de bœuf, et les chefs la lui mirent sur la tête au milieu d'applaudissement général. Il y baptisa 12 enfants et se préparait à en instruire 200 autres, lorsque des messagers du camp vinrent le chercher. Les Sauteux avaient décidé de marcher de nuit, vu que les Sioux rôdaient continuellement autour du fort.

Il dût à regret les quitter cette nuit-là même afin de ne pas s'exposer aux coups des Sioux. Il se proposait au printemps suivant d'intéresser l'évêque de Saint-Louis à ces Sauvages si bien disposés.

L'habit des Gros-Ventres était bien primitif et peu modeste. Ils changeaient souvent de femmes mais peu d'entre eux étaient polygames. Ils pratiquaient d'horribles pénitences. Ils se tranchaient la chair aux bras, aux cuisses et à la poitrine, se faisant des blessures de 10 à 12 pouces de longueur. Ils se perçaient avec des lames de couteau la peau des épaules. Ils y passaient des cordes et traînaient ainsi en chantant et pleurant les os desséchés de 7 à 8 têtes du buffalo et tout cela dans le désir que le maître de la vie les rende heureux à la guerre. Plusieurs avaient des jointures au doigts d'enlevés suivant le nombre d'enfants qu'ils avaient perdus.

Le commis du fort, un Canadien-Français de l'Assomption, P. Q., du nom de Bruqui, le recut avec beaucoup d'égard et lui donna des remèdes pour ses Saúvages. Il repartit avec une escorte de 15 cavaliers sauteux.

Pendant cette expédition les fidèles assistaient à la messe à tous les matins. Un bon nombre y communiait. Les chasseurs firent chanter nombre de grandes messes pour remercier Dieu de la chasse abondante qu'il leur avait donnée. M. Belcourt tua lui-même trois vaches et il reçut comme présent 1,200 langues formant la charge de deux bœufs. En un seul jour les chasseurs avaient abattu jusqu'à 310 vaches. Au retour M. Belcourt pressé d'arriver plutôt fit 20 lieues par jour pendant 4 jours de suite. C'est assez dire qu'il était bon cavalier. Le 5 aout 1846 il atteignait Saint-Paul des Sauteux, épuisé de fatigue. Il nous donne ici un détail curieux au sujet de la bosse des bisons.

"J'ai examiné, dit-il, en quoi consistait la différence des intestins pour nourrir cette bosse qui en fait un animal si distinct des animaux domestiques avec une chair si tendre. J'ai remarqué qu'une partie des boyaux fins qui sont courts dans ceux-ci sont étonnément longs chez ceux-là. Je n'exagérerais pas en disant qu'ils ont bien 7 à 8 brasses de longueur et sont toujours remplis d'une liqueur blanchâtre absolument comme la fraise de veau."

Il avait amené avec lui, de la prairie, un cerf apprivoisé avec quelques langues de bison fumées qu'il se proposait d'amener avec lui en Canada l'année suivante.

En 1846, un navire de guerre transporta au fort York 300 soldats d'infanterie et 50 sapeurs. On se proposait d'utiliser ces derniers à l'exploitation des mines et à la canalisation de la rivière Nelson, afin d'éviter les nombreux portages qui en rendaient la navigation difficile. Quelques-uns des officiers et soldats étaient catholiques. Dès leur arrivée à La Fourche, ces officiers rendirent visite à Mgr. Provencher. Quelques jours après Mgr. à son tour alla les saluer. Pour cette circonstance le drapeau fut hissé en son honneur au haut du mat. Il se produisit cette même année une agitation violente au sujet du monopole de la traite réclamée par la compagnie de la Baie d'Hudson. Quelques-uns parlaient même de faire un mauvais parti au juge Thom. M. Belcourt réussit à les calmer en leur indiquant le moyen constitutionnel d'une requête à la reine.

Voici un passage de la correspondance de M. Belcourt qui explique la situation et l'attitude qu'il prit en cette circonstance. "Cet hiver (1845-1846) le peuple fut indigné de la conduite de la Compagnie qui saisissait les gens, les mettait en prison, puis s'emparait des effets qu'elle soupçonnait devoir être destinés à la traite de Sauvages. Ajoutez à cela, les jugements emportés et sans forme du juge Thom qui fait tout à la fois, l'office de conseiller, avocat et juge et quelquefois même n'entend pas les témoins et condamne d'emblée. Considérant ces malversations, les gens se sont assemblés dans le dessein d'aller briser la prison puis d'aller ensuite signifier au gouverneur local qu'ils allaient à leur tour faire des lois auxquelles il aurait à obéir ainsi que le juge lui-même. Plusieurs étaient déterminés à aller beaucoup plus loin mais avant on m'envoya supplier d'une manière formelle, de bien vouloir me rendre aux vœux publics qui étaient de me voir un instant au milieu d'eux. J'y condescendis volontiers connaissant que l'influence que j'avais sur eux, en général, pourrait apaiser le trouble en leur conseillant une marche régulière. En effet, une foule immense m'attendait avec impatience. Je leur fis d'abord remarquer que comme chrétiens nous devions souffrir nos supérieurs civils même méchants. Mais je ne leur cachai pas qu'il y avait un moyen légal d'avoir justice; c'était d'adresser une requête au gouvernement britannique et de se contenir en attendant la réponse.

"Je leur fis valoir la sagesse de ce conseil et à la fin tous les esprits se calmèrent, trouvant cependant bien long, le temps qu'il faudrait endurer encore. Comme il n'y avait dans le pays personne en état de dresser une requête, il m'a fallu m'y mettre et de plus dresser des instructions à donner à un commissaire, faire nommer un comité pour signer la lettre de commission et certifier la légalité des signatures. Par ce moyen j'ai évité des malheurs et des émeutes mais je n'ai pas contenté les officiers de la Compagnie.

"Maintenant le facteur en chef Christie dit que l'ai tenu une assemblée illégale et que j'ai mis le trouble dans la colonie, tandis que je lui ai sauvé la vie ainsi qu'au juge et au shérif.

"Pour le juge Thom, sa vie n'est pas sûre car les Bois-Brûlé ont dit hautement que s'il était encore ici, au retour de leur voyage de la prairie, ils iraient le faire noyer. Mgr. Provencher en a averti M. Christie charitablement."

Le comité nomma comme commissaire pour présenter cette requête au ministre des colonies, M. James Sinclair, natif de la rivière Rouge et commerçant à la Fourche.

M. Belcourt suggérait à M. Sinclair de s'assurer en Angleterre l'appui d'O'Connell.

Au retour de la chasse, M. Belcourt se décida à visiter la province de Québec. Depuis deux ans, il avait accompagné les camps de chasseurs dans la prairie et n'avait pas revu ses missions de Wabassimong, lac La Pluie et baie des Canards.

Plusieurs changements avaient eu lieu qui n'étaient pas de son goût. La mission de Wabassimong avait été abandonnée. Les Sauvages n'avaient pas voulu entendre parler de religion et avaient fait des menaces. Le P. Aubert, O. M. I., vendit les animaux qui restaient à la Compagnie, pendant l'hiver de 1846-1847. Le gardien de ces animaux était retourné à la rivière Rouge, parce qu'il avait grande peur d'être tué. Mgr. Provencher avait été obligé dans ces circonstances d'abandonner temporairement cette mission. Les Métis et les Sauvages ayant appris que le départ de M. Belcourt était définitif, adressèrent une requête bien touchante à Mgr. de Québec, signée par 235 personnes suppliant Sa Grandeur de leur renvoyer leur missionnaire.

M. Belcourt partit le 10 juin 1847. Il ne fit pas un long séjour à Québec, car au mois d'août suivant, il reprit de nouveau la route de l'ouest par la voie de Buffalo et Saint-Paul. Il partit de Saint-Paul à cheval suivi de trois voitures chargées d'effets. Pour éviter toute attaque de la part des Sioux, il suivit le chemin des bois. Son meilleur cheval s'enfuit un jour, sans qu'il put le retrouver. Il dût ralentir sa course. Il prit 40 jours à faire le trajet entre Saint-Paul et Saint-Boniface. Il n'arriva à ce dernier endroit qu'au commencement d'octobre. Il avait dû le long de la route se faire chasseur, abattant force canards, perdrix, faisans et même un ours pour se nourrir. Bien plus, il fut contraint de faire à pied plus de la moitié de la route.

Arrivé à Saint-Boniface le 8 octobre, il en repartit le 16 du même mois. Sir Geo. Simpson, mal renseigné, croyait que M. Belcourt avait soulevé la population et l'avait poussée à se plaindre de la compagnie, auprès des autorités impériales. Ainsi trompé, il avait proféré des menaces et écrit à Mgr. de Québec à ce sujet. Les officiers de la compagnie étaient indignés contre M. Belcourt. Dans ces conditions la situation n'était plus tenable. Il repartit pour Québec afin d'y rencontrer Simpson et se disculper. En effet Simpson ne tarda pas à se procurer d'autres renseignements sur cette requête. Il comprit que M. Belcourt avait endigué le torrent d'indignation des colons, en le contenant dans les limites des voies constitutionnelles. Il sollicita une entrevue avec M. Belcourt, lui exprima ses regrets, l'invita à diner et fit tout ce qu'il put pour faire oublier cet incident fâcheux.

M. Belcourt eut bien désiré retourner à Saint-Paul des Sauteux. On comprend qu'après ces frictions produites sur une question qui s'agitait encore et qui menaçait de se terminer par un coup d'éclat, comme d'ailleurs ce fut le cas deux ans après, il eut été imprudent de renvoyer M. Belcourt à la rivière Rouge. Il en éprouva une peine accablante. L'idée de ne plus revoir ses chers Sauteux, après 17 ans d'apostolat au milieu d'eux, le désolait.

C'est alors qu'il songea à se fixer à Pembina, situé à la frontière internationale. Il espérait y attirer ses chrétiens de Saint-Paul des Sauteux. Pendant ses voyages avec les chasseurs, il s'était lié d'amitié avec plusieurs commerçants américains.

De plus l'évêque de Dubuque lui avait fait demander par un de ses prêtres s'il consentirait à ouvrir une mission à Pembina. M. Belcourt accepta cette invitation qui allait au devant de ses désirs.

Cédant aux sollicitations de M. Belcourt, Mgr. de Québec consentit à le laisser partir et lui donna son exeat.

1848-1858

Pembina. Saint-Joseph. Ses dernières années. Sa mort en 1874.

Dès le mois de juillet 1848, M. Belcourt avait pris possession de sa nouvelle mission. Il commença par se construire une cabane en écorce d'orme qui avait 18 pieds de longueur. Il dut travailler de ses mains pour vivre. Son évêque, qui était pauvre, ne pouvait lui offrir que $100 par année. Il se livra à l'élevage de quelques animaux et sema un petit champ. Les Sauteux de Saint-Paul, venaient le visiter et quelques-uns se fixèrent à Pembina. Pendant l'hiver, il voyageait presque continuellement pour évangéliser les Sauvages des contrées avoisinantes. C'est ainsi qu'en 1849 il parcourut 300 lieues en raquette. Il avait à cette époque un personnel assez considérable à soutenir. Il consistait en Delle Isabelle Gladu, sa ménagère, Delle Lefebvre, maîtresse d'école, une sauvagesse cuisinière, et un engagé ou deux. Il lui fallait nourrir, vêtir ou payer tout ce monde.

Il construisit une petite maison pour se loger avec M. Albert Lacombe, tandis que les demoiselles restaient dans l'autre. Il est certain qu'il fut question à cette époque d'un évêché à Pembina. Le nom de M. Belcourt fut mentionné parmi les candidats mais la nomination d'un évêque à Saint-Paul fit tomber ce projet à l'eau.

La rivière Rouge déborda en 1850 et il résolut de transporter sa mission à Saint-Joseph où le terrain était plus élevé.

M. Lacombe dont il est question, devint le célèbre P. Lacombe, O. M. I., qui a rempli de son nom et de ses œuvres l'ouest canadien. Il secondait alors les efforts de M. Belcourt et apprenait le sauteux. Il faisait le catéchisme à plus de 100 enfants dont 40 firent leur première communion.

En 1850 M. Belcourt se mit à construire à Saint-Joseph une chapelle de 50 par 15, ainsi qu'un moulin à scie et à farine.

Le gouverneur Ramsey estimait beaucoup M. Belcourt et l'encourageait dans ses travaux. Les Mandans et les Sauteux du lac Rouge demandaient à ces missionnaires de venir les instruire, mais MM. Belcourt et Lacombe ne pouvaient suffire à la tâche.

M. Belcourt s'adressa au gouvernement américain sollicitant de l'aide. On se contenta de lui donner des espérances. En attendant il se mit à fabriquer des chassis et des portes, pour se procurer du pain.

Il envoya un jeune Métis chez les Mandans, dans le haut du Missouri. Ce jeune homme qui était chrétien parlait un peu leur langue. Il devait passer l'hiver chez eux, pour se perfectionner dans leur langue et lui servir ensuite d'interprète.

Il reçut un jour du secrétaire d'Etat américain une demande pour une copie de sa grammaire et de son dictionnaire sauteux, s'engageant à l'indemniser pour ce travail. Il espérait que le Congrès les ferait imprimer dès qu'il aurait pu terminer l'une et l'autre.

Quand ses ressources étaient épuisées, M. Belcourt n'avait pas d'autre recours pour maintenir son établissement que d'envoyer quelques charettes dans la prairie, pour lui procurer des provisions. M. Belcourt se proposait de faire de Pembina un pied à terre et de parcourir toutes les tribus de l'ouest jusqu'aux Montagnes-Rocheuses pour les instruire et ramener la paix entr'elles. Il voulait même apprendre les diverses langues de ces aborigènes, faire une étude de leurs mœurs et coutumes et laisser à ses successeurs un mémoire pour les aider dans cet apostolat. Il croyait que Saint-Joseph était appelé à devenir une grande ville, par l'exploitation des mines de charbon, la richesse du sol et la construction du chemin de fer Pacifique américain. Il fit l'essaie de toutes espèces de graines y compris même celles de Job pour faire des chapelets. Il semble que rien n'échappait à son activité débordante.

En 1855 il retourna dans la province de Québec. Il aurait bien aimé à enrégimenter M. Poiré pour ses missions, mais il dut revenir seul à Saint-Joseph. Les Américains construisirent un fort à Saint-Joseph. Ils y maintenaient une garnison comprenant une compagnie de dragons, 200 fantassins et quelques artilleurs pour servir les deux canons qui défendaient le fort. Ce déploiement de force militaire avait pour but d'en imposer aux Sauvages qui parfois devenaient ménaçants.

Les Sioux tremblaient devant les Métis qu'ils craignaient comme des Manitoux. Les Sauteux avaient enlevé 40 chevelures aux Sioux dans leur propre pays. Ces derniers après cette défaite, désiraient faire alliance avec les Métis et s'adressèrent à M. Belcourt à cette fin. Il leur conseilla de rester dans les limites de leur territoire, pour ne pas provoquer les autres tribus, de demander l'envoi d'un prêtre au lac Travers, source des eaux de la rivière Rouge. Avec un prêtre à leur tête et le signe du chrétien à leur cou, ils pourraient visiter les Métis et les Sauteux avec la plus grande assurance.

Il y avait à cette époque un bon nombre de Métis français, sioux tels que les Rainville, Lafrenière, Larocque, etc., qui sympathisaient avec les Métis sauteux et rendaient un rapprochement plus facile.

Au cours de l'été de 1855, les chasseurs Métis et Sauteux avaient été attaqués par trois nations siousses réunies.

Les Sauteux les avaient défaits, leur tuant un grand nombre de guerriers quoique les Sioux fussent plus de 20 contre un.

Les chevaux des Sauteux épouvantés par les cris des guerriers s'étaient enfuis. Ils en perdirent 201 et plus de 30 bœufs. Les troupes américaines attaquèrent également les Sioux plus tard, en tuèrent 80 et en firent 50 prisonniers. M. Belcourt perdit deux de ses chevaux dans cette bataille. Il réussit la même année à terminer un couvent et à obtenir des religieuses qui reçurent un octroi du gouvernement.

M. Rice, député du comté, lui aida beaucoup à recevoir ce secours. L'école de Saint-Joseph était fréquentée par 200 enfants. On pouvait se procurer à ce couvent des interprètes parlant le sauteux, cri, sioux, assiniboine, français, anglais, italien et allemand. En 1856, Pembina qui s'était relevé depuis l'inondation, comptait 1,500 âmes. Ce poste ne fut pas entièrement abandonné en 1850. Plusieurs familles catholiques y restèrent après le départ de M. Belcourt pour Saint-Joseph. Comme ces deux missions étaient rapprochées, M. Belcourt venait souvent y dire la messe dans la chapelle qu'il y avait érigée (1848-1849). Il prépara un mémoire sur Pembina qu'il transmit au major Wood pour être envoyé à Washington.

Il avait construit à Saint-Joseph un presbytère de 20 par 16, sa chapelle avait 30 par 20.

Il espérait que M. Lacombe le remplacerait à Saint-Joseph et qu'il pourrait se rendre chez les Mandans et demeurer parmi eux.

M. Cretin de Saint-Paul (Minn.) lui avait envoyé une cloche pour sa chapelle de Saint-Joseph. Elle fut laissée le long de la route à cause des mauvais chemins. Il l'envoya chercher pendant l'hiver en traîne à chiens.

De temps à autres, on constate que M. Belcourt se rendait à Saint-Boniface pour y saluer Mgr. Provencher et les autres missionnaires qu'il avait connus. Il visita également son ancienne mission de Saint-Paul des Sauteux.

En 1856, il nous apprend qu'il avait réussi à faire imprimer sa grammaire sauteuse, car il nous annonce que l'édition était épuisée. Il comptait sur le Congrès américain pour l'impression de son dictionnaire. Pendant l'hiver de 1856-1857 la picotte se répandit chez les Sauvages et fit des ravages désolants. Dans certains camps, pas un seul Sauvage ne survécut. Les chiens mangeaient leurs maîtres et les chevaux paisaient en liberté n'ayant plus de propriétaire. Personne néanmoins ne songea à s'en emparer de peur du fléau.

Bientôt M. Lacombe le quitta pour se rendre au lac Sainte-Anne, au nord d'Edmonton, en attendant qu'il entrât dans la congrégation des Oblats de Marie Immaculée. M. Lacombe ne demeura que deux ans à Pembina (1849-1850). M. Belcourt se trouva seul de nouveau. "Que c'est triste, dit-il, en 1857, d'être toute sa vie, en face de soi-même" et il supplie M. Cazeau de Québec d'avoir pitié de lui et de lui envoyer un collaborateur.

Il retourna définitivement en Canada en 1858. Il alla en 1859 exercer le ministère tout d'abord à Rustico, dans l'île du Prince-Edouard; puis à Sainte-Claire dans le comté de Dorchester où il était curé en octobre 1865. Il retourna de nouveau à Rustico peu de temps après. Il mourut à Shédiac le 31 mai 1874 et fut inhumé à Memramcook.

M. Belcourt a laissé un livre de lecture en sauteux qui fut publié à Québec en 1839 ainsi qu'une étude sur *les principes de la langue des Sauvages appelés Sauteux* imprimée la même année à la même place. Il légua son dictionnaire sauteux à Mgr. Taché qui le fit imprimer sous la surveillance du P. Lacombe.

Nous avons également de lui une lettre adressée à M. A. K. Isbister en 1847 au sujet du mouvement de protestation de l'année précédente. Elle fut imprimée avec les documents officiels de 1849.
St.-Boniface, 5 mars 1920.

Jean Jolliet et ses enfants

Par MGR. AMÉDÉE GOSSELIN, M.S.R.C.

(Lu à la réunion de mai 1920.)

Ceux qui connaissent le *Louis Jolliet* du regretté Ernest Gagnon se demanderont peut-être ce que nous pouvons bien avoir d'intéressant sinon d'important à ajouter sur cette famille. Peu de chose, nous l'avouons sans détours. Mais, comme les détails font souvent l'agrément de l'histoire, nous avons pensé, qu'après en avoir recueilli un certain nombre sur Jolliet père et ses enfants, il serait aussi bon de ne pas les laisser perdre et cela d'autant plus qu'ils pourront servir à corriger et à compléter le *Dictionnaire généalogique* de l'abbé Tanguay sur le sujet en question.

Le chef de cette famille, Jehan Jollyet—c'est ainsi qu'il signait—était fils de Claude Jolliet et originaire de Sézanne en Brie.[1] Quand vint-il au pays ? Nous n'avons pas la date exacte, mais il y était déjà en 1637. Cette année-là, en effet, le 15 novembre, il signait son contrat de mariage avec Marie d'Abancour dite LaCaille, fille d'Adrien et de Simone d'Orgeville.[2]

Parmi les témoins et signataires du contrat se trouvaient le P. Nicolas Adam, Jésuite, Nicolas Marsolet, "interprète montagnais" et Jean Nicolet, "interprète algonquin et montagnais."

Si les registres de Notre-Dame de Québec, refaits de mémoire après l'incendie de 1640, sont exacts, le mariage de Jolliet fut célébré à Notre-Dame-de-Recouvrance, le 9 octobre 1639. Il ne faudrait pas en conclure que les époux avaient leur domicile à Québec même. Mais l'église de cette ville étant la seule paroissiale à cette époque, on y venait de tous les environs pour les baptêmes, les mariages et les sépultures aussi bien que pour les offices des dimanches et fêtes.

Les anciens actes nous disent que Jolliet était *charron* de la Compagnie des Cent Associés. C'est vrai, mais il fut aussi, sinon en même temps, l'un des premiers colons de la côte de Beaupré. Qu'on examine la carte dressée en 1641 par Jean Bourdon.[3] A l'endroit appelé la Longue-Pointe, tout à côté la rivière dû Petit-Pré, mais à l'Est, on pourra lire les noms de la veuve La Caille et de Jolliet. Il

---

[1] Ferland, *Notes sur les Registres* de N. D. de Québec, p. 27.

[2] Tanguay, *Dictionnaire généalogique*, I, p. 324. Quant au contrat, il est signalé dans le Repertoire d'Audouart.

[3] Cette carte se trouve au premier volume du *Dictionnaire généal.* de l'abbé Tanguay.

y avait là deux terres ou propriétés réunies en une seule après la mort de la veuve d'Abancour dont la fille, femme de Jolliet, était l'héritière. C'est là que Jolliet demeurait ordinairement, au moins après son mariage. Il le dit dans son testament: "demeurant proche la Longue-Pointe, sise en la côte de Beaupré." C'est donc là aussi, c'est-à-dire dans la paroisse du Château-Richer, que naquirent tous ses enfants y compris le futur découvreur du Mississipi. C'est du moins notre conviction.

La plupart, sinon toutes les terres de Beaupré, avaient d'abord été concédées sur simple billet. Celles de d'Abancour et de Jolliet étaient du nombre. La situation fut régularisée pour plusieurs en 1650. Cette année-là, en effet, Olivier Letardif, commis général de la Compagnie des Cent Associés et en même temps l'un des associés et le représentant de la Compagnie dite de Beaupré, se mit à donner des contrats aux habitants de la seigneurie. Jolliet eut son tour le 31 juillet.

Réunissant les deux propriétés en une seule, Letardif concédait à Jean Jolliet "le nombre de six arpans de terre en prez et bois sur le grand fleuve St Laurant et de dix perches de front pour chacun arpant et de profondeur jusqu'à lieue et demye, tenant d'une part, du costé du Nordest, à la vefve de feu Monsieur de Repantigny et d'autre part, du costé du sudouest, aux terres non conceddés. . . ." à condition de "s'y établir dès la présente année, y avoir feu et lieu ou autre pour luy" etc. Puis, viennent les obligations ordinaires de rente, de cens, de chapons vifs etc.

C'était certes un beau *lopin* de terre que ces 756 arpents de prés et de bois. Jean Jolliet rêva-t-il jamais d'y établir plus tard, après l'avoir cultivé lui-même avec amour, l'un ou l'autre de ses trois fils et de perpétuer son nom, dans une longue postérité, sur les bords de la rivière du Petit-Pré ? Qui pourrait le dire ? Mais ce rêve bien naturel, s'il le fit jamais, ne devait pas se réaliser. Moins de vingt ans après qu'il en eût reçu le contrat, ce bien n'appartenait plus à ses héritiers.

Jean Jolliet lui-même ne devait pas jouir longtemps de la pleine possession de sa terre. Au printemps de 1651, il tomba malade et se fit transporter à l'Hôtel-Dieu. Le 23 avril, il manda le notaire Audouart et lui dicta son testament. Quelques heures après, il était mort. Les funérailles eurent lieu le lendemain, 24 avril, à Notre-Dame de Québec.

Le testament ne contient rien d'important. Jolliet voulant témoigner sa reconnaissance à l'Hôpital pour les bons soins qu'il y a reçus, lui lègue une somme de soixante livres. A son église paroissiale, il laisse trente-huit livres, à charge de faire prier pour le repos de son âme. Et c'est tout. Avec ces deux items, le notaire Audouart trouva moyen de remplir d'une écriture fine, deux grandes pages de papier que René Maheut et Florimond Montel signèrent comme témoins.

La veuve Jolliet qui restait avec quatre enfants dont le dernier n'avait que quatre mois, épousa après six mois de veuvage, le 19 octobre 1651, Geoffroy Guillot dit Lavalé, habitant de l'île d'Orléans.[1] La terre de Jolliet restait moitié à sa femme, moitié aux enfants. Il fallait tout de même procéder à l'inventaire des meubles afin que, advenant le partage des biens, chacun eût sa part. Cet inventaire eut lieu le 8 mars 1652 devant Auber. Henry Pinguet et Martin Prevost furent chargés d'estimer les meubles. Plusieurs outils de charron que Jean Bourdon laissa à la veuve furent évalués à 45 livres par Noël Morin. Le tout, se montant à la somme de trois mille livres, fut laissé entre les mains de Guillot et de sa femme pour en rendre compte en temps voulu. La terre de Jolliet fut donnée à bail ou abandonnée pour un temps, semble-t-il, car on voit que Guillot était habitant de l'île d'Orléans en 1655.[2] La famille était revenue au Château-Richer en 1662. Trois enfants leur étaient nés: Jean, Elizabeth et Louise.[3]

Du côté de Jolliet, Marie d'Abancour était restée avec quatre enfants en bas âge: Adrien qui pouvait avoir huit ou dix ans. Louis qui en comptait six, Marie trois, et Zacharie, né quatre mois avant la mort de son père. On s'était occupé de leur avenir. A la date où nous sommes, trois étaient déjà placés: Adrien était au Cap-de-la-Madeleine, Louis faisait son grand séminaire et Marie était mariée depuis deux ans. Quant à Zacharie, n'ayant que douze ans, il allait sans doute à l'école; tous les enfants de Jolliet avaient une fort bonne écriture.

Un malheureux accident vint, en 1665, jeter le deuil dans la famille. C'était le 30 juin. Des vaisseaux venant de France arrivaient à Québec. En les voyant poindre au bout de l'île d'Orléans, cinq habitants de la côte de Beaupré s'étaient jetés dans un canot pour aller au devant et rapporter des nouvelles: Félix Auber, Jacques Lugré,

---

[1] Tanguay le nomme Godfroy, mais nous avons trouvé Geoffroy dans trois ou quatre documents. Originaire de Ruffot, écrit Tanguay; natif de Bernac, dit le registre de Confirmation.

[2] Auber, 27 sept. 1655.

[3] Idem, 20 août 1662. Ces renseignements et plusieurs autres ont été puisés dans les annotations que feu Philéas Gagnon avait accumulées dans le *Dict. Généal.* de Tanguay. Nous en donnons crédit à sa mémoire regrettée.

Berson dit Châtillon, Vivant Verdon et Geoffroy Guillot Lavallée. Il faisait gros vent; ce fut bientôt la tempête. Les rameurs luttèrent énergiquement contre les éléments déchaînés et ils n'étaient pas éloignés du premier vaisseau lorsqu'une vague plus forte que les autres fit chavirer l'embarcation. Des cinq hommes ainsi jetés à la mer, trois se noyèrent. Le malheureux Guillot était du nombre. Félix Auber et Jacques Lugré ne durent leur salut qu'à la pensée qui leur vint d'implorer le secours de la bonne sainte Anne, au moment où, épuisés de fatigue, ils allaient disparaître sous les flots.[1]

Marie d'Abancour, veuve une seconde fois, ne se découragea point. Après avoir fait faire l'inventaire des biens de la communauté, par Auber, le 8 juillet, et mis ordre à ses affaires de famille, elle convola en troisièmes noces, le 8 novembre de la même année, avec Martin Prevost, habitant de Beauport et père de neuf enfants dont six vivants. Elle laissa Zacharie Jolliet et la petite Louise Guillot au Château-Richer chez son gendre François Fortin et emmena avec elle, à Beauport, l'aînée de ses filles, Elizabeth Guillot. Lors du recensement de 1667, Elizabeth, âgée de onze ans, servait en qualité de domestique chez Bertrand Chesnay et Louise, qui n'en avait que huit, est inscrite, avec la même mention, chez Simon Guyon.[2]

En 1676, Zacharie Jolliet qui allait atteindre ses dix-sept ans fut envoyé chez Noël Morin, résidant dans la banlieue de Québec, pour y faire son apprentissage de charron.

Comme aucun des fils de Jean Jolliet n'avait l'intention de cultiver le bien paternel et qu'il fallait de l'argent pour établir Louis et pour payer les frais d'apprentissage de Zacharie, Marie d'Abancour se décida, en 1668, à vendre sa terre du Petit-Pré. Mgr de Laval s'en fit l'acquéreur le 8 octobre. C'est encore la terre de six arpents de front sur lieue et demie de profondeur, mais située cette fois, entre Jobidon, représentant M. de Repentigny, à l'Est, et Bertrand Chesnay de la Garenne, à l'ouest.

On fait remarquer dans l'acte que ces terres sont demeurées "en non valeur parce qu'elles se trouvent infectées de folle avoine et que les bâtiments, (deux maisons et une grange), tombent en ruines, faute de moyens pour faire travailler aux dites terres et pour réparer les bâtiments."[3] Voilà où en était rendue la propriété de Jean Jolliet après trente ans ou environ de possession.

---

[1] Archives du Séminaire de Québec: "Relation des miracles opérés à Ste Anne du Petit-Cap," par Thomas Morel, ptre., mis.

[2] B. Sulte: *Histoire des Can.-Français,* Vol. IV.

[3] Arch. du Sém. Contrat fait par Rageot chez Martin Prevost, à Beauport.

Le prix de la vente se monta à 2,400 livres dont Mgr de Laval s'engageait à payer l'intérêt jusqu'à amortissement complet du principal. Sur cette somme, 1,200 livres revenaient à la veuve Jolliet, à présent femme de Martin Prevost, et 300 à chacun des enfants. La part des enfants était déjà en grande partie dépensée, comme nous l'allons voir.[1]

Outre ce que l'on avait déboursé pour l'apprentissage de Zacharie, Louis qui venait de quitter la soutane s'était endetté pour une somme de plus de mille livres envers Mgr de Laval. Les documents que nous allons citer feront voir les commencements difficultueux du futur découvreur du Mississipi.

Louis Jolliet se destinait d'abord à l'état ecclésiastique et il avait été tonsuré, le 10 août 1662, "dans la chapelle de la congrégation, au collège des Jésuites." Il avait alors dix-sept ans. Ayant reconnu après quelques années d'épreuves qu'il n'était pas appelé au sacerdoce, il quitta la soutane à l'automne de 1667.[2] Il lui fallait maintenant s'établir et, en attendant, trouver moyen de gagner sa vie. Nous ne savons dans quel but et après quels conseils un voyage en France fut aussitôt décidé. L'auteur de *Louis Jolliet* se demande si ce ne fut pas "à l'instigation du 'vice-roi' (M. de Tracy), ou de l'intendant Talon, et dans le but de poursuivre certaines études spéciales," que Jolliet entreprit ce voyage. C'est possible, mais nous croyons que Mgr de Laval y fut aussi pour quelque chose. Grâce à M. de Tracy avec lequel il s'embarquait sur le "Saint-Sébastien," Jolliet pouvait bien avoir son passage gratuit, mais il lui fallait trouver de l'argent pour ses autres dépenses car il était lui-même sans le sou.

L'évêque de Pétrée qui connaissait bien le jeune homme et qui l'appréciait à cause de ses talents et de ses belles qualités, lui ouvrit sa bourse et lui avança les fonds nécessaires. C'est ce que Jolliet nous apprend lui-même dans le document que nous prenons la liberté de citer en entier ici:

"Mémoire de ce qui m'a été fourny depuis le mois d'octobre 1667[3] jusqu'au mois de novembre 1668 par Mgr de Pétrée dans ma nécessité.

---

[1] Disons, pour mémoire, qu'en 1678, Mgr de Laval revendit cette terre à Julien Allart qui l'avait déjà prise à bail depuis quelques années. Elle est aujourd'hui possédée par MM. Letarte, Jobidon et Richard.

[2] Sur le recensement de 1667, Jolliet est mentionné comme clerc. Or, ce recensement, au moins pour la ville de Québec, a été fait en septembre et en octobre.

[3] Ernest Gagnon affirme, dans son ouvrage, page 13, que Jolliet quitta la rade de Québec, sur le "Saint-Sébastien" le 28 août 1667. Et pourtant, Jolliet ne date son compte que du mois d'octobre. Le recensement qui l'indique encore comme clerc a bien été fait en septembre et en octobre ce qu'il est facile de constater en confrontant l'âge qu'on y donne aux jeunes enfants avec leur acte de baptême.

Pour mon passage, un habit quand je partit pour france nonantes livres de france........................... 90

Receu de Monsieur poitevin par ordre de Monseigneur tant pour hardres que pour ma pension à St. Josse, cent soixante et une livres prix de france.................... 161

Receu de Monsieur de lauson par le même ordre de Monseigneur de pétrée vint huit livres prix de france........ 28

Pour l'extraordinaire du passage du vaisseau soixante livres de france.. 60

Pour ma depense pendant mon séjour à LaRochelle, cent livres et dix sols prix de france....................... 100.10

toutes lesquelles sommes ensembles font, prix de france, quatre cents trente livres dix sols, et, prix du canada, cinq cents quatre vint sept livres......................... 587

Au bas de ce compte, Jolliet ajoute:

Depuis le 9 octobre 1668, il a été fourny chez M. de la Chesnaye: douze aulnes d'estoffes 48 livres; pour du ruban, 10 livres; une aulne de toile d'ollande, 7 livres; en soye, boutons et un chapeau, 12 livres, 10 sols; pour deux paires de soulliers, 13 livres; pour toile à doublé et façon d'habit, 10 livres 7 sols et, en argent, trois livres.

Pour marchandises de traittes scavoir deux fusils, deux pistolets, six paquets de rassades, vint quatre haches, une grosse de grelos, douze aulnes d'estoffes à l'iroquoise, dix aulnes de toiles, quarante livres de tabac, trois cents cinquante quatre livres six sols.

Toutes lesquelles sommes ensemblement se montent à mille quarante cinq livres treize sols six deniers, prix du Canada, que je confesse avoir receues conformément au present mémoire, et promets en tenir compte et les payer à mon dit Seigneur de pétrée toutes fois et quantes, en foy de quoy j'ay signé le present escrit pour luy valoir d'obligation, fait à Québec le quatorsiesme d'octobre 1668.

(signé) JOLLIET, avec paraphe.

De leur côté, les parents de Jolliet firent ce qu'ils purent pour l'aider à payer sa dette ou le mettre en état de faire le voyage aux grands lacs qu'il était sur le point d'entreprendre. A cette fin, Marie d'Abancour avait consenti, le 8 octobre, que, pour se rembourser, Mgr de Laval retînt une partie de la rente annuelle qui lui était due à elle. Le 9 novembre, Adrien Jolliet envoyait à Mgr de Laval la note suivante: "Je consens que Monseigneur L'esvesque de Pétrée livre à mon frère Louis Jolliet les trois cents trente livres qui me sont deues pour ma part de la terre qui lui a esté vandue, en foy de quoy j'ay signé le présent escrit pour luy valoir de quittance; fait au Cap de la Madeleine, le 9 novembre 1668.

(signé) ADRIAN JOLLIET.

Et voilà comment Louis Jolliet put faire son premier voyage aux grands lacs.

Le 12 septembre 1671, il reconnaissait avoir reçu de Mgr de Laval, outre les trois cent trente livres que lui avait données Adrien, les trois cents livres qui lui revenaient à lui-même ainsi que 180 provenant de la rente de sa mère.

Les paiements de la rente et le remboursement du capital de la terre de Jolliet donnèrent lieu à toute une série d'actes de reconnaissance, de quittance, etc., que nous n'avons pas l'intention de rapporter ici bien que nous les ayons sous les yeux. Nous nous contenterons d'y glaner quelques renseignements de nature à mieux faire connaître la famille de Jolliet. Quant au découvreur lui-même, il va entrer, par son voyage au Mississipi en 1673, dans la grande histoire et nous n'avons rien d'important à ajouter à ce que ses biographes en ont déjà dit. Mais avant de parler de ses frères et de sa sœur, nous dirons un mot de son fils ainé, Louis.

Louis Jolliet était né à Québec le 11 août 1676 et y fut baptisé le 13. Il entra au petit séminaire de Québec le 2 avril 1687 et en sortit le 2 mars 1694, en première année de théologie, "ne voulant pas se faire prêtre," dit un vieux manuscrit. Quelques années, plus tard, en 1698, il est commis chez François Pachot, à Québec.[1] Il est encore en cette ville en 1699 et en 1700.[2] En 1701, on le trouve en la rade de Québec, commandant le *Neptune* et sur son départ pour la France. On était au 22 août.[3]

On voit par une lettre de l'abbé Tremblay du Séminaire des Missions Etrangères de Paris, en date du 4 avril 1705, que Jolliet est en France, qu'il commande toujours le *Neptune*, et qu'il se prépare à partir vers la mi-avril. Une autre lettre du même, en 1707, en fait encore mention.[4]

Louis Jolliet, fils, mourut deux ou trois ans plus tard à LaRochelle. Ceci est prouvé par "l'Inventaire des biens, meubles, papiers, argent monoyé et non monoyé de Claire Bissot veuve de Louis Jolliet," fait par La Cetière, le 17 décembre 1710. Le notaire écrit: " . . . le sieur

[1] Acte de Chas. Rageot, au greffe; 21 mars 1698.

[2] 1699, 21 octobre, actes de Roger. Il signe "Jolliet fils."

[3] Ce renseignement ainsi que les deux précédents sont empruntés à feu Philéas Gagnon.

[4] Archives du Séminaire de Québec.

de la Gorgendière nous a représenté un paquet qu'il a déclaré avoir été envoyé à la d. deffunte demelle Jolliet par M. de Montrelé qui est des habits de deffunt le Sr Louis Jolliet, son fils, décédé à LaRochelle et duquel elle était héritière et légataire. . . ."[1]

Le paquet dont il est fait mention ici vint par les vaisseaux de 1710, après la mort de la veuve Jolliet qui décéda en mars de la même année. Il est donc permis de croire, sans l'assurer toutefois, que Jolliet, fils, mourut à la fin de 1709 ou au commencement de 1710.

Ce Jolliet, en tout cas, ne paraît pas avoir laissé une fortune si on en juge par ce qui revint à sa mère, "son héritière et légataire." Les effets qui lui furent envoyés consistaient en deux *justocorps*, cinq ou six paires de culottes plus ou moins passées, deux ou trois paires de bas de soie, vieux et tachés, et c'est tout.

Nous avons dit plus haut que Marie d'Abancour, veuve Jolliet avait épousé, en secondes noces, Geoffroy Guillot et, en troisièmes noces, Martin Prevost. Ce dernier l'enterra, mais nous ne pouvons dire ni où, ni quand. Le recensement de 1681 n'en fait pas mention. Elle était certainement décédée en 1684, comme le prouvent plusieurs papiers que nous avons sous les yeux.

Cette absence de documents sur la mort de Marie d'Abancour se répète pour tous et chacun des enfants de Jean Jolliet. A part un anonyme, inhumé à Québec en 1644, nous ne pouvons préciser ni le lieu, ni la date du décès pour aucun des trois dont il nous reste à parler. Quant à Louis Jolliet, premier seigneur d'Anticosty et autres lieux, tout ce qu'on a pu dire de plus certain jusqu'à présent, c'est qu'il est mort entre le 4 mai et les 15 septembre 1700,[2] dans une des îles du golfe Saint-Laurent.[3]

Adrien Jolliet. Son acte de naissance n'a pas été retrouvé. L'abbé Tanguay, dans son *Dictionnaire généalogique*, place Adrien après tous les autres enfants de Jean. Il était pourtant l'aîné et son frère Zacharie le reconnaît pour tel dans un acte de 1669.[4] C'est donc lui, Adrien, qui, le 11 juin 1648, "revêtu d'un surplis" et "couronné de fleurs," *marchait* "aux côtés de la croix," dans la procession du Saint Sacrement à Québec.[5] Louis n'avait pas trois ans et Zacharie ne devait naître que deux ans plus tard.

---

[1] Nous devons ce renseignement à M. Pierre-Georges Roy qui a eu l'obligeance de mettre à notre disposition ses notes sur la famille Jolliet.

[2] Cf, *Bulletin des Recherches Historiques*, Vol. XX, p. 267, note du R. P. Charland, O.P.

[3] Ernest Gagnon, oper. cit., p. 205.

[4] Archives du Séminaire de Québec.

[5] *Journal des Jésuites*, p. 110.

Adrien Jolliet passa-t-il, comme ses frères, par le Collège des Jésuites ? Nous n'en avons pas de preuve directe, mais nous le croyons. Il avait une très bonne et même belle écriture. Où donc aurait-il appris à lire et à écrire sinon au Collège, ou du moins à la petite école des Jésuites ? Non seulement il a une bonne main, mais il connaît son orthographe, mieux même que Louis qui a pourtant étudié assez longtemps.

En 1658, il avait alors dix-sept ou dix-huit ans, on trouve Adrien Jolliet aux Trois-Rivières. Qui l'avait entraîné là ? C'est ce que nous ne pouvons dire.

Cette année-là, les Iroquois se montraient plus audacieux que jamais. Ils rôdaient jusque près des habitations, dans l'espérance de lever quelques chevelures et de faire des prisonniers. Entre autres faits de ce genre, la Relation de 1658 raconte[1] qu'ils parurent aussi aux Trois-Rivières "et y firent prisonniers trois jeunes hommes qui ne faisaient que d'en sortir pour aller au travail, sans que l'on peust leur donner aucun secours, quoyque les Iroquois les entrainassent à la veue de tous ceux du bourg."

Et plus loin: "Dans le même mois de juin, une bande d'Onnneiotchronnons . . .prirent trois Français aux Trois-Rivières, qu'ils entraînèrent avec eux en l'Isle de Montréal, où, voulant surprendre quelques-uns de nos gens, l'un d'eux fut tué; ce qui les irrita si fort qu'ils brûlèrent sur la place un des trois français qu'ils tenaient captifs, emmenant les deux autres vers leur pays, où l'on dit qu'ils les ont fait mourir à petit feu."

Le *Journal des Jésuites* va ajouter quelques précisions à ces données un peu vagues. A la date du 17 juin 1658 on y lit: "Le bac de montréal arriva à Québec, qui porta pour nouvelles que trois français, jeudi dernier, 13 du susdit mois, furent pris par un canot de 6 Iroquois à 5 heures du matin, à la première rivière. Ils s'appellent Adrien Ioliet, Fouquet, Christophle."

Un autre entrée faite au *Journal* le 16 septembre nous apprend que les deux prisonniers emmenés par les Iroquois et que l'on disait avoir été brûlés à petit feu, venaient d'être ramenés à Montréal par Garakontié: c'étaient Jolliet et Christophle.[3]

---

[1] *Relation de* 1658, p. 4.

[2] Ibid., pp. 16 et 17.

[3] C'est donc Fouquet qui avait été tué à Montréal.

Adrien Jolliet était donc aux Trois-Rivières en 1658, peut-être avant. C'est là qu'il épousa Jeanne Dodier le 22 janvier 1664.[1] Le mariage fut célébré par le Père Le Mercier, dans la chapelle des Trois-Rivières, "en présence de Moral de St. Quentin, de François Le Maistre, etc." Le contrat avait été passé devant Ameau le 31 décembre, 1663.

Bien qu'Adrien Jolliet se soit marié aux Trois-Rivières, il résidait probablement à cette date au Cap. Il y était du moins le 24 juillet 1665, comme il appert par un acte de Jacques de la Touche qui le dit: "habitant et demeurant dans le bourg du Cap de la Madeleine."[2]

Le 23 avril 1666, le même notaire est encore au Cap, chez Adrien Jolliet, où il a été appelé pour rédiger un contrat de société entre Adrien Jolliet, Denys Guyon, Laurent Philippe, François Collart, Antoine Serré, Benoît Boucher, Jacques Maugras et Jacques Largillier, "touchant le voyage qu'ils vont présentement faire pour les Outaouaks."[3]

Ce dernier acte peut expliquer comment il se fait que le nom de Jolliet ne se trouve pas sur le recensement de 1666. Ce que nous comprenons moins c'est que celui de sa femme ne s'y rencontre pas non plus. Aurait-elle suivi son mari dans les pays d'en haut ? A-t-on oublié d'en faire mention ? Mystère.

On voit par le recensement de 1667 que Jeanne Dodier, qui n'est cependant pas indiquée comme épouse de Jolliet, demeure chez Trottier (Jean), qu'elle prétend être âgée de vingt ans, (on lui en donnera quarante cinq en 1681), et qu'elle a avec elle une enfant appelée Jeanne Jolliet dont le nom est suivi du chiffre 7. Il doit y avoir erreur quelque part.

Jeanne Dodier n'a pu avoir vingt ans aujourd'hui et quarante-cinq quatorze ans plus tard. Quant à sa fille Jeanne, le 7 qui accompagne son nom signifie sept mois et non pas sept ans comme on pourrait le croire. Dans le recensement de 1681, elle est mentionnée comme étant âgée de quinze ans.

---

[1] L'acte de mariage se lit comme suit: "Anno dni 1664 die 22 januarii tribus denunciationibus de more praemissis in sacello nostro ad tria flumina nulloque legitimo impedimento detecto Ego Franciscus le Mercier Societ. Jesu sacerdos, parochi vices agens interrogavi et consensu habito per verba de presenti, coniunxi in matrimonium Adrianum Joliet filium Joannis Joliet et Mariae dabancourt ex parochia castelli Richer et Joannam dodier filiam Joannis dodier defuncti et franciscae le maire ex parochia de Memer Senomani. Testes fuere dnus des Marais, dnus de St. quentin, Franciscus le Maistre, Nicolaus la Prée, etc.,

(Double de l'original, conservé aux archives du Séminaire de Québec.)

[2] Archives du Séminaire de Québec.

[3] *Rapport des Archives d'Ottawa* pour 1905, p. LIV. Ce contrat est mentionné dans l'Histoire de la paroisse de Champlain, p. 94.

Adrien Jolliet mourut jeune. Nous n'avons pas son acte de sépulture, mais Louis, son frère, déclare dans un document du 12 septembre 1671, qu'il est "défunt." Or, le 13 avril 1669, Adrien lui-même étant de passage à Québec avait signé une quittance dans laquelle il se disait pour lors: "habitant demeurant aux Trois-Rivières." Il mourut donc entre ces deux dates.[1]

En 1677, Frontenac écrivant à Colbert une lettre dans laquelle il s'efforce de démontrer que les ecclésiastiques ont de gros revenus, disait: "L'enterrement du frère de Jolliet, mort au service du Sieur de la Salle, et enterré en son absence dans le cimetière, luy a cousté 53 livres."[2]

Dans le cimetière? Mais où? A Québec? A Montréal? Serait-il décédé durant son séjour à Québec, au printemps de 1669? On sait que La Salle était venu en cette ville à la fin de l'hiver, qu'il était retourné à Montréal, y avait engagé des hommes durant l'été, qu'il était encore en cette ville le 6 juillet et qu'enfin il était parti vers cette date pour son premier voyage dans l'Ouest avec MM. Dollier et de Gallinée.[3] Des quatorze hommes qui l'accompagnaient au départ, quelques-uns l'avaient abandonné à la fin de septembre pour revenir à Montréal. Adrien Jolliet était-il de ceux-là et vint-il mourrir à Montréal? C'est possible, et alors Frontenac aurait dit vrai en affirmant que Jolliet avait été enterré durant l'absence de M. de la Salle puisque celui-ci ne revint à Montréal qu'à l'été de 1671.[4] Voilà bien des points d'interrogation auxquels nous ne pouvons répondre autrement que nous l'avons fait.

Tanguay ne donne pas d'autres enfants à Adrien Jolliet que Jean-Baptiste, né vers 1667. Or, ce n'est pas Jean-Baptiste qui est né vers 1667, mais Jeanne. Lors du recensement de 1681, on dit que Jeanne a quinze ans et Jean-Baptiste douze, ce qui mettrait la naissance de ce dernier à 1669.

Jusqu'ici, ces indications nous paraissent claires, mais il y a autre chose. Le 13 février 1675, Mathurin Normandin dit Beausoleil qui avait épousé, nous ne savons quand ni où, la veuve d'Adrien Jolliet, fit baptiser un fils qu'on nomma Jean-Baptiste et dont la marraine fut: "Marie-Ursule Jolliet."[5]

---

[1] Les deux actes dont il est question ici sont aux Archives du Séminaire de Québec.

[2] Pierre Margry: *Découvertes et Etablissements des Français dans l'Ouest et dans Sud de l'Amérique Sept. 1re partie*, page 305.

[3] Pierre Margry: Oper. cit. pp. 109 et suiv.

[4] Faillon: *Histoire de la Colonie Française*, Vol. III, pp. 297 et 312.

[5] Registre du Cap-de-la-Madeleine, dont copie au Séminaire.

De plus, au même registre du Cap-de-la-Madeleine, sous la date du 12 août 1685, on mentionne en deux lignes le mariage de Jean Julien et d'Antoinette Jolliet.

A moins que ces deux filles ne soient qu'une seule et même personne avec Jeanne, ce sont deux autres enfants d'Adrien, car elles ne peuvent appartenir ni à Louis ni à Zacharie.

De même, quelles sont ces demoiselles Jolliet que mentionnent les Annales des Ursulines, avant 1686 ?[1] Marie, fille de Jean, avant 1660, peut-être, mais après, nous n'en connaissons pas d'autres que celles d'Adrien. Mais alors que sont devenues ces enfants? C'est ce que nous ne pouvons dire.

La veuve d'Adrien Jolliet, remariée avec Beausoleil, vivait encore en 1688.[2] Quant à Beausoleil, il était décédé en 1684 si c'est le même que celui dont parle Tanguay.[3]

L'auteur du *Dictionnaire généalogique* ne paraît pas avoir vu le vieux registre du Cap-de-la Madeleine, 1673-1687. Aussi ne mentionne-t-il pas les enfants issus de ce mariage de la veuve Jolliet avec Beausoleil. En voici quatre dont nous inscrivons ici les noms à titre de renseignement. Il n'est pas impossible qu'il y en ait eu d'autres.

Jean-Baptiste, baptisé le 13 février 1675.

Marie-Françoise, baptisée le 12 février 1678.

Marie-Madeleine, baptisée le 3 juillet 1680.

Joseph, baptisé le 12 avril 1682; il eut pour parrain Jean Jolliet, son frère utérin.[4]

Jean-Baptiste Jolliet, fils d'Adrien, épousa Marie-Jeanne Cusson, non pas en 1702, comme dit Tanguay, mais avant 1698. Voici la liste de leurs enfants faite d'après le Registre du Cap-de-la-Madeleine, entre 1698 et 1710:

Joseph, né et baptisé le 9 "de cette année," (sic) 1698.

Jean-Baptiste, né le 11, baptisé le 13 février 1700.

Marie-Thérèse, née le 19, baptisée le 20 février 1702.

Marie-Jeanne, née le 9, baptisée le 10 janvier 1704.

Adrien, né le 1er, baptisé le 2 février 1705.

Marie-Jeanne, née le 2, baptisée le 6 décembre 1706.

Pierre, né le 14, baptisé le 17 mai 1708.

Marie-Jeanne, née le 16, baptisée le 17 février 1710.

Si l'on ajoute à ces noms ceux de Marie-Charlotte, de François et de Marie-Catherine que mentionne Tanguay, on aura onze enfants

---

[1] *Les Ursulines de Québec*, Vol. 1, p. 324.

[2] Archives du Séminaire: Quittance de 10 livres, etc., 22 mars 1688.

[3] Vol. I, p. 35.

[4] Registre du Cap. dont copie au Sém.

connus, nés du mariage de Jean-Baptiste Jolliet et de Marie-Jeanne Cusson. Nous n'avons pas l'intention de les suivre plus loin. Nous ferons remarquer seulement que c'est de cette branche, c'est-à-dire d'Adrien par Jean-Baptiste, François et Antoine que descendait l'honorable Barthélemi Joliette avec lequel le nom s'est éteint.[1]

Marie Jolliet, fille de Jean et de Marie d'Abancour, épousa, le 6 avril 1660, François Fortin, chirurgien de la ville de Dieppe, demeurant alors à la côte de Breaupé; elle avait douze ans ce jour-là

François Fortin était arrivé au pays vers 1657 avec Petiot de Corbières. Les actes l'appellent François Fortin, Sieur Desrosiers.[2] Son contrat de mariage, du 8 janvier 1660, nous apprend qu'il était fils de François, bourgeois de Dieppe, et de Catherine Collemont.[3]

Fortin acquit des propriétés assez considérables au Château-Richer. Il y achète une première terre de Jean Cloutier le 29 janvier 1660 et une autre, de Julien Fortin Bellefontaine, le 31 octobre 1661.[4]

Un an plus tard, le 1er octobre 1662, Marie d'Abancour et son époux Guillot, cédaient à Fortin et à sa femme le quart de la terre de Jean Jolliet, c'est-à-dire un arpent et demie de front sur la profondeur. Ils ne gardèrent cette propriété que trois ans et, le 1er octobre 1665, ils la remettaient aux héritiers de Jolliet moyennant la somme de 1300 livres en compensation des dépenses et des améliorations qu'ils y avaient faites.[5]

Le 28 septembre 1666, François Fortin est à l'Hôpital, malade. Il se propose de passer en France pour y refaire sa santé.[6] Quelques jours plus tard, le 11 octobre, Fortin et sa femme déclarent, dans un acte, qu'ils n'ont pas d'enfants vivants.[7]

François Fortin et sa femme partirent pour la France après le 11 octobre 1666; le recensement de 1667 les ignore complètement et

---

[1] Cf. Tanguay: *Dict. Genéal.*, Vol. V, pp. 14 et 15. Aussi: Ernest Gagnon: *Louis Jolliet*, p. 5.

On écrit aujourd'hui la ville de Joliette d'après le nom du fondateur, l'hon. Barthélemi. Quand cette famille a-t-elle changé l'orthographe de son nom? Nous n'en savons rien, mais ce qui est certain c'est que Jean le premier du nom signait Jollyet ce qui équivaut à Jolliet et que Louis, Adrien et Zacharie, comme leur sœur Marie du reste, signaient: JOLLIET. Nous avons vu leur signature. Louis, fils de Louis, et Nicolas, fils de Zacharie, signaient aussi: JOLLIET.

[2] Greffe d'Auber, 18 sept. 1658.

[3] Greffe d'Audouart.

[4] Greffe d'Auber.

[5] Greffe d'Auber, Archives du Séminaire de Québec.

[6] Greffe d'Auber.

[7] Greffe de Becquet.

Les notes qui précèdent sont empruntées aux annotations de feu Philéas Gagnon.

pour cause. Ils étaient allés demeurer à Dieppe et c'est de là que, le 21 avril 1670, ils ratifièrent la vente de la terre de Beaupré, faite en 1668, reconnaissant en même temps qu'ils avaient reçu leur part d'héritage.[1]

Cette année-là, 1670, Fortin fit le voyage du Canada. Un acte du 4 novembre le dit de présent à Québec, mais résidant ordinairement à Dieppe.[2] Nous ne pouvons dire quelle fut la durée de ce voyage. En 1673, on les trouve tous deux à Ouville-LaRivière, paroisse de Longueuil, en France.[3]

Le 13 février 1685, ils signèrent ensemble, en faveur de Mgr de Laval, une quittance générale concernant leur part d'héritage dans les biens des Jolliet. Quelques jours plus tard, Marie Jolliet était décédée. Le 26 mars, François Fortin écrivait d'Offranville,[4] à M. Dudouyt, à Paris, cette lettre désolée:

"Monsieur, c'ést avec bien des larmes que je vous apprens le trépas de ma chère moitié; toute les peines et les travaux du passé ne pouvaient ébranler ma constance, mais c'est à ce coup si rude qu'il faut un extraordinaire secours du ciel pour en supporter la pesanteur. Je m'adresse donc à vous, Monsieur, comme à celuy qui a eu le plus de lumières des peines que nous avons endurés ensemble pour recevoir de vous quelque consolation et pour vous prier en même temps de vous souvenir de son âme au très saint sacrement de la messe et de dire à Monseigneur l'évêque qu'il se souvienne des petits services qu'elle lui a rendus étant chez nous au Château-Richer. C'est ce qu'elle m'a recommandé deux jours avant de mourir ayant appris l'arrivée de Monseigneur à Paris. J'écrirai à Mgr un de ces jours toutes les particularités de sa maladie. Je prie Monseigneur d'avoir égard à toutes mes peines, il y avait trois mois que ma femme était retenue au lit. Jugez du reste. Etant de tout cœur, monsieur, votre très humble serviteur.

(signé) f. fortin, avec paraphe.[5]

De son mariage avec Marie Jolliet, François Fortin aurait eu une fille nommée Marie et mariée en 1688 à Louis Couillard.[6] Cette enfant est née en France vraisemblablement; Tanguay met sa naissance à 1670. Elle n'a du revenir au Canada qu'après la mort de sa

---

[1] Archives du Séminaire de Québec.

[2] Greffe de Rageot.

[3] Archives du Séminaire.

[4] Archives du Séminaire. Offranville: petite ville a huit kilomètres de Dieppe.

[5] Archives du Séminaire.

[6] Cf. *Dict. Généal.*, Vol. I. Aussi: M. l'abbé A. Couillard-Desprès: *La première famille française au Canada*, p. 296.

mère et peut-être même de son père. En tous les cas, nous n'avons pu trouver son nom dans le recensement de 1681.

Zacharie Jolliet, le plus jeune des fils de Jean Jolliet et de Marie d'Abancour, avait été baptisé le 23 décembre 1650, quatre mois avant la mort de son père. D'après l'auteur de *Louis Jolliet,* Zacharie aurait étudié, lui aussi, pendant quelque temps, au collège des Jésuites. Nous le croyons aisément, d'autant plus que la petite école des Pères était à cette époque la seule qui existât. Zacharie Jolliet savait lire et écrire. A l'époque du recensement de 1666, Zacharie demeurait au Château-Richer, chez sa sœur Madame Fortin. L'année suivante, on le trouve à la côte Sainte Geneviève, chez Noël Morin, y faisant son apprentissage de charron qu'il termina apparemment à l'automne de 1668.[1]

Le 24 novembre 1678, il épousait à Québec, Marie Niel. Le contrat de mariage passé devant Duquet est du 17 novembre.

Comme ses frères, Zacharie fut un voyageur et un traiteur, soit pour lui-même, soit pour d'autres. C'est ainsi que le 13 mai 1682, il part en traite pour le compte de François Hazeur.[2] On le dit alors "habitant de Québec." Un acte du 7 février 1684 le qualifie de "bourgeois de Québec."[3]

Durant l'hiver de 1684-1685, il est chez les Mistassins[4] et à l'été on le trouve un peu plus loin, à Némiscau, pour y établir le poste de ce nom comme il appert par le document suivant:

"Le deuxie juillet mil six cent quatre vingt cinq nous Zacharie Jolliet, porteur des ordres de Monseigneur le Général pour l'établissement du poste de Nemisco, assisté d'Ignace Denis, serions arrivé à la d. rivière Nemisco où nous aurions dressé un poteau auquel nous aurions appliqué les armes de Sa Majesté à une lieue de la maison faite en 16 quatre-vingt plus près des Anglais que la d. maison à une belle pointe qui se nomme Nemisco pour en prendre possession entière et troubler autant qu'il sera possible la traitte que font les Anglais au d. lieu, le tout conformément aux ordres de Monseigneur le Général dont et de tous ce que dessus nous avons dressé nostre présent procès-verbal que nous avons fait signer par le dit sieur Ignace Denis pour

---

[1] Archives du Séminaire de Québec.

[2] Note fournie par M. Pierre-Georges Roy. (Archives provinciales).

[3] Archives du Séminaire de Québec.

[4] Ibid. Second registre de Tadoussac. Voir notre travail: *A Chicoutimi, au Lac St-Jean à la fin du XVIIe siècle.* Mémoires de la Société Royale, Vol. II, p. 133.

servir et valoir ce que de raison fait au d. Nemisco ce deuxie juillet 16 quatre vingt cinq.

(signé) Za. Jolliet
Ignace Denis.[1]

Notons en passant que M. de Saint-Simon et le Père Charles Albanel passant par Némiscau en 1672 y "arborèrent les armes du Roy sur la pointe de L'Isle, qui coupe le Lac, le neufiesme de juillet."[2]

On sait par un acte de Génaple, du 20 mars 1692, que Zacharie Jolliet était alors au pays des Outaouais. Quelques mois plus tard, le 18 novembre, le même notaire nous apprend que Jolliet est mort. "Marie Niel, dit-il, veuve de Deffunt le Sr Zacharie Jolliet, demeurante en cette ville, rue Sous-le-Fort, reconnaît devoir à Charles Macart, marchand, 1260 livres et 17 sols, pour marchandises que le sieur créancier lui a fournies pour envoyer à son dit mary au pays des Outaouais, depuis le 16ne jour de juin de l'an dernier, 1691," et autres marchandises pour elle-même, etc.

Marie Niel déclare alors qu'elle payera "aussitôt que les pelleteries et autres effets délaissés par son défunt mary, au dit pays des Outaouais, en seront descendus et arrivez l'an prochain, 1693." Le tout signé: "Marie Niel," d'une très belle écriture.

Ceci se passait le 18 novembre 1692. Quelques jours plus tard, le 25 novembre, la veuve Jolliet épousait Jacques de Verneuil.

Le Dictionnaire généalogique de l'abbé Tanguay nous fait connaître trois enfants issus du mariage de Zacharie Jolliet et de Marie Niel: Louis, Nicolas et François.

Louis fut baptisé le 22 juillet 1679, à Québec; c'est tout ce que nous en savons.

Nicolas, baptisé à Québec le 4 mai 1682, entra au Séminaire de Québec le 22 avril 1694, venant de l'école de Saint-Joachim où il avait passé dix-huit mois, sans avoir pu apprendre à lire.[3] Il sortit du Petit Séminaire en 1697; il savait lire et écrire, même très bien. En 1700, on le rencontre au Château-Richer. Nous ne pouvons dire ce qu'il faisait là. On trouve sa signature aux registres de cette paroisse le 16 avril 1700 et sur un acte de Jacob du 24 novembre de la même année. Enfin, un acte de Chambalon, en date du 30 juin 1701, nous le montre partant pour la Baie du Nord. Puis, nous le perdons de vue.

---

[1] Bulletin des Recherches Historiques, Vol. XX, p. 390.

[2] *Relation* de 1672, p. 55.

[3] Archives du Séminaire de Québec.

François, le dernier né, fut baptisé le 21 octobre 1690. Il entra au Petit Séminaire le 10 Octobre 1697, âgé de sept ans, sachant un peu lire, disent nos Annales. Il acheva d'apprendre et, en 1699, sa mère l'envoya à l'école de Saint-Joachim.[1] Nos renseignements s'arrêtent là.

En définitive, nous n'avons pu préciser la date du décès ni de la femme de Jean Jolliet, ni d'aucun de ses enfants. Voici à quoi nous nous arrêtons pour le moment:

Marie d'Abancour, décédée entre 1678 et 1681.

Marie Jolliet, femme de Fortin, décédée entre le 13 février et le 26 mars 1685.

Adrien Jolliet, décédé entre le 13 avril 1669 et le 12 septembre 1671.

Louis Jolliet, décédé entre le 4 mai et le 15 septembre 1700.

Zacharie Jolliet, décédé à la fin de 1691 ou au commencement de 1692.

Les chercheurs qui pourront préciser davantage rendront service aux futurs rééditeurs du *Dictionnaire Généalogique* de l'abbé Tanguay qui a fait sa large part. Pour nous, nous serons satisfait si nous avons contribué en quelque chose à faire mieux connaître la famille de l'illustre découvreur du Missisipi, seigneur d'Anticosty et autres lieux, Louis Jolliet.

[1] Ibidem.

François, le dernier né, fut baptisé le 21 octobre 1680. Il entra au Petit Séminaire le 10 Octobre 1697, âgé de sept ans sachant un peu lire, disent nos Annales. Il achevá d'apprendre et, en 1698 sa mère l'envoya à l'école de Saint-Joachim.[1] Nos renseignements s'arrêtent là.

En définitive, nous n'avons pu préciser la date du décès ni de la femme de Jean Jolliet, ni d'aucun de ses enfants. Voici à quoi nous nous arrêtons pour le moment :

Marie d'Abancour, décédée entre 1678 et 1681.

Marie Jolliet, femme de [illegible], décédée entre le [illegible] et le [illegible] mars 1685.

Adrien Jolliet, décédé entre le 15 avril 1669 et le 12 septembre 1671.

Louis Jolliet, décédé entre [illegible] et le 15 septembre 1700.

Zacharie Jolliet, décédé à [illegible] 1701 ou [illegible]ement de 1692.

Les chercheurs qui pourront [illegible] inventaire [illegible] service aux futurs rédacteurs du Dictionnaire généalogique [illegible] qui a fait sa large part. Pour nous, [illegible] contribué en quelque chose à faire [illegible] être de la [illegible] du Mississipi [illegible] Louis Jolliet.

[1] Ibidem.

Le régionalisme littéraire[1]

Opinions et théories

Par M. ALBERT LOZEAU, M.S.R.C.

(Lu à la réunion de mai 1920.)

En feuilletant mes petits livres,—le premier surtout, entièrement écrit au lit, sa seule originalité peut-être: je n'en veux pas dire de mal, mais je défie l'homme soucieux de perfection de se relire sans dégoût "dix ans après,"—tel lecteur a pu se demander avec inquiétude s'ils font partie de la littérature régionaliste ou nationaliste, s'ils appartiennent à l'église orthodoxe ou à la secte dissidente, pour employer le langage courant. Ce grave sujet faillit autrefois troubler ma solitude. Alors que j'étais étendu sur le dos depuis neuf ans, entre les murs d'une chambre dont la fenêtre donnait sur des pans de briques sales, on me reprochait doucement de ne pas me consacrer à la peinture du paysage canadien, quand à peine pouvais-je me permettre quelques notations de lumière et d'ombre, au lieu de m'occuper presque exclusivement de poésie psychologique. Je n'aurais pas désiré mieux! Je m'excusais; j'invoquais des circonstances atténuantes, des empêchements de vie mutilée. . . . Quelques amis me pardonnaient ce travers. On fait ce qu'on peut: pour peindre la nature, il est indispensable de la voir. J'avais bien des souvenirs que, du reste, j'eus tort d'utiliser en les arrangeant: ils étaient si lointains, si vagues! De l'histoire, je savais ce qui s'enseignait alors dans les collèges commerciaux: suffisamment d'Histoire de France, très peu d'Histoire du Canada. A cet égard, mes lacunes étaient—et sont restées, malgré beaucoup de lecture—effroyables! Les élèves d'il y a vingt ans qui ne sont pas devenus tout à fait des déracinés y ont quelque mérite! Toute une portion de leur âme fut laissée en friche, terrain inculte où le sens national a poussé comme il a pu, grâce à la force du sang ancestral aidée de la foi catholique. Nos

---

[1] Un collaborateur de l'*Action française* a fait judicieusement remarquer à quelle confusion prête le terme "régionalisme" pris dans son acception française et appliqué à la nationalisation de notre littérature. Le régionalisme français a pour objet la décentralisation politique et intellectuelle; il combat l'attraction qu'exerce la capitale dans tous les domaines de la pensée et de l'art; il se dévoue à la conservation des coutumes et des parlers locaux. Le mot ne nous convient donc qu'à demi. On a joué autrefois du vocable "libéralisme," dont on qualifiait la doctrine du parti libéral canadien, bien que le libéralisme français et celui d'ici diffèrent de beaucoup. Cf. *Le Libéralisme*, par Emile Faguet.

modernes écoliers sont mieux pourvus. Je n'ai jamais eu d'ailleurs la moindre aptitude à la poésie patriotique; au surplus, on me l'affirme et j'en conviens. Le terroir, je l'aimais sans doute, mais je n'en savais pas grand'chose: la campagne m'était pour ainsi dire inconnue. Et puis, en ce temps-là, la question du régionalisme littéraire ne se posait pas souvent dans les jounaux; on y regarde de plus près aujourd'hui.

Une discussion acrimonieuse, où les gens paisibles hésitent à s'engager, s'étant élevée dans notre monde littéraire, à l'exemple de la fameuse querelle des Anciens et des Modernes, quant à la valeur respective des œuvres du terroir et de celles qui s'en écartent, au double point de vue artistique et national; et des opinions péremptoires, aparemment incompatibles, s'étant exprimées à la tribune du conférencier et dans la presse, je sollicite la permission de dire mon humble mot sur cette question controversée.

Insistons dès le début sur un point capital: nous ne pourrons jamais ni ne souhaitons nous passer de la France; elle est la source vive où, sous peine de périr, nos cerveaux devront constamment s'abreuver. Comme l'a dit M. Asselin: "Prenons toutes les mesures nécessaires pour que la culture humaine n'affaiblisse pas chez nous l'esprit national, mais le fortifie, l'éclaire et le guide." De son coté M. l'abbé Groulx assure "que les maîtres de la pensée de France doivent rester les maîtres de notre insuffisance, parce qu'il importe à notre durée que les courants de la pensée française nous apportent cette substance d'art et de morale, ces vertus de la race et de l'esprit qui font l'essence de notre culture." (*L'Action française*, n° 2, première année.)

En tenez-vous pour le régionalisme ou pour l'exotisme? Selon votre réponse, on vous félicitera ou l'on vous blâmera plus ou moins poliment, car les convictions sont profondes et les partis tranchés! Croyez-vous qu'un sage mélange des deux doctrines puisse être proposé? Vous serez suspect aux protagonistes de l'une et de l'autre: qui n'est pas pour moi est contre moi! Le régionaliste absolu vous citera *Maria Chapdelaine* pour établir la beauté de notre nature et prouver le charme de "nos gens," de nos traditions et coutumes nationales—ce que nul ne conteste. L'exotique intégral répliquera que Louis Hémond, en venant puiser matière à chef-d'œuvre à des centaines de milles de sa terre natale, a fait de la littérature exotique humaine et vivante dont bénéficient à la fois la vieille et la nouvelle France. Les deux ont raison. *In medio stat virtus*. Dans tous les pays, on trouve des écrivains qui, tantôt, limitent leur regard à leur maison, leur champ, leur village et leur province et, tantôt, vont chercher au loin, très loin dans le monde et le passé, de nouveaux sujets d'inspiration. Peu importe la provenance des matériaux, s'ils sont propres à l'édification d'une œuvre artistique immortelle! Quand on les a chez soi, c'est folie et petitesse de cœur de les dédaigner par principe; mais rien ne défend d'utiliser quand même la matière étrangère avec goût et talent. C'est affaire de tempérament et d'adresse.

Les deux camps se disputent, chacun tire à soi le plus possible d'auteurs et les vante paternellement, en vertu de principes qui semblent de poids fort inégal: il s'agit de prendre position et, on ose l'espérer, de rapprocher, en dissipant les malentendus, des adversaires qui se rencontrent à plus d'un endroit sans le savoir: ils sont trop occupés à se battre! Ajoutons qu'à notre avis, les divergences sont entretenues, accentuées même, par une critique sans nuance, de part et d'autre. Pour se bien comprendre, rien ne vaut une franche explication sincèrement demandée et non moins sincèrement donnée.

* * *

Le régionalisme littéraire est une doctrine excellente quand elle est largement interprétée; mais n'est-elle pas compromise par des énoncés de principes douteux et des arguments préjudiciables à l'art canadien ? On le dit, il y paraît parfois. Ecarts de plume, phrases ambiguës échappées au cours tumultueux de la discussion, toutes choses dont l'adversaire fait sa joie et sustente son ironie. La méthode chère employée à déprécier[2] ou ridiculiser les opinions et les ouvrages régionalistes n'est pas inédite. Elle consiste principalement à détacher une ligne par-ci, un paragraphe par-là, à couper tout lien avec le contexte, à relever les erreurs typographiques, les fautes, prétendues ou réelles, de ponctuation, à commenter de façon fantaisiste, puis à s'esclaffer! Les mêmes procédés appliqués aux savants et spirituels critiques les démoliraient aussi bien. On se chargerait volontiers de la démonstration si le jeu n'était injuste et puéril. "Hors du terroir, point de salut! Boutons le génie français dehors!" (M.

---

[2] Il n'est pas certain que Gill ait manqué son poème "Le Cap Eternité" au point que le prétend M. Asselin et que semble l'admettre M. Desrosiers (voir le premier numéro de la *Revue Moderne* et l'*Action française* de décembre 1919). Dans cette œuvre incomplète, on rencontre des pièces entières de premier ordre, comme "Ave Maria," "La cloche de Tadoussac," et plusieurs fragments des autres chants, matériaux épars d'une œuvre inachevée, sont d'un grand poète. Il nous paraît qu'il y a là de l'originalité, de la force, de l'émotion vraie et rien qui sente le livresque: l'artiste ayant ébauché son poème sur les lieux mêmes et ne s'étant inspiré que du livre de la nature. Ses traductions, bien qu'honorables, sont inférieures au reste, selon nous.

Victor Barbeau.) Le brillant chroniqueur[3] exagère en assurant que nous voulons nationaliser à outrance—pour lui *nationaliser* signifie *banaliser*—et que nous sommes les "éteignoirs" de la culture générale. Il n'a pourtant qu'à ouvrir *l'Histoire de la littérature canadienne-française* de M. l'abbé Camille Roy pour y lire: "Il ne faut nationaliser que dans la mesure où cela se peut sans nuire à la formation générale de l'esprit."[4] La limite est difficile à tracer; c'est beaucoup au sujet de cette vague limite que les têtes s'échauffent et qu'il s'est écrit des phrases comme celles que je vais citer et commenter.

* * *

"Défense à l'homme né dans le Québec d'être humain avant d'être catholique et Canadien." (M. L. Desrosiers. *La Revue Nationale*, juillet 1919).[5]

Telle que présentée, sous sa forme de règle inviolable, d'intangible décret, et dans sa tournure d'*ukase*, cette opinion est aisément réfutable. Nous supposons qu'elle est sérieuse, car nous n'en sommes pas certain. A coup sûr, si cette loi singulière ordonne aux écrivains canadiens-français de produire au premier plan leur nationalité et leur croyance et de reléguer au second leur *humanité*, elle aura toute la vertu d'un arrêté ministériel qui prétendrait contraindre les organes du corps humain à fonctionner indépendamment les uns des autres! Si le législateur estime, au contraire, la dissociation impraticable, que vient faire ici la "défense?" En tout cas, cette prescription n'est pas claire et, par conséquent, prête à la controverse. Malgré la confiance que nous avons en son auteur, nous aimerions plus de lumière.

La première condition pour parler aux hommes, c'est d'être humain dans toute l'acception du mot; pour nous, l'homme n'est pas séparable du Canadien-français et l'un ne saurait avoir la priorité

---

[3] Les parodies qu'on a faites des articles de "Turc" ne diminuent pas son talent et n'avancent en rien la cause du régionalisme. Ne s'imitent facilement que les écrivains qui ont une manière, fût-elle parfois étrange. Avoir une manière, c'est déjà quelque chose, dit à peu près Sainte-Beuve. Qu'on discute et critique les opinions de "Turc" quand on les juge erronées, personne n'y trouve à redire. Le ridicule est une arme à deux tranchants. . . .

[4] M. l'abbé Camille Roy, le théoricien par excellence du régionalisme tel qu'on doit l'entendre au Canada, disait encore, étudiant le *Paon d'Email* de M. Paul Morin: ". . . S'il est bon de nationaliser notre littérature, il ne faut pas le faire jusqu'au point de rétrécir, à la ligne précise de nos horizons, le champ visuel de l'esprit canadien. Tout ce qui est humain peut intéresser nos âmes canadiennes et il est bien permis à nos poètes d'aller chercher hors des paysages laurentiens l'objet de leurs chants, pourvu . . . qu'ils y réussissent. . . ."

[5] Nous discutons en toute charité ces opinions de confrères dont nous honorons le talent et respectons la bonne foi.

sur l'autre: ils sont indissolublement unis. Une loi, si absolue soit-elle, est impuissante à couper l'homme en deux! Il faut éprouver les sentiments de l'humanité en général pour être entendus des hommes en particulier. Les hommes d'ici ressemblent aux autres: en sont-ils moins Canadiens ?—qu'ils soient de la province de Québec ou de l'île du Prince-Edouard ? Ce n'est pas *d'abord* comme Canadiens catholiques qu'ils comprennent et ressentent, c'est comme hommes, simplement. L'homme de partout, en gros, c'est le même être. Nous sommes persuadé que M. Desrosiers le sait aussi bien que nous.

Dans l'ordre des sentiments intimes, quand je suis heureux ou malheureux, je sens que je le suis pareillement à tous les autres hommes, quoique Canadien né dans le Québec, et que j'exprime les états de mon âme de façon peu différente de la commune manière, puisque je les retrouve, identiques pour le fond et la forme, dans les littératures exotiques; à certaines originalités d'expressions près et qui tiennent au génie de la langue employée. "Insensé qui croyait que je n'étais pas toi!"

Nous pensons que, naturellement, il existe une alliance harmonieuse entre "l'homme tout court" et "l'homme canadien-français," sans nier que ce dernier offre des traits moraux distinctifs, et même physiques plus ou moins sensibles—ce que les étrangers remarquent et ce qui nous échappe, ce qui fait qu'un Français de France ne ressemble pas tout à fait à un Français du Canada,[6] bref, ce qui ne se pèse pas à la balance publique et ne s'examine point à la lentille du microscope. Ces particularités ne suffisent pas cependant à faire de nous des exemplaires uniques d'humanité, d'une pâte spéciale, peut-être supérieure à l'ordinaire—tirage à part, nombre limité! On a quelquefois l'air de le croire: sentiment excusable, en somme, puisque chaque peuple a tendance à se hausser au premier rang des peuples. Détrompons-nous, ce n'est pas vrai! Pour en revenir à notre homme né dans le Québec, le dédoublement, s'il se produit, demeure un fait anormal.

---

[6] A titre documentaire, enregistrons ces paroles (qui nous déconcertent un peu) de M. l'abbé Martial Levé, telles que rapportées par le *Devoir* du 7 avril dernier. " . . . Vos ancêtres sont de chez nous, notre histoire est la vôtre. Si vous ne voulez commencer d'exister qu'en 1760, vous retranchez de vous-mêmes quelque chose d'essentiel. Vos historiens, tout en vous concédant des origines françaises, affirment que le type a changé, comme si nous étions des avortons. D'avoir vu cette foule à Notre-Dame, d'avoir visité vos collèges, de vous voir ce soir, me fait vous reconnaître et dire: ce sont des Français. Presque tout ici rappelle la France et, tenez, je crois que parfois vos historiens vous bourrent le crâne. Vous avez la même langue chaude, colorée, claire dont l'accent particulier et savoureux fait penser au parler populaire de France."—Encore une pierre, tout de même, dans le jardin ontarien!

Mais il y a une "âme canadienne" qui cherche à se dégager de liens factices, et qui sans doute y parviendra tout en restant "humaine."

Brunetière disait que l'on doit juger les écrivains de tous pays dans leur manière d'envisager les trois grands thèmes universels: l'amour, la mort et la nature. Il les faisait comparaître devant son tribunal improvisé et les interrogeait tour à tour. Il ne se souciait pas qu'ils fussent Anglais, Espagnols, Allemands ou Russes, catholiques, protestants ou mahométans; en leur qualité d'hommes, à titre d'êtres pensants, il leur demandait dans quelle mesure ils représentaient la collectivité humaine. Il les classait d'après le son rendu par chaque âme, le son propre et général en même temps. Il les évaluait en autant qu'ils étaient plus ou moins expressifs de l'entière humanité comme de leurs particularités ethniques. "C'est en mettant sous nos yeux l'anatomie de son être qu'il (l'écrivain) nous invite à la connaissance de l'homme." (Desmarais) Il ne séparait pas l'homme de la race, ni ne défendait inutilement à l'un d'avoir le pas sur l'autre.

Que signifie donc au juste cette "défense d'être humain avant d'être Canadien"? Retournée, la phrase n'a pas plus de sens. Il semble cependant que, parfois, selon les évènements et les circonstances et sans qu'aucun ultimatum n'intervienne, ce soit l'homme dans ce qu'il a de canadien, si l'on peut ainsi dire, qui se manifeste plus fortement dans l'être que nous sommes, et qu'il y ait des choses qui nous touchent de plus près cu plus profondément à cause de nos hérédités, du milieu où nous vivons, de notre position spéciale comme petit peuple abandonné, avec cette brisure dans notre passé qui nous oblige à défendre constamment ce que les autres n'ont qu'à goûter en paix. Mais cela ne tient-il pas encore en grande partie à la commune nature humaine ? et les Irlandais sentent-ils autrement ?

On doit glisser sur tout ceci d'une plume extrêmement prudente: M. Desrosiers n'a peut-être que trop appuyé, faute dont aussi bien nous avons pu nous rendre coupable dans l'exposé ci-dessus, le terrain est mouvant, les frontières sont mal connues. Se chargera qui voudra de distinguer "l'homme général" de "l'homme particulier," d'indiquer exactement le point de jonction et non moins précisément le point de séparation, ou l'état de parfaite fusion que nous croyons l'état normal. Il faudrait un Pascal pour résoudre pareil problème, et encore Pascal lui-même se contentait-il de découvrir sous l'auteur un *homme?* Faisons comme lui.

* * *

Je suis un catholique pratiquant, un Canadien convaincu. En dehors des sujets où la morale est concernée, (la théorie de l'art pour l'art ne serait, comme on l'a dit, qu'une énorme blague d'atelier) je ne suis qu'un homme qui tâche d'être un artiste. Je regarde avec amour la nature de mon pays, la seule que je connaisse, et je la peins en poète je ne sais jusqu'à point universel ou national. Je n'y songe pas; je cède aux penchants de mon cœur, aux inclinations de mon esprit: je suis une âme sous le ciel. Il est probable que des influences diverses agissent à mon insu; je n'en saurais dire, par conséquent, l'importance et le caractère réel. De crainte de m'enfermer dans une formule gênante et stérile—ce que Louis Madelin appelle "l'imbécilité des formules d'école"—je me suis tenu loin des clans, chapelles et cénacles, de tous ces cercles étroits où, dès qu'on y pénètre, il est sous-entendu que "nul n'a du talent que nous et nos amis."

En art, il ne se fait rien de bon que dans une complète indépendance intellectuelle. Les lois fondamentales qui régissent tous les arts et sous lesquelles se plient librement les facultés créatrices n'entravent pas cette indépendance nécessaire à l'artiste. Au contraire, elles la sauvegardent, la fécondent et la consacrent. Il n'en est pas ainsi des théories particulières, ou particularistes à l'excès, qui n'ont pas de chefs-d'œuvre à leur actif ni de siècle dans leur passé, qui sont de nature à brider la plupart des tempéraments, à les affaiblir au détriment des forces intellectuelles d'un pays.

La doctrine régionaliste bien comprise est certainement susceptible de produire des œuvres intéressantes et même supérieures; en fait, elle en a produit. Je n'en citerai qu'un exemple typique: "*Autour de la Maison*," par Michelle LeNormand, l'œuvre la plus spontanée, la plus simple et la plus vraie, qui n'est le pendant et la réplique d'aucune autre[7] et qui a déjà suscité d'ennuyeuses imitations. La théorie régionaliste repose d'ailleurs sur un fondement solide: le sens commun. Ma liberté s'en accommode. Mais une condition est indispensable à sa vitalité: que chacun n'apporte pas sa barrière, ses contraintes, ses défenses—son impératif catégorique personnel! Parlant des critiques d'école, Montesquieu, cité par Sainte-Beuve, disait finement: "Rien n'étouffe plus la doctrine que de mettre à toutes les choses une robe de docteur. . . . Vous ne pouvez plus être occupé à bien dire, quand vous êtes effrayé par la crainte de dire mal. . . . On vient nous mettre un béguin sur la tête, pour nous dire à chaque mot: "Prenez garde de tomber! Vous voulez parler comme vous, je veux que vous parliez comme moi." Va-t-on prendre l'essor, ils vous arrêtent par la manche. A-t-on de la force et de la vie, on vous l'ôte

---

[7]"Il est remarquable que les femmes, si habiles et si maîtresses qu'elles soient trouvent rarement leur forme elles-mêmes; elles en usent bien, mais elles l'ont empruntée à un autre." (Sainte-Beuve). C'est une raison de vanter les quelques femmes originales de chez-nous.

à coups d'épingle. Vous élevez-vous un peu, voilà des gens qui prennent leur pied et leur toise, lèvent la tête, et vous crient de descendre pour vous mesurer. Courez-vous dans votre carrière, ils voudront que vous regardiez toutes les pierres que les fourmis ont mises sur votre chemin." Moins de théoriciens et plus d'artistes.

Une doctrine est véritablement excitatrice d'énergie intellectuelle et génératrice de beauté littéraire quand elle permet au disciple de la dépasser, c'est-à-dire de s'appuyer sur elle pour l'élan initial, d'en élargir le champ et d'en reculer les bornes, sans en altérer le principe. C'est le cas de la doctrine régionaliste à larges horizons, qui n'est pas responsable des rapetissements qu'on lui fait subir.

On ne saurait davantage lui reprocher de ne pas conférer le talent à ses adeptes. Sous sa direction, chacun travaille à ses risques et périls. "Le nationalisme intellectuel, dit M. l'abbé Groulx, n'a pas produit que des chefs-d'œuvre." En effet, pas plus que le romantisme, le Parnasse, le naturalisme et le symbolisme. "Pourquoi, continue M. l'abbé Groulx, en dépit de la justice, tiendrait-on une doctrine excellente, et qui est le bon sens même, responsable des applications maladroites qu'on en fait?" Cela revient à dire que, pour chanter les héros de notre histoire, il est nécessaire de posséder le don rare de la poésie épique, et que si l'on en est dépourvu, aucune doctrine n'en sera déclarée coupable. A chacun son talent.

Serait-ce montrer un mauvais caractère que de faire grief à la critique en général d'avoir, de temps à autre, immodérément louangé des œuvres plutôt faibles, quand elle ne les a pas proposées comme modèles du genre? La doctrine s'en trouvait desservie: mieux aurait valu se taire.

* * *

Le régionalisme aurait pu, dans son intérêt, se passer également—il n'endosse pas tout ce qui s'écrit—de cette opinion née, comme la précédente, d'un sentiment louable.

"A valeur d'art égale, *voire même quelque peu inégale*, de deux œuvres, dont l'une aura jailli du terroir ou de la tradition, tandis que l'autre aura emprunté son inspiration à l'étranger, la première nous paraîtra toujours, du point de vue national, supérieure à la seconde." (M. Arthur Saint-Pierre. *La Revue Nationale*, janvier 1920.) Nous connaissons de fervents régionalistes sur qui cette phrase a produit l'effet d'un choc nerveux! L'intention en est pourtant excellente, je le répète; mais l'opposition du point de vue national au point de vue artistique l'est-elle aussi? Car on peut répondre: La littérature est un art qui vit de perfection, comme la peinture, la sculpture, etc. C'est la forme, unie au fond, qui lui confère sa pleine valeur. Une œuvre de perfection moindre au point de vue artistique, le seul à considérer ici, sera au-dessous, quels qu'en soient l'auteur et le sujet, d'une œuvre de perfection plus grande. M. de La Palice aurait trouvé çà! Soutenir le contraire, c'est renverser l'échelle des valeurs et rabaisser l'art en déformant le sens esthétique.

On peut, sans avoir une vision directe des choses, y suppléer en une certaine mesure par une imagination heureuse et une vaste érudition. (Nous ne nous occupons que de l'écrivain sédentaire, non du voyageur.) Il va de soi que le procédé n'est pas recommandable; mais si l'on juge que par exception, grâce à des dons extraordinaires d'évocation et de style, il a réussi, on doit l'avouer loyalement et mettre, en ce cas, sa préférence au rancart. Entre une page légèrement imparfaite et reconnue telle, et une autre moins imparfaite, que le fond soit étranger ou local, il faut préférer la seconde. Le point de vue artistique l'emporte ici: c'est une question de grammaire, de langue et de métier où le patriotisme n'a rien à voir. Appliquez ce raisonnement à la peinture ou à la statuaire, et vous en saisirez la faiblesse et le danger. Avec les plus célèbres critiques, M. l'abbé Camille Roy déclare que "la forme ajoute toujours au fond une valeur *décisive* et *incontestable*." A valeur égale, mais à valeur égale seulement, il est naturel de préférer le sujet canadien en art, quoique cette préférence justifiable ne puisse être érigée en dogme. Personne n'y songe parmi les gens sensés.[8]

S'il ne s'agit que d'incliner les auteurs canadiens à l'observation plus attentive des âmes et des paysages de chez nous, qui en valent la peine, nous sommes d'accord, et M. Saint-Pierre peut compter sur notre humble appui dans le bon combat qu'il mène; mais nous voulons que dans nos œuvres la forme égale le fond, ce qui n'est pas plus demander ici qu'on n'exige ailleurs, et ce qui n'est pas non plus, Dieu merci, au-dessus de nos forces ni de notre courage! "Si l'on peut concevoir chez nous un art sans régionalisme, nous n'avons que faire du régionalisme sans art," dit M. l'abbé Olivier Maurault, qui s'occupe avec tant de zèle intelligent de l'avancement des arts au Canada. "Tenons la langue nette, ne cesserons-nous de répéter, car la langue est le miroir de l'esprit national."

---

[8] "Il se peut que la solution du problème soit dans un heureux dosage de l'une et de l'autre disciplines, (l'exotisme et le régionalisme) nous ne sommes pas éloigné de la croire." (M. l'abbé Maurault. Le *Devoir*, 9 mars 1920.) N'oublions pas qu'il existe une littérature d'imagination qui puise ses sujets partout dans l'univers, au fond des cieux comme au fond des mers. Jules Verne et Wells l'ont assez bien illustrée, il nous semble. Quand nous serons plus savants, des œuvres de ce genre ne dépareront pas notre littérature.

"Voire à valeur légèrement inégale!" Promesse d'indulgence funeste aux jeunes talents, reconnaissance quasi-officielle du droit au moindre effort, encouragement indirect à la médiocrité, prix de consolation indigne d'être proposé aux écrivains nationaux! Je sais bien que ce n'est pas ce qu'on a voulu dire, puisque M. Saint-Pierre lui-même déplore que "l'écrivain reste presque toujours plus ou moins inférieur à sa tâche, et (que) la forme est insuffisante à mettre le fond en pleine valeur." (*La Revue Nationale*, février 1920.) N'empêche que beaucoup de régionalistes indolents ou peu doués fonderont des espérances là-dessus! Non! Il faut orienter les nobles rêves vers une plus lointaine étoile; il faut stimuler les légitimes ambitions, leur demander plus qu'en apparence elles ne peuvent donner pour en obtenir des résultats inattendus. Viser plus haut, toujours plus haut, afin de ne pas déchoir! Et si l'on se casse les ailes—ce qui n'arrive pas à tout coup—la chute est honorable: n'y-a-t-il pas une certaine gloire.

"D'avoir vu l'impossible et de l'avoir tenté" ?

Et ne pourrait-on pas s'appliquer le vers de La Fontaine:

"J'aurai du moins l'honneur de l'avoir entrepris" ?

Même en faveur d'une littérature régionaliste encore jeune, qui sollicite à bon droit aide et protection, et avec les meilleures intentions du monde, il est injuste de préférer l'inférieur, le fût-il à peine, sous prétexte d'encouragement; il est imprudent de le dire; il est humiliant, enfin, de l'entendre proclamer par une Revue nationale!

* * *

Autre aspect de la question du nationalisme littéraire.

Malgré tout le mal qu'on en a dit, je crois à la parole de Crémazie: une littérature véritablement nationale (comme la française, la russe, l'allemande, l'italienne) est impossible sans une langue nationale propre, c'est-à-dire canadienne. En d'autres termes: à quel point l'originalité dans l'expression littéraire est-elle diminuée pour le dernier-venu, quand deux états d'esprit différents s'expriment dans une langue commune et que deux caractères étrangers, ou distincts à certains égards, se fondent dans un même moule? Je crois que voilà le fond de la pensée du vieux poète. La littérature canadienne-française est à peu près vis-à-vis de la française ce que la littérature américaine est vis-à-vis de l'anglaise. Un livre d'Irving ou de Roosevelt, pour la masse des lecteurs, c'est de l'anglais. Bien qu'il y ait un caractère américain très net, rigoureusement parlant, la littérature américaine n'existe pas, mais elle est en voie de formation, parait-il. Si l'on en juge par certaines œuvres récentes qu'a signalées la critique française, (*Le Mercure de France* "Lettres américaines," etc.) les écrivains des États-Unis sont en train de rajeunir et de transformer à leur usage le vieil idiome anglo-saxon, ce qui, à brève échéance, pourrait bien modifier la situation présente de leurs Lettres. En attendant, leur littérature est anglo-américaine. Il manque à nos voisins quelque chose comme une bonne petite langue gaélique pour pouvoir figurer aujourd'hui, à titre indépendant, dans une Histoire générale des Littératures. (Cf. *L'Âme Américaine* par Edmond de Nevers, p. 270, t. 2.)

Avant la résurection par Mistral de la langue d'oc, les Provençaux avaient produit des livres français sur les mœurs et coutumes de leur coin de terre, des œuvres régionalistes par le fond où s'exprimait l'âme provençale. Ces productions tombaient toutes dans le vaste domaine de la littérature française et s'y dispersaient. Elles forment maintenant un groupe distinct, grâce à une langue distincte. Elles restent françaises, sans doute, mais avec un cachet spécial, et une voix nouvelle qui leur donne comme une autre nature.[9] Elles existent par elles-mêmes. Preuve que c'est la langue qui "nationalise" une littérature, qui "de ses chaînes la délivre," qui la "baptise," pour ainsi dire, et l'empêche de s'incorporer à la substance de la littérature-mère. Nous ne prétendons pas que la communauté de langue crée des conditions contraires à l'existence et même au progrès de notre littérature, mais nous croyons qu'elle constitue un grave inconvénient pour sa souveraineté, et qu'elle place nos lettres dans une situation d'infériorité vis-à-vis de la littérature française, en les maintenant sous son influence directe et sa domination, si bienfaisantes soient-elles. En somme, Crémazie a-t-il soutenu une autre thèse et dont la vérité soit plus évidente ?

On peut donner une teinte locale aux œuvres canadiennes qui les revête en quelque sorte d'un caractère particulier, semblable à celui de la littérature belge d'expression française ou de la suisse romande,[10] en traduisant nos convictions nationales et religieuses Il faut cependant prendre garde qu'en pays bilingues où l'une des langues écrites est la française—il y a même trois langues littéraires en Suisse, —les écrivains nationaux se signalent souvent à l'étranger de culture

---

[9] Quelques Anglais et Irlandais du XVIIIe siècle, Hamilton entre autres, tout comme un Allemand: Grimm, ont écrit en français. Sainte-Beuve, dans ses *Causeries du Lundi*, étudie leurs ouvrages au même titre que ceux des Français eux-mêmes.

[10] "Les œuvres italiennes écrites par des Suisses appartiennent à la littérature italienne, les écrits allemands dépendent de la littérature allemande. . . . Il parait plus aisé d'isoler la littérature suisse française de la littérature française proprement dite. Toutefois, la distinction est souvent délicate et arbitraire. C'est ainsi que J.-J. Rousseau, né à Genève, et Mme de Staël, fille d'un Genevois, occupent une place prépondérante dans la littérature française, et que les manuels français enregistrent les noms de Benjamin Constant, de Cherbuliez et de Rod." *Nouveau Larousse Illustré*, tome 7, page 851.

latine autant, sinon davantage, par leur défaut partiel ou total de qualités françaises d'ordre intellectuel—ordre, mesure, clarté—que par leur conception de la vie. Pour la composition et le style, sans parler du goût, ils ne peuvent se suffire à eux-mêmes; il leur faut chercher ailleurs que chez eux des exemples et des directions, en attendant qu'ils aient leurs Corneilles, leurs La Bruyères, leurs Pascals, etc. Rodenbach, délicat jusqu'à la névrose, n'est un Belge que par sa brume; toutes les Anthologies des poètes français le citent: littérairement, il n'est qu'un Français "moins pur." Emile Verhaeren, de tous le plus près de Victor Hugo, est un puissant lyrique; mais il est excessif, emporté, tumultueux: la discipline classique n'a pas modéré la fougue de son rythme ni réduit l'extrême opulence de son verbe. Il bouscule, il éblouit—ses couleurs sont un peu criardes—mais il choque et fatigue. Un fervent de Racine ou d'Alfred de Vigny ne le peut longtemps goûter Maurice Maeterlinck est un grand artiste subtil et mystérieux, que Jules Lemaître a dû parfois trouver bien embrouillé! Comme la plupart d'entre nous, il n'a pas lavé son cerveau dans la Loire!

Cela ne veut pas dire que nous soyons condamnés à n'avoir que des défauts, mais cela nous avertit qu'il faut tirer le meilleur parti de ce qui nous appartient en propre—qu'il est nécessaire de baigner sans cesse notre langue, pour l'épurer et la fortifier, dans le "clair ruisseau" français—et que nous ne devons pas nous décourager par la comparaison inévitable des maîtres de là-bas aux élèves d'ici. Cultivons notre jardin, sans négliger de jeter un coup d'œil par-dessus la clôture. La poésie est partout, a-t-on dit, il ne s'agit que de la faire sortir.

Décrire ce que nous avons sous les yeux nous est évidemment plus facile que de peindre d'après les autres ce qui nous est inconnu: nous avons ici du grand, du beau, du pittoresque à foison; il suffit de regarder. Mais prétendre, de ce fait, nationaliser nos œuvres de "fond en combles" et "d'un travers à l'autre," au point qu'elles formeraient une littérature autonome se gouvernant par ses seules lois, qu'elles ne seraient plus une branche de la littérature française, qu'elles en seraient "coupées" et comme étrangères,[11] c'est se forger une félicité

[11] Toutes les littératures empruntent les unes aux autres quant au fond. Mais pour qu'une littérature prenne une figure propre, il faut que les divers éléments qui entrent dans sa composition soient parfaitement fondus et forment un tout homogène. C'est à faire au "style." "O imitateurs, troupeau servile!" s'écrie Du Bellay. L'imitation recommandable s'assimile les modèles sans les copier, s'en inspire pour faire autrement. Nous aurons encore longtemps besoin de nous mettre à l'école des grands maîtres.—"Une inconscience présomptueuse pourrait seule nous faire croire que nous avons déjà produit tout ce qu'il faudrait pour assurer notre autonomie littéraire," dit M. Adjutor Rivard. *Le Canada Français*, juin 1920.

décevante, aussi longtemps qu'elles ne seront pas rédigées en une langue exclusivement propre au pays, fût-ce un patois. Un patois! vous récriez-vous: ne faites pas les dédaigneux; tels fidèles des parlers locaux, Jasmin notamment, lui on dû leur gloire. L'invention de cette langue n'est d'ailleurs pas désirable: ne parlons-nous pas la plus belle du monde? "Nous devons nous résigner à faire beaucoup de littérature française au Canada," disait M. l'abbé Camille Roy, dans ses *Essais sur la littérature canadienne.*[12] Sans être partisan du colonialisme littéraire, on peut admettre que nous en ferons toujours: la communauté de langue nous y contraint, et l'on ne se sent pas le goût d'en pleurer. Acceptons courageusement le sort que la Providence nous a fait, en tâchant d'insuffler à cette littérature française toute notre âme canadienne. Et ne nous plaignons pas trop si le visage de l'enfant reflète encore celui de l'aïeule. . . .

En résumé, notre littérature sera canadienne et française, humaine et québecoise, si on le préfère—canadienne par le sujet et l'idée, tant que l'on voudra, française par la forme, tant que l'on pourra: française et canadienne, sinon elle ne sera pas grand'chose, notre situation étant ce qu'elle est.[13] Encore faudra-t-il savoir choisir le sujet, tout ne se prêtant pas également au thème littéraire pour qui n'a pas le don de transmuer l'étain en or pur. Sa Majesté la Langue française, comme on l'a si bien appelée, ne couvre pas n'importe quoi des plis de son royal manteau.

Rien ne nous empêche d'engendrer des chefs-d'œuvre, en dépit des obstacles nombreux, des disputes et des railleries; ainsi que le disait je ne sais plus quel personnage facétieux: il suffit d'avoir du génie!

Montréal, 1920.

---

[12] "Notre langue et notre littérature ne peuvent vivre et se développer normalement que si elles restent francaises, même dans leurs emprunts, et tendent de plus en plus à l'être. Soyons, au point de vue littéraire, une province, mais une province intellectuelle de France!" M. Adjutor Rivard. *Le Canada Français,* juin 1920.

[13] L'écrivain canadien-français de talent peut rendre une note personnelle, quoique se servant de la langue de France. Le style de Lamartine, par exemple, ne ressemble pas à celui de Leconte de Lisle, ni celui de Jules Lemaître à celui de Louis Veuillot. Chacun de ces auteurs laisse sur la langue commune qu'il emploie sa marque individuelle, son nom propre. Cette originalité ne nous est pas défendue, et nous pouvons la conquérir par une haute et patiente culture qui, en développant nos facultés naturelles, accentuera nos traits distinctifs. Mais il nous sera toujours difficile d'égaler les maîtres, à cause des influences anglicisatrices et de notre matérialisme avancé.—Dans sa *Philosophie de l'art,* Taine écrit, parlant de la littérature belge (1868): "Elle est presque nulle. Elle n'a pas révélé de ces esprits créateurs qui ouvrent des vues originales et enveloppent leurs conceptions de belles formes capables d'un ascendant universel." Nous croyons qu'il faut attendre encore au moins un quart de siècle avant de pouvoir appliquer ce jugement avec justice à la littérature canadienne-française.

Transactions of The Royal Society of Canada
SECTION II

SERIES III MAY, 1920 VOL. XIV

PRESIDENTIAL ADDRESS

By W. LAWSON GRANT, M.A.

(Read May Meeting, 1920)

In 1893 Sir John Bourinot, so long of this Society *decus ac tutamen*, delivered the Presidential address, taking as his subject:—*Canada's Intellectual Strength and Weakness; a short historical and critical review of Literature, Art and Education in Canada.* I have of late occupied myself with the endeavour, however inadequately performed, to bring this address up to date; to see how far we have increased our strength or overcome our weakness; how far we may now deem ourselves to have an intellectual standing among nations. In a Kultur-map of the world, published by Germany in 1913, Canada shared with the greater part of Africa the distinction of being *black*, *i.e.*, of having no assignable culture. Was this justified ? One limitation I shall set myself: Sir John discussed, as was fitting for the President of the whole Society, our achievements, whether wrought by Canadians of French or English tradition; as President of this Section only I shall confine myself to the latter.

In some lines of work at least we have made great progress since 1893; in the arts of painting and architecture Sir John could say that "so public-spirited a city as Toronto, which numbers among its citizens a number of artists of undoubted merit, is conspicuous for its dearth of good pictures, even in private collections, and for the entire absence of any public gallery."

Toronto to-day not only possesses an Art Gallery, the nucleus of which is the fine old home of Goldwin Smith, but the gallery at this moment houses an exhibition of the work of a Toronto coterie of artists, Lawren Harris, J. E. H. Macdonald, F. H. Varley and others, whose work is in the truest sense the product of a school. Whether they depict the sterile and desolate beauty of Northern Ontario, and draw their chief inspiration from the genius of Tom Thompson, whether it is a scene from "the Ward," or the portrait of a Professor, their work is in every sense Canadian, and yet done with a technique which shows that they have not left unstudied the modern schools of England and of France. That is the only true originality, to gain the skill and the technique of the older tradition and yet to transform and transfuse it with the inspiration of Canadian skies and Canadian air. The work is for the most part that of young men, and has not yet attained its zenith; but it is a true and vigorous expression of Canadian life and Canadian art; racy of the soil, yet adhering to the great humanistic traditions of Europe.

I am not comparing them with their elder brothers, of whom Sir John spoke, many of whom are still in the full vigour of their inspiration; but I speak of them to show that the work wrought and being wrought by O'Brien and Horatio Walker and Dickson Patterson and a score of others has found worthy successors to whom, when the time comes, they may pass on the torch.

Toronto also possesses the Royal Ontario Museum, founded by the Provincial Government, and largely supported by private help. With its five divisions of Archæology, Biology, Geology, Mineralogy and Palæontology, it is superior to any such collection in the Empire outside of London, and in certain lines is worthy to rank as the younger brother of the British Museum or of the Metropolitan Museum in New York. The Dominion Gallery here in Ottawa, begun in Sir John's time, has now grown to its present noble proportions. The Canadian war pictures, done in part by Canadian artists, and eventually destined to be taken out of the cold storage in which they lie at present, are the embodiment of a very noble and grandiose conception, alike of the artists, of the Government and of private munificence. Here it is fitting that I pay a just tribute to our Canadian Lorenzo de Medici, banker, statesman and patron of art and letters, Sir Edmund Walker, without whose aid neither Art Gallery of Toronto, nor Art Gallery of Ottawa, nor Art Museum of Toronto, nor our collection of Canadian war paintings would be what they are.

In architecture too, wherein Sir John Bourinot was compelled to sing small, Canada has gone ahead. Fine as were the Parliament Buildings of Canada in his day, they are finer now. In Toronto a school of younger men, of whom Mr. Henry Sproatt is the chief, has adopted the Collegiate Gothic of the Tudors to our Canadian climate, and in Burwash Hall and Hart House has co-operated with the wise generosity of the Masseys to erect buildings superior to any of the modern English work in Oxford or Cambridge.

In general, Canada has awakened—or at least is awakening—to a real architectural sense. Our houses are commodious, seemly and dignified; so too are our banks and our hotels; even our railway-stations show a glimmer; and such cities as Toronto and Ottawa and Victoria show dawnings of an appreciation of the kindred art of town planning.

I pass to the field of literature. If literature includes, as Sir John Bourinot quotes Matthew Arnold as maintaining, every written expression of the human spirit, not excepting treatises on ballistics or b-stearodipal-miten, then the time would fail me to tell, as Sir John endeavoured to tell, of the myriad productions of our brethren in Sections 3, 4, 5. In literature more normally so-called undoubtedly the greatest progress has been in the study of history. The enterprise and daring of various publishers has united with the widening activities of our historians to produce a series of works in which the point of view, if not always free from provincialism, is at least wider than that of Dent or Kingsford, and the writers of an elder day. I class Kingsford among these, for though several volumes of his monumental work were yet to appear when Sir John Bourinot wrote, its outlines were already drawn, and its style and proportions determined. "The Makers of Canada," "Canada, and its Provinces," "The Chronicles of Canada" are series which do credit, after all allowances are made, alike to authors and to publishers. The publications of the Champlain Society put at our disposal a wealth of historical material, and in form and matter do honour alike to the artistic skill of the printer and the sound learning of the historian.

Since 1896 the University of Toronto has published its "Review of Historical Publications Relating to Canada," and in the present year of grace this has expanded into a quarterly, so that we now have a "Canadian Historical Review."

The West too is beginning to come to its own in the field of historical studies. Even in Sir John Bourinot's time we had the narratives of such early fur-traders as Alexander Mackenzie, the Henrys, father and son, and David Harmon, but much the best history of the West had been written by an American, the late H. H. Bancroft. Now we have a school of western historians growing up, of whom Lawrence Burpee, Dr. Bryce and His Honour Judge Howay are honoured Fellows of this Society.

This great development in the past twenty-five years of painting and of history is directly connected with our increase in material wealth. Painting, more than any other art, demands a wealthy patron, and from the growth of public and private wealth have sprung the artistic schools of which I have spoken.

History is in the main an academic subject, and with the growth of wealth, there has come a growth of universities; six provinces now have Provincial Universities, and private or corporate beneficence has given Quebec two great institutions in Laval and McGill. As our universities have grown, so too has the study of history in them, till we now have not only Professors of History but historical departments;

contact with the historical schools of Great Britain, promoted especially by the institution of the Rhodes Scholarships, has been a potent helper, and still more potent perhaps is the splendid work done by Dr. Doughty and his colleagues at the archives, more especially in London by Mr. H. P. Biggar. Ottawa is now the Mecca of the Canadian Historian; books, pamphlets, original MSS, and transcripts of European papers; here they are in rich profusion. Nor must I omit to mention Dr. Doughty's friend and colleague, Dr. Adam Shortt, who early set to us younger men the tradition of sound learning and of breadth of view, of dry-as-dust digging among our original sources combined with a constant touch with British and American scholarship.

Let us turn from Arts which demand the support either of a small body of wealthy patrons, or of enlightened universities and governments, to those whose roots must be set in a soil large and extended as well as deep and rich. Historians are people without imagination enough to be novelists, and novelists are people without imagination enough to be poets. The history which we have been composing in Canada is thorough, self-respecting work; but it demands a trained mind and some breadth of outlook rather than those higher creative faculties which distinguish a Thucydides, a Michelet or a Carlyle. In the higher reaches of creative imagination we are still to some extent deficient; indeed we cannot be said in all respects even to have redeemed our early promise.

The causes of this are various, but one of them at least is to our honour, and would have pleased old Thomas Carlyle. We have wrought rather than written, have been laborious rather than lyrical. In time of peace we have built bridges and dug ditches, and brought our crops to market; in time of war we have poured out our blood; and we have left to a later generation to tell worthily the epic of the railway builders, and to sing the undying deeds of those whose rich blood is wrought into the essential fibre of our nation. Literature always comes late. As Hegel said "The owl of Minerva does not take her flight till the shades of eve begin to fall." Sir Sidney Lee has pointed out that till near the end of the reign of Queen Elizabeth English Culture was almost wholly a reflexion of that of France and of Italy. England was not only breaking the might of Spain; she was also absorbing, assimilating, working into her national life all that was best of European art and life; till in Spenser and Shakespeare and the great Elizabethans—who were for the most part the great Jacobeans—the universal and the national were blended. So may it be with us!

In fiction I could name many names, and could give to each its just word of praise. That quick Canadian eye which made our intelligence work in France so admirable has not been idle in Canadian fiction. But it is on the whole true to say that since Sir John Bourinot's time few if any of our novelists have aimed high, have built on a grandiose plan; that we have no very great names, and that most of our work has been descriptive rather than interpretative. A paper presented to this section last year; "The Canadian Novel, its Future," by J. M. Gibbon, and since republished in "The Canadian Bookman" for July, 1919, ventures the prophecy that Canada is soon to have "her prophet, in time likely her group of prophets who shall interpret her many-sided but always vigorous life to her own people and to the nations who have accepted her as come of age." Another article in the same number of *The Canadian Bookman*, "The Canadian Novel, its Achievements," by Mr. E. J. Hathaway, shows that we can add a long list of names to those given by Sir John Bourinot. Gilbert Parker had in 1893 hardly swung above the horizon; Ralph Connor and Isabel Ecclestone Mackay had not described Scotch-Canadian life; for the west we were still dependent upon the great travellers and fur traders of the XVIII and early XIX centuries, or upon the historians; Norman Duncan, and Frederick William Wallace and W. Albert Hickman had not given us the thrill and terror of the Northern Atlantic and of the Labrador fisheries. Since then they have done so, though to compare them with Joseph Conrad is to see the difference between description and interpretation; and the time would fail me to tell of Stephen Leacock, and of Arthur Stringer and of Charles Roberts in his later role.

Yet when very sincere praise for good workmanship and real insight is given to them all the fact remains that there is as yet no school of Canadian fiction to compare with such a British school as that of Hugh Walpole and D. H. Lawrence and Compton Mackenzie, and the many others who trace their descent through Wells and Shaw to Samuel Butler. We have nothing to compare with the amazing wealth of the British novel since the later nineties. Our production is sporadic, unrelated, save perhaps in the case of the sea-stories of Duncan and Wallace and Hickman.

In poetry we are in still worse case. The Acadian School is dissolved. C. G. D. Roberts has published his collected works, and bidden farewell to Erato and Euterpe; Bliss Carman is fighting a gallant fight against disease, and has scant leisure for song; of the Ontario School Lampman died long years ago, and the fierce Highland heart of Wilfrid Campbell has found port after stormy seas. Of our newer poets John Macrae died leaving us one immortal lyric; from those still living we have from time to time verses which show that the fire still burns upon the altar; but two names only seem to me worthy of extended notice, Marjorie Pickthall, and our own secretary, Duncan Campbell Scott.

In her little book, "Drift of Pinions," and in "The Lamp of Poor Souls," (1916,) Miss Pickthall revealed a rare and sensitive talent. Few who have read them will not go back again and again to "Mary Shepherdess," or to "A Mother in Egypt" or to "Duna." Of late she has spread her strengthening wings for bolder flights, and has mastered blank verse; a short drama, "The Wood-Carver's Wife" in the *University Magazine* for April, 1920, represents a sustained and successful effort in blank verse, interwoven with short swallow flights of lyric. Alike in the blank verse and in the lyrics her word weaving is curiously and daintily felicitous. She has ceased to sing entirely in a minor key, and while she brings the eternal note of sadness in, she now grapples boldly with the deepest problems of human life and art, though always with the curious romantic restraint which she has caught from Rossetti, and which gives rather the effect to me of one looking at a tragedy through stained glass. When I speak of Rossetti I am far from any thought of imitation. Miss Pickthall draws her literary inspiration from many sources; from Rossetti and Swinburne, from the Irish singers such as Yeats and Moira O'Neill, and at times from *A Shropshire Lad;* but she has made their music her own, and her strain is reminiscent but not imitative. I would like to linger over her borrowing from Swinburnê, so much finer and more purified than the long loping lolloping line which is all the Australians have taken from him.

But the most considerable body of poetry produced in Canada in the Twentieth Century is that of the poet who honours us by being the Secretary of this Society, Duncan Campbell Scott. In the intervals of his long and honourable career in the Department of Indian affairs, Mr. Scott from time to time put forth his modest little volumes. His literary career has been singularly self-contained, and sets us a noble example in its freedom from any touch of affectation or self-advertisement. "The Magic House and Other Poems," appeared in 1893, the year of Sir John Bourinot's paper, and since then we have had "Labour, and the Angel," in 1898; "New World Lyrics and Ballads," in 1905; and "Lundy's Lane and other Poems," in 1916; besides a volume of short stories: "In the Village of Viger" (1896), and other smaller and uncollected booklets. Each volume seems to me to be an improvement upon the last, to show a steady development, to represent the gradual evolution of a temperament, not without a sensitive response to outside influences, yet essentially evolving rather than receiving.

Though not without response to many new impulses, though one of the first to essay *vers libre*, and to write it with restrained and rhythmic charm, Duncan Scott like Majorie Pickthall carries on what was best in the Victorian tradition, and has that sense of form and restraint, that instinctive feeling that poetry must have a pattern so often lacked by our bolder and more brawling Georgian poets.

Both Marjorie Pickthall and Duncan Scott owe something to Canadian life. Scott especially owes much. One side of his poetry is indeed essentially Canadian. The landscape, the air, the clouds and their colours which he loves to describe, are essentially the landscape and the cloudscape of Canada. Much of his verse could only have been written by one who loved the forest and the prairie and the Indians. Miss Pickthall is more bookish, less essentially Canadian, but she too in her latest work has laid the scene in the early French days, and has delicately and yet boldly tinted in the flowers and berries of the Canadian summer. But on their larger side, the side of ideas, both are universal. The vague hope of eternity with which Scott closes his lines "In Memory of Edmund Morris," or Marjorie Pickthall's strange mediæval fancy of the woodcarver who slays his wife's lover to bring into her face the dumb despair of the Virgin over her dear dead son who is also her dear dead Lord, owes nothing to Canada, but is drawn from hearts that have pondered over love and hatred and envy and despair and the human heart and man's strange destiny.

But I have been able to linger so long over these two just because no others seem to me to have produced any bulk of work of equal merit. How different from the England which all through the war published its yearly volumes of Georgian verse; so that now the poets have almost ousted the novelists, and England is like a nest of singing birds, of some of whom I hope Professor Edgar will tell us to-morrow.

One reason for the comparative lack among us of what is to me the highest form of creative art is found in the word "school" which I have used so often. "Poetry", says Wordsworth, is "emotion recollected in tranquillity." To put it in another way, Poetry is at once intensive and solitary. Most great literary movements have sprung from some coterie, or cénacle, or group. Not to speak of Athens or of Rome, it was so in the many literary movements of XIX Century France, whether Parnassians or Symbolists or neo-Catholics; it is so in England to-day. "As iron sharpeneth iron; so a man sharpeneth the face of his friend." In the contact of mind with mind the emotion is engendered, and then in the after tranquility the poem is shaped. In Canada we have neither the groups nor the tranquillity. Duncan

Scott would have been a greater poet had Lampman lived, and had certain others not moved away from Ottawa. Such coteries breed not only creation but criticism. Bourinot sighed for a good monthly, and lamented that we had but one literary weekly, *The Week;* now we have not even one. But we have at least three Quarterlies of merit: *Queen's Quarterly*, the oldest and in some ways still the best, which has appeared regularly since July, 1893, and whose uniformly high standard does honour to the Scotch tenacity of my own *Alma Mater; The University Magazine*, whose editor has laid under a heavy debt all students alike of politics and of poetry, and to whose wise discrimination we owe the first florescence of McCrae and of Marjorie Pickthall; and now *The Canadian Bookman*, from which we all hope that there may develop the much-needed school of Canadian literary criticism. Our other magazines or weeklies, such as *The Canadian Magazine*, *Maclean's*, or *Saturday Night* are vigorous and racy, but have for the most part but one eye upon the literary merit of their articles. Few gifts of greater value could be given to our Canadian life by a public spirited millionaire than that of a literary and political weekly, on the lines of *The Spectator*, *The New Statesman* or *The New Republic.*

Literary criticism has long been our weakest line. Though *The University Magazine* has made an impression, and though the book-reviewing in our dailies is improving, we still tend with an uneasy arrogance which veils a real humility to hail each new imitator as "The Canadian Keats," or "The Canadian Kipling," or we indulge in a pitch of extravagant laudation in which all standards disappear.

Alexander McLachlan's verse, for example, is not unworthy of praise. He owed little to Canada, and had a typical Scotch mixture of religious mysticism and fierce political radicalism Such stanzas as "Mystery," or "A Lang-Heidit Laddie" are true poetry. They owe nothing of their inspiration to Canada, but much to Burns and somewhat to Wordsworth. But in spite of their debt, there is in them a simplicity and a freshness which raise them far above the realm of mere imitation. But what can we do but lift our hands in despair when the Rev. E. H. Dewart, D.D., editor of McLachlan's completed work (Toronto, 1900), tells us that "In racy humour, in natural pathos, and in graphic portraiture of character, he will compare favourably with the great peasant bard. In moral grandeur and beauty he strikes higher notes than ever echoed from the harp of Burns." Or again, "In quiet contemplation and moralising he reminds us of Cowper and Wordsworth, both of whom he surpasses. His ardent love and worship of nature is akin to that of Wordsworth, but he clothes natural scenery and phenomena (especially the starry heavens, the sun and the seasons) with a spirituality, a pervading intelligence, a guiding glory and a fire hardly equalled in English literature."

Or, again, Isabella Valancey Crawford was a true poetess. She died young, worn out in the pursuit of literature, receiving too late the meed of praise which was her due. But what are we to think when Mr. J. W. Garvin, her editor, says:—"The more we study these children of her brain, the more we marvel at what she accomplished. What other poem in the language more powerfully and nobly expresses the divine right of man to freedom from slavery than 'The Helot?' What other dialect poem surpasses in conception, in humour and in heart-searching philosophy 'Old Spookes Pass?' What other epic of its kind excels 'Malcolm's Katie' in picturesque description, in brave-hearted purpose, and in tender constant passion?"

Let us hope that future editors will leave this style of criticism to the American slip-covers of American best-sellers. The literary criticism in *Canada and its Provinces* is sane, and both *Queen's Quarterly* and *The University Magazine* have done much to keep us in the paths of discretion, but the one really first-class bit of Canadian literary criticism by a Canadian is a little book entitled "Roberts and the Influences of His Time," by James Cappon, which originally appeared in the form of articles in the *Canadian Magazine.* Cappon, still one of our members, is a Scot by birth, a favourite pupil of Edward Caird; but he came many years ago to Canada, and threw in his lot whole-heartedly with us. "Roberts and the Influences of His Time," is slighter than a study by Sainte-Beuve or by Matthew Arnold, but like their work it is not only a sane and sympathetic criticism of the poet, but a real interpretation of the literary influences which have helped to fashion him.

I feel acutely that this paper has been too much a mere catalogue of names diversified with occasional impertinences. I would greatly have loved to go more deeply into the causes of our strength and of our weakness; to estimate the eventual effect of the war upon Canadian life; to discuss whether Prohibition and Poetry are compatible, and whether literature can conceivably flourish in the land of the Lord's Day Alliance; but these high themes must wait till another day, and I must go on to try to make at least one practical suggestion to this section for the furtherance of our work.

I have already spoken of our great need in Canada of a really good weekly. A further suggestion may be ventured, drawn from the experience of France. Our authors leave us to go to strange lands not alone for the sake of money, but for the same reason which led the sophists to Athens, which leads the provincial to London or to Paris,—the need of a richer and a fuller life. But financial rewards and encouragements are not wholly to be despised. Long ago the muse of Manhattan Island sang to Charles Roberts:

> "You've piped at home, where none could pay,
> Till now, I trust your wits are riper,
> Make no delay, but come this way,
> And pipe for them that pay the piper."

Recently the Academie Française celebrated the centenary of the Prix Monthyon. Some of us remember how Canada thrilled when Frechette received a similar prize from the Academy. Why should not one or other of our millionaires found one or more such prizes to be given by this society, at the recommendation of this section, to our rising novelists or poets or essayists or historians? The objections are obvious. There would be, as there are in Paris, accusations, not wholly foundationless, of jobbery and log-rolling. What matters it? Every way the kingdom of letters would be forwarded.

To our council we should commend further supplication to the Government for a National Library. They should storm and batter at the gates till that disgraceful lack is removed.

Another suggestion which must sooner or later come up for discussion is that of the enlargement, if not of the splitting of this section. While we must beware of exaggerating differences, while we must remember that even the starkest humanist has in him a touch of the scientist, and that in a sense even the binomial theorem is humane, we must recognise that the work of this section does in a very real sense divide itself into Belles-lettres and History on the one side; and Philosophy and Sociology and Economics and Folk-lore on the other. That they touch hands I admit, but so do the various sciences of sections 3, 4, and 5. The time is not yet ripe for division, but for an enlargement of numbers we are fully ready.

The Declining Fame of Thomas Carlyle

By H. L. STEWART, M.A., Ph.D., F.R.S.C.

(Read May Meeting, 1920)

Within the last few years it has been widely contended, and it has been perhaps still more widely taken for granted, that Thomas Carlyle is a spent force in English literature. It is conceded, indeed, that his books must always live in the imagination of some for the sake of their amazing originality of style, their depth of humour, their gift of graphic description, for what Lord Morley has called "the words and images, infinitely picturesque and satiric, marvellous collocations and antitheses." That he was among the very greatest masters of expression who during the nineteenth century made the English language their vehicle is still as generally acknowledged as it was even at the climax of his literary dictatorship. To not a few that extraordinary style was, and remains, in some degree offensive, so that Matthew Arnold's advice, "Flee Carlylese as you would flee the devil," often awakens a note of sympathy. It seems so rugged, so barbaric, so lacking in the grace, the elegance, the smoothness which constitute such a charm in artistic speech. But there has never been any question of its power, or even of its fascination for those who, while they are again and again repelled, have to come back again and again to wonder. *The French Revolution* stands to-day by common consent, as it has stood ever since it was published, almost alone among writings of its kind for vividness, for arresting and often bewildering imaginative strength, a prose poem—if ever there was one—whose music is all the richer for its cunning dissonances, and in whose colours we have revealed as seldom before the literary potencies of light and shade.

But, when one passes from form to substance, it does appear to be true that the fame of Carlyle as a thinker has notably declined. We are being assured that the reverence felt for him a generation ago was a huge mistake, that he is among those whom the less competent judgment of the past immensely over-rated, and whom the men of to-day, with their minds clarified by a deeper experience, have definitely deposed from the pedestal. It will be the contention of the present paper that those who speak thus have precisely inverted the truth, that of the charges levelled against Carlyle by far the greatest weight belongs to such as are quite ancient, that the newly coined reproaches are either gross exaggeration or sheer misunderstanding, and that in appraising the positive merits much finer discernment was shown by the older judges than by the later.

I

There are three distinct phases in Carlyle's work. He was an historian, he was a literary critic, and he was a social pamphleteer. His shortcomings, such as they are, in the first of these departments were long ago pointed out. The historians who speak of history as a "science" have never been able to forgive him for his rhetoric, for the lurid contrasts to which he so often sacrificed exactness, for the disregard with which he always treated the economic factor, the mass-movement, the significance of an age in determining the character of leaders rather than that of leaders in determining their age. For at least forty years it has been emphasized and re-emphasized that Carlyle was quite blind to those sociological laws without which the past can never be explained. Of equally long standing is the criticism that he wrote history with certain preconceived theses which he meant to vindicate—such as the paramount importance of the "Hero," or the inevitable collapse of democracy, and that he vindicated these by the simple expedient of arranging his data for the purpose, reducing here and magnifying there, so that the perspective should be adapted to the dogma he had in mind. As far back as 1894 Mr. Frederic Harrison found the most notable example of this in the picture of the French Revolution not as an enduring movement whose significance fifty years had been unable to exhaust, but as a single violent explosion brought to a sudden close by Napoleon's whiff of grapeshot. "Not a judicial page," wrote Lord Morley in 1877, "or sense of any wisdom in the judicial is to be found in his greatest pieces of history."

The same kind of complaint was long ago urged with still more force against Carlyle's pamphlets. R. H. Hutton objected that he was constantly demanding our submission to a Hero, but gave us no hint how the Hero was to be identified. Leslie Stephen could find no fertile suggestion of a remedy, or a way out, or anything socially practicable in the diatribes against parliamentary government. The *Occasional Discourse on the Nigger Question* ended for ever Carlyle's friendship with John Stuart Mill, for it seemed nothing more than an abusive tirade against the most fundamental principles of the rights of man, and when it was followed up by support of the South in the American Civil War the temper of abolitionists in general was strained more than it could bear. Believers in democracy have quoted to us over and over again the predictions in the paper called *Shooting Niagara* that a lowered franchise would conduct England into what Carlyle called "the Bottomless," and that fifty years at most would complete the doom.

Scientific men, too, have always remembered with astonishment how completely Carlyle detached himself from the movements of contemporary science, and how little he appreciated the value of some of its most fertile inquiries. In 1830 he entered in his *Journal* the judgment about economics that it needed far less intellect than successful bellows-mending, that on the whole it did less good, that though a young science it was obviously decrepit, and that for his own part he wished it a soft and speedy death. His language about Bentham shows nowhere the least realisation of what the Utilitarians had done to establish a sound basis for the criminal code, or of the immense improvement which had been already effected in that province through their efforts, while for criminology as such no epithet of scorn was too bitter for him to use. The very idea of a social science he always spoke of with horror. Within a few years of his death Miss Julia Wedgwood called attention to the fact that the immense import of Darwinism had never even begun to impress itself upon his mind, that for him the evolutionary hypothesis was simply as though it had never been.

As a literary critic, too, in his judgments he used to perplex and even amaze his contemporaries. They could not understand how he could see no genius in Wordsworth, how he thought the *Pickwick Papers* "lowest trash," how he pitied an age that would read Balzac and George Sand, how he dismissed Macaulay's *History* as quite worthless and Mill's *Autobiography* as a "mournful psychic curiosity" but otherwise of no value whatever, how he spoke of John Keble as a little ape, of Newman as having no more brains than a moderate-sized rabbit, of Gladstone as on the whole the "contemptiblest man" known to him. If it be the function of a man of letters to guide his time in fixing the rank of its living teachers, then a strong case against Carlyle can easily be built up. But it was built up long ago, and it was not left for our magazines of to-day to make it either clearer or stronger.

Some at least of the older lines of attack may be distinctly seen as converging in a paragraph of Herbert Spencer's *Autobiography*. Spencer arraigns Carlyle for showing a spirit that was the very antithesis of the philosophic, never setting out from premises and reasoning his way to conclusions, but relying on nothing better than intuitive dogma, never thinking calmly but always in a passion. He points out how feeble must have been the insight into history of one who argued that the rule of the strong hand, because it was beneficial in an undeveloped social order, must be good for all time, as if human nature were incapable of growth and change. He urges that sneering at political economy as such must rest on the ludicrous denial of any scientific uniformities whatever by which the organized desires of men are governed. He dwells upon the incurable blindness of mistaking utilitarianism for mere selfishness, and of ignoring the fact that it takes into account both the pursuit of others' welfare and the exercise of the highest sentiments. He asks with what reason a man could keep on insisting upon the "Laws of this Universe" and our obligation to respect them, yet direct his ceaseless scorn upon those patient thinkers who devoted their lives to finding out what these laws are. And Spencer sums up his estimate by saying of Carlyle that "he had a daily secretion of curses, which he had to vent upon somebody or something."

Criticisms of the sort I have indicated were very general among those who wrote of Carlyle a generation ago, and they are now being reproduced in great abundance. I am not here concerned to argue against them, for although I feel that some of them are much overdone, they seem to contain a very important element of truth. But the earlier critics, unlike most of those who are now seeking to correct our estimate, were at the same time enthusiastic in dwelling upon the great undying glories of Carlyle's work, in comparison with which these were no more than spots upon the sun. They used to remind us how he was the first to make the work of Goethe really appreciated by Englishmen, and to inspire a genuine interest in the whole Romantic movement of German literature. They remembered with gratitude how he was a pioneer in making continental thought known to his countrymen a century ago, in making their taste less insular, more receptive to the currents of speculation abroad, more hospitably sensitive to the mental habits and attitudes among those who spoke a language different from their own. They noted how to him, more than to anyone else, it was due that such names as Richter, and Tieck, and Novalis, passed from being mere names to Englishmen, and became an introduction to very fertile fields of European thought. They did not think it to his discredit that such efforts were directed in the main, though by no means exclusively, to the exposition of German writers, for the Germany of which he then spoke was the Romantic Germany of a hundred years ago, not the militaristic nation of our own time, and we may perhaps add now that we have learned in a trying school how the temperament of foreign countries at any period cannot with advantage be left unexplored. The older critics, too, could not forget how Carlyle was the first, and perhaps long remained the greatest exponent of the genius of Burns. Some of them at least realised that, although he was no technical philosopher, we owe it to him that the significance of the Kantian school was first pressed upon the notice of British thinkers, that innumerable weaknesses in the dominant English Empiricism of his day were pointed out with a force which later critics had gone far indeed to confirm, and that the strength of the coming neo-Kantian philosophy in England was anticipated by at least fifty years. They saw in his paper on Mohammed, and in many incidental paragraphs elsewhere, some very early and very pregnant suggestions for the new science of Comparative Religion. One of them very truly declared that Carlyle's *French Revolution* had done more to bring that great cataclysm before the English public than all other English writings upon that subject taken together, and that he was absolutely the first to do historic justice to Oliver Cromwell and Puritanism. They spoke with reverence of his achievement in raising the level of literary reviewing to a point from which it had never since quite fallen, fixing thought upon the deepest and most fundamental issues in which literature relates itself to life. Even in what they took to be his most vulnerable, because his least temperate, aspect they found in his social pamphleteering a force which drew attention to the defects in many a current belief and practice and institution. His gospel of work marks, according to R. H. Hutton, the opening of an epoch in which idle aristocracy ceased to be bearable. And his paper on Chartism was probably the wisest word on that subject which the England of 1838 was given a chance to hear and to disregard. Men like Kingsley and Dickens and Ruskin and the whole circle of writers who took their part in destroying the old political economy now blessedly extinct drew their inspiration from no other than Carlyle. And those who understood the dark mid-Victorian epoch, in which *laissez-faire* was the watchword of a heartless commercialism, had no spokesman like the author of *Past and Present.* "He was not merely the foremost literary figure of his time," said Lord Morley; "he was one of the greatest moral forces of all time."

II

So much for the judicial balance of those who taught our fathers what to think of Carlyle. Let us now look at some current estimates by which feeling towards him in the present is being changed. I select two. One is by Mr. W. L. Courtney, the editor of the *Fortnightly Review;* the other is by Professor S. P. Sherman, of the University of Wisconsin. Of these Mr. Courtney has the advantage of very much more light, while Professor Sherman has the stimulus of abounding heat.

Mr. Courtney declares it to be an acknowledged fact that the younger generation does not now open Carlyle's books. He thinks that this neglect is quite natural, that it is typical of the spirit of the present as contrasted with the spirit of the past, and that a prophet who has been so disastrously mistaken in all his vehement forecasts must now be treated as an extinct volcano. We are reminded that *Sartor Resartus* used to be a favourite book with undergraduates, and that freshmen thirty years ago loved to talk about the Immensities and the Eternities. It seems that the taste of undergraduates and freshmen has changed, and Mr. Courtney regards it as having changed for the better. He points out that *Sartor* and *Frederick* have been convicted of misleading the world on the relative value of Germany and France both in the field of thought and in the field of action. He recalls how Carlyle hated the things we now know to be most vital, how he scorned democracy, and parliament, and statistics, and political economy, and philanthropy towards criminals, and universal suffrage. He calls him a militarist, an enthusiast for the strong man armed, a worshipper of autocracy with its implied suppression of individual freedom. And he notes as early as the publishing of *Sartor* itself the "complete Germanisation of Carlyle's mind."

Professor Sherman in the New York *Nation* of 14th September, 1918, took as his subject "Carlyle and Kaiser-Worship." The great work on the French Revolution, says Mr. Sherman, "may be said to teach three lessons; First, that Louis XVI did not know his business, and therefore deserved to die; Second, that the French Parliamentary Assembly was necessarily, like all such assemblies, a pack of quarrelsome and ineffective doctrinaires, anarchists, and professors of palaver; Third, that Napoleon Bonaparte knew his business, and therefore deserved to rule." "For Carlyle" exclaims this epigrammatist, "the reappearance of God in the affairs of France was manifested by the whiff of grapeshot with which the Corsican lieutenant dispersed the enemies of the Convention. The great truth which Carlyle saw dancing in the hellfire of the French Revolution was that God is a first-rate military man."

Passing to *Heroes and Hero-Worship*, Professor Sherman finds that Odin, Mohammed, Cromwell, Bonaparte, are all glorified on no other ground than that of their success. He points out that when Napoleon is defeated Carlyle deserts him as no longer God's lieutenant. This critic is particularly struck by Carlyle's account of Charlemagne's conversion of the Saxons. He thinks it an unmistakeable endorsement of what the German war-lords have called *Shrecklichkeit*. For Carlyle admitted that preaching was not the instrument used, declared that if an enterprise of any sort is supported by beak and claws it will in the long run conquer nothing which does not deserve to be conquered, even wrote such words as these: "What is better than itself it cannot put away, but only what is worse. In this great duel Nature herself is umpire, and can do no wrong." What is this, Professor Sherman asks, but the now too familiar doctrine of Bernhardi that the survivor in all contests is biologically justified?

The same sort of moral is next drawn from *Cromwell's Letters*. We are told that Carlyle's special admiration for the Lord Protector arose from the fact that here seemed to be a superman, one who unhesitatingly slashed through the red tape of parliamentary procedure with a sword. We are reminded how the Long Parliament was sent about its business because it "rebelled against the *rôle* of an obedient jack-in-the-box," how Cromwell actually told the members that they had been there long enough! Professor Sherman suggests that this was a foretaste of the iron hand which shut up so lately the "ungaggable" members of the Reichstag in a guardhouse. Whether the critic thinks that it would have been democratic to allow the Long Parliament having sat twelve years without an election to sit twelve more at its own choice, or what democratic instrument he would himself in Cromwell's place have devised to dissolve it, I shall not presume to guess. Carlyle was in short, he tells us, just a realistic politician of the type we have now so painfully learned to know.

Now, about Professor Sherman's rapid summarising of the "lessons" in *The French Revolution* it is difficult to know just what to say, for—as has been well remarked—no other objection is quite so hard to meet as an objection that is *totally* irrelevant. Carlyle does reproach Louis XVI with not knowing his business; he does deride the extravagances of the French Assembly; and he does approve the whiff of grape-shot with which Napoleon tamed the Paris mob. Nor can I think of any recent writer, except apparently Professor Sherman, who would question the justice of these estimates. Louis XVI did not know his business, but Carlyle does not mean by such "business" either the waging of war or the suppression of democratic reform. He means the guidance of men, the organising of a nation's welfare, the directing of equal justice, the curbing of class selfishness, the securing for twenty or twenty-five millions of people those human rights which an entrenched oligarchy was determined to deny them. This was a great task indeed, and poor Louis was as unfit for it as the late Tsar for a task very much the same a few years ago. What Professor Sherman means by saying that in Carlyle's view Louis deserved to die for his incompetence I have not the remotest idea, nor are we given any reference in the text by which such an absurd charge could be supported. The author of *The French Revolution* was not so destitute of the historical sense as some of those who pretended to read the moral of Russia in 1917, nor was he hysterically unjust to the last of the Capets as so many have been to the last of the Romanoffs. On the contrary, Carlyle has expressly said in the chapter on the execution that here was another case of the children suffering for their fathers' sins, that the outrageous line of French monarchs transmitted to one of the least guilty a long inherited curse:

> It is ever so; and thou shouldst know it, O haughty tyrannous man; injustice breeds injustice; curses and falsehoods do verily return "always home," wide as they may wander. Innocent Louis bears the sins of many generations; he too experiences that man's tribunal is not in this Earth; that if he had no Higher one it were not well with him.

Equally misleading is Professor Sherman's account of the doctrine taught in *Heroes*. It is difficult to understand how anyone who had read the lecture on Mohammed could represent Carlyle as applying to Islam no other test than that of winning battles, or could regard the paragraph on Charlemagne's mission to the Saxons as an approval of *Shrecklichkeit.* Even a hurried glance at the text will show that the point made is utterly different. Carlyle is exposing the old delusion that Mohammed's success is completely explained by his use of the sword for propagandism. He very pertinently remarks that the prophet began in a minority of one, that he had first to *get* his sword, and that he got this by convincing the Arabs of his noble vocation. In fact the whole argument of this striking lecture is that Islam made its way because, morally gross in many details as Carlyle admits it to be, the new faith was an immense improvement on that which it displaced. The Christian religion, he reminds us, has the far finer boast of diffusing itself by preaching; yet even the record of Christianity is not unsullied, for Charlemagne and others had recourse to the carnal weapon. Hence one should not indulge in wholesale condemnation of any faith upon this ground alone. And in general one may be sure that if a creed has no intrinsic value even the sword will not in the end avail for it. "Nature is umpire," and only the true can last. How remote this is from Professor Sherman's version! I have spent so much time upon this critic, because he is so similar in vituperative rashness to others that are seeking to accelerate the decline of Carlyle's fame.

Mr. Courtney is a much more formidable antagonist, just because he is so much more restrained, and because he has lighted upon some unquestionable blemishes, the same to which attention had been drawn fifty years earlier by Mill and by Mr. Frederic Harrison and by many others. One must add, however, that his new point, the so-called "complete Germanisation of Carlyle's mind" as shown not in *Frederick* but in *Sartor*, and the charge that Carlyle misled the world as far back as 1829 about the relative merits of German and French thought, are capable of neither defence nor apology on any sound principle of literary criticism. In *The French Revolution* no doubt much unfairness was shown to the philosophic pamphleteers of Encyclopædism But nothing else than the angry mood now prevalent, and rightly prevalent, towards the Germany of the present can explain the attempt to argue that it was wrong to place the school of Goethe higher than the school of Voltaire, to value the philosophy of Kant higher than the philosophy of the *Encyclopédie*, to pour scorn upon the wretched empiricists like Cabanis and exalt in their place the thinkers of the type of Hegel. To speak of *Sartor* as evidence of a Germanised mind in any sense which makes this a reproach is to forget how much pregnant thinking by those English philosophers who came to their own sixty years later was foreshadowed in that most remarkable work. It is the same sort of appeal to transient prejudice which would exclude German opera, discredit German physiological and chemical research, even discourage the learning of the German language. In this point, though in this alone, Mr. Courtney's method of attack is not much better than Professor Sherman's.

Both these critics are plainly under the influence of what we have come to call "war psychosis." Singularly enough, the same mood has spread itself over a few who cannot plead war psychosis at all. We have too much reason to know, for example, that Mr. Bertrand Russell preserves a philosophic calm amid the national tempests of the hour. He at least can claim the credit given in Tennyson's *Princess* to those who "leap the rotten walls of prejudice, disyoke their necks from custom." But he seems to have been caught by that popular stream against Carlyle which he has avoided with such success when it was directed elsewhere. In a paragraph of his *Principles of Social Reconstruction* Mr. Russell brings once more the old charges of temperamental inhumanity, of repugnance towards almost the whole human race, of adoration for tyrants, and a glorifying of war. It makes no difference to him, apparently, that those who knew the Chelsea prophet best in life formed a quite different estimate of these personal feelings, or that Charles Kingsley and Charles Dickens should be thought of as the last men by whom inhuman callousness would have been condoned.

III

It is Carlyle's polemic against democracy, and his alleged justification of Might, which have united forces of such varying origin in the present crusade against him. Did he then really pin his faith for the future to a revival of the political reactionaries? Did he defend those tyrannies of the strong man armed by which the world has been so nearly undone? Let us grant at once that his accounts of both Cromwell and Frederick are open to reproach. Let us grant that his attacks upon democracy were often unfair. Let us grant that he magnified enormously the advantages and turned a blind eye to the risks of trusting an autocratic expert. Does this mean that he was "Prussianised"? I contend that to say this does grave injustice to Carlyle, and pays an utterly undeserved compliment to Prussianism.

We need in this debate to keep our heads. The prevailing resentment arises in a great degree from the ambiguities of a word. If by "democracy" we mean just a plan of government, it is a matter of opinion how far the plan is good or bad, and not a few of those against whom no charge of inhumanity would be entertained have judged democratic government exceedingly evil. What rouses temper is quite another sense of the word, and here at least Carlyle is open to no reproach, but must rather be counted among our foremost democrats. Few have denied with equal vigour all sacrosanctity in caste, or have insisted with equal force upon every man's worth as determined by personal ability or personal character, and as determined not at all by birth, by descent, by tradition, by the prestige of a name or the homage paid to unearned wealth. No writer has crystallised into more telling phrase our human protest against the usurpations of mere rank.

Carlyle did not believe that by universal suffrage, or even by popular institutions the ideal of justice was to be reached. No doubt we now think this judgment largely mistaken, but it was at least arguable, it had a profound vein of truth, and the error—such as it was— was an error about means, not about the end. Herein it differs *toto coelo* from the creed we call Prussianism. As Carlyle himself put it in defending his attitude against the strictures of Lecky, he did not hold that Might is Right, but rather that Right is Might. In his best moments of insight he even contradicted his own errors. Recall, for instance, the passage about the deathbed of Louis XV as that not so much of a French king as of the decaying French kingship. Recall the paragraph about the birth of democracy in America, "announcing under her Star Banner, to the tune of Yankee-doodle-do, that she is born, and whirlwind-like will envelope the whole world," about the new constitution standing there "inexpugnable, immeasureable," about "the stern Avatar of Democracy hymning its world-thrilling birth song in the distant West, whence it must go forth conquering and to conquer, till dead Feudal Europe should be born again as a land of industrialism." And, though we shall doubtless conclude that his notion of a benevolent despot is now less plausible than ever it was before, let us bear in mind how he defined such a Hero, how kingship was, in his estimate, for public service, not for personal privilege, lest as we note his honest mistake we dishonour our great man of letters by confusing him with those to whom his resemblance is merely on the surface. The real key to his whole position seems to lie in that problem which he so sagaciously stated both for his time and for ours, that of combining zeal for the public good with the advantages of expert guidance and control, or—as he put the query; What steps shall be taken by a people which believes in the French Revolution and also believes in Frederick the Great?

That Carlyle was democratic in the sense of an enthusiast for the just rights of the common people may be seen in two famous protests against class arrogance. His first social task was to preach the gospel of work, the obligation and dignity of strenuous, productive labour. As he preached it this was almost a new truth to Englishmen in the first quarter of the nineteenth century. The ideal of a luxurious and leisured life for the upper social orders had scarcely begun to be challenged. Look at writers such as De Quincey and Coleridge and even Sydney Smith. They exhausted themselves in extolling the social value of that part of the community which we should call idle. The idea is put forward that these persons are to be admired not for what they *do*—for in truth they often do nothing at all—but for what they *are*. Those whom Sydney Smith in his quaint phrase called "the lower and middling classes" are bidden to give thanks daily for that pattern of cultured refinement which those above them are fitted both by nature and by circumstance to display. Carlyle was among the first, as he was by far the most effective, to insinuate against this ideal some wholesome doubts. He tried, indeed, not to exaggerate the grievance presented by the idler, and to acknowledge the notable exceptions which must be made. "Among our aristocracy," he wrote in 1832, "there are men, we trust there are many men, who feel that they also are workmen, born to toil ever in their great Taskmaster's eye, faithfully with heart and head for those that with heart and head do under the same great Taskmaster toil for them." But in that mordant chapter of *Past and Present* which he entitled "Unworking Aristocracy" he branded those who had no such sense of obligation, who looked upon their rank as a mere privilege, and on duties as outside their province. Speaking of the leisured landlord, he put the case as democratically as one could desire: "You ask him at the year's end, 'Where is your three hundred thousand pounds? What have you realised to us with that?' He answers in indignant surprise, 'Done with it? Who are you that ask? I have eaten it, I and my flunkeys, and parasites, and slaves, two-footed and four-footed, in an extremely ornamental manner, and I am here alive by it; *I* am realised by it to you.' It is, as we have often said, such an answer as was never before given under this sun."

This gospel of work continued to be preached by our prophet all his life. It was the kernel of truth underlying that otherwise very questionable campaign of his against the supposed right of negroes in the West Indies to leave their bountiful soil untilled and pass their days in the freedom that for them meant sloth. This denunciation by Carlyle is often put down to his mood of racial contempt. But we do him sore injustice if we judge him so. His contempt was far more for slothful nobility than for slothful negroes. "And such a man," he exclaims, "calls himself a *noble* man! His fathers worked for him, he says, or successfully gambled for him; there *he* sits; professes not in sorrow but in pride that he and his have done no work, time out of mind. It is the law of the land, and is thought to be the law of this Universe, that he alone of recorded men shall have no task laid upon him, except that of eating his cooked victuals, and not flinging himself out of window."

The next social order to which Carlyle addressed his admonitions was different. It was the rising middle class, the manufacturers, the great employers of labour, the magnates of commercialism. The points of moral similarity and points of moral difference between the upper and middle orders a century ago constitute a subject of very great historical and psychological interest. What we now call the Industrial Revolution had just perfected itself, with its enormous development of machinery, and the immense rush which it had occasioned from the country to the cities. The growth of the capitalist, made possible by the great mechanical inventions and by the massing of skilled workers in great industrial centres, had silently withdrawn from the old harmonious feudalism the basis on which it had so long reposed. Intelligent mechanics would not preserve that docility towards squire and parson which might be counted upon among dull farmers and duller labourers. The middle class, with quite new demands, had come into existence. Wealth was claiming, and could compel, that social recognition which had formerly been the prerogative of birth. The brains that had devised the spinning-jenny, constructed the steam-engine, fashioned the Lancashire canals, drained the Lincoln fens, built Menai Bridge and Waterloo Bridge, all belonged to those ranks which had so far been politically insignificant. Brindley was the son of a Midland collier. Hargreaves was a handloom weaver. Watt got his first notion of mechanical dexterity as he watched his father planing at a carpenter's bench. No great sagacity was needed to see that men who were doing so much for the nation's progress would not long submit to be ruled by those who were merely preserving game.

Thus two social classes confronted each other in rivalry for public domination, united only by a common resolve to keep the toiling multitudes subservient. As George Meredith would have put it: "There were names historic, and names mushroomic; names, which the Conqueror might have called on his muster roll, names that had been clearly tossed into the upper stratum of civilised life by a mill-wheel or an office stool." But, alas, there were other names too, names of which hardly any man dared to make mention, but which everyone knew to be reckonable by millions, names notable neither in history nor in mechanical invention, but very notable indeed for a sustained patience in suffering, and a slow-growing but all the more inexorable resolve that—in Carlyle's later words—if something were not done something would before long do itself, and in a manner that would please nobody. "With the working people again," wrote our prophet in dealing with eighteenth century France, "it is not so well . . . . Unlucky! For there are from twenty to twenty-five millions of them. Every unit of whom has his own heart and sorrows, stands covered there with his own skin, and if you prick him he will bleed." Was this explosion that of an anti-democrat? Just the same warning was issued in *Past and Present* to the England of Carlyle's own day.

As the vice of the landed gentry had been idleness, so—as he saw it—the vice of the middle class was Mammon worship, the glorification of wealth, the denial of any sort of human relationship between themselves and their work-people, the acknowledgment of nothing more than a "cash nexus." "Working Mammonism," indeed, he once said, "is better than idle Dilletantism." But both were bad enough. Uniting the two in a common denunciation, he fastens, as his custom was, derisive names to them, to the latter "His Grace of Rack-rent," and to the former "Plugson, Hunks, and Company, of Undershot."

This disregard in practice of any duty from employer to workman, except tha tof getting as much as he could extort in work for as little as he could escape with paying, grounded itself upon the economic doctrine of *laissez-faire*. The notion was that the state exists for no other purpose than to preserve public peace, to keep the ring while competitors fight out their individual struggle among themselves, to be a gigantic policeman, in short, with the duty of restraining violence but no duty of stimulating social welfare. It was the doctrine preached, for example, by Nassau Senior, when he resisted the Factory Acts, on the ground that to prohibit the employment of a child ten years old wherever his parents chose to hire him out and the capitalist chose to engage him was interference with personal liberty, a travelling outside the proper function of government, and in fact the first step towards the ruin of British trade. Against such a monstrous dogma Carlyle reasserted that old philosophic truth—at least as old as Aristotle—that the state has a spiritual end. Not just to keep open the field for free competition, not just to make sure that "supply and demand" is allowed its perfect work, not just to punish violence and defend rights of property, but to stand towards every human being in a relation like that of a parent to a child, was for Carlyle the state's chief business. Hence his ferocious diatribe against political economy as "the dismal science;" hence his mocking of the maxim that to buy in the cheapest market and sell in the dearest is the whole duty of man; hence his constant burlesque of what he called "the Gospel according to McCroudy." At present it is often maintained that the inhumanities of the older economists were imputed to them by the spiteful wit of those who dealt in caricature. But unfortunately there is much on record to convince us that the current economic formulæ were safe from this, for they had reached the limit beyond which exaggeration could not well go. When Lord Stowell, for instance, was denouncing the proposal to set up schools for teaching the children of the poor, he grounded himself upon the following as an admitted scientific truth: "If you provide a larger amount of highly cultivated talent than there is a demand for, the surplus is very likely to turn sour!"

Thus, if Carlyle was anti-democratic, he meant by this attitude something very different from the class arrogance which the word so often conveys and from which it draws its evil omen. What he had in mind was rather this, that the business of governing is, like every other enterprise, based on science, and that if nowhere else important decisions of policy are taken by a count of heads, in which those who know a great deal and those who know next to nothing have equal votes, it is absurd to take a plebiscite on the greatest problems of all. Such a principle is open to obvious abuse, and no doubt we are agreed that Carlyle pushed it much too far. But there is a kernel of momentous truth at the heart of it. No company is guided in the details of its business management by a mass meeting of all the shareholders, with long debates, bursts of eloquence, and vote by ballot. It has a board of directors, chosen indeed by those interested, but trusted, and not constantly dictated to as to their line of action. So in the state, Carlyle argues, beware how you select your rulers. Your problem is to get a body of the ablest men in office; but, having put them in office, treat them like steersmen of a ship, working under that good old maxim, "Don't talk to the man at the wheel." If the steering turns out disastrous, you must change your steersman. But it is folly to keep him where he is, and rely upon directing every turn of his rudder by a chorus of passengers' voices. Sometimes, indeed, under democracy the guides are scarcely even passengers with any serious interest in the voyage at all. This becomes a case of steering not according to the chart but according to the shouts from the shore.

IV

Thus, as one considers the two types of hostile attitude towards Carlyle, that of a generation ago and that of the last five years, one is struck both by a melancholy fall in the competence of those who write against him, and by the altered incidence of the attack. Temperateness, frank and grateful acknowledgment of his unquestionable services to our literature, a careful sifting out of those elements of wisdom which underlay even that which was most faulty in his teaching, these marks belong to every estimate by such writers as Lord Morley, Leslie Stephen, R. H. Hutton. Violence, disregard of the merits and concentration on the demerits, an ignoring of much that was true in the eager search for all that can be proved false, such is, in short, the tone of such men as Mr. Bertrand Russell and Professor S. P. Sherman. The old critics used to assume that it was Carlyle's greatness rather than his littleness which concerned mankind. The new critics assume the reverse. Those of the past felt that they were judging a poet, a seer, a magnificent literary artist, and they did not forget to make allowance for the peculiarities of such genius; for they knew that a judicial temper must not be expected in a satirist, precise historic accuracy in a glowing rhetorician, unfailing human charity in an habitual dyspeptic. They knew however, at the same time, that high achievement by a man of letters is often found even where these defects are conspicuous, and they devoted their energy to appraising this. Those of to-day go to work upon Carlyle's doctrines as if they were legal documents, to be dissected with the literal exactness of a lawyer—and not a lawyer of the broader type-inquiring not into what contains lessons but into what can be shown to be defective, and making no deductions whatever from their censure in view of changed circumstance or fresh light. Such a contrast must not, of course, be made too sweeping, or I should fall into just the same sort of error which I reprobate. Mr. Courtney, writing a few months ago, belongs on the whole to the older level, just as Herbert Spencer, writing thirty years ago belongs on the whole to the later. But in general the distinction will be found to hold good.

It is seen, again, in what I have called the "altered incidence of the attack." The older critics used to speak much about Carlyle's neglect of science, his *a priori* assumptions in history, his myth about the "Hero," his rash idolatries and his still more rash depreciations. All these charges can be made good, and they constitute real ground for serious discounting of the prophet's fame. The critics of the present dwell to only a slight extent upon these matters, emphasising instead such points as have no permanent significance, but touch the passing popular mood. They tell us of Carlyle's disbelief in democracy, omitting all mention of the qualifications under which this disbelief was expressed, and of the sagacious judgment which embodied itself in his demand for submissiveness to the expert. They make much of his so-called inhumanity, on the basis of a few vitriolic phrases, and in spite of our abundant evidence that he was at heart a lover of all his kind. They exploit his panegyric upon Frederick and the Germans, choosing to forget how prone is every writer to exaggerate the good qualities of those whom he has undertaken to set before us, and how many others—against whom no sort of inhumanity can be pretended—wrote in a very similar strain. They even invoke the enthusiasm of the *entente cordiale* to cast discredit on one who taught that the work of the Encyclopædists was inferior to *Faust* or to the *Critique of Pure Reason.*

Thus, while one must admit that many reproaches now being urged against Carlyle are well grounded, it should be acknowledged at the same time that the most serious among them are no new discoveries of the present epoch, no evidence of the superiority of the *Zeitgeist* in our own day as compared with that of thirty or forty years ago, but that contemporary critics in so far as they are right are but reproducing the criticism of the past, and in so far as they seek to improve upon it are showing distinctly less insight both into Carlyle's merits and into his defects than was shown by those who formed the judgments about him which have come down to us by tradition. The inference is that his fame, in so far as present day causes are leading to its decline, may be expected to make a sharp recovery when those who write of him get back their intellectual balance.

One thing seems to be certain, that his repute—though in a sense it must be said to have fallen—has at least not fallen far towards oblivion. The very tempest of invective is good proof that he is not forgotten, and that those who hate him, no less than those who love him, are unable to escape from the magic of his words. Mr. Courtney himself, while assuring us that Carlyle is out of favour with undergraduates, does not simply record so satisfactory an improvement, but has to join the chorus of those who argue at length in what respects Carlyle was wrong. Professor Sherman has a different view, asking us of what use it is to guard ourselves against the malignant influence of Prussian literature when Prussianism is still streaming into our Anglo-Saxon communities through the forty volumes of Carlyle. Thus two of our most recent guides on this matter, while each thinks a particular influence bad, are at complete variance as to how far that influence extends. Mr. Courtney judges it quite negligible; to Professor Sherman it is an awful public danger. But both are constrained to write about it, and there is still scarcely a book of the least consequence on political theory which appears without some extensive reference, whether sympathetic or denunciatory, to Thomas Carlyle. One is reminded of a neat remark by Mr. L. T. Hobhouse about the advocates of Tariff Reform, that they like to begin by saying "Free Trade is dead," and yet proceed to revile free trade with a rancour from which the dead are usually exempt.

Herein lies a coincidence in itself worth noting. As a rule we can quietly disagree about the worth of a famous man, especially when he is long since gone. Although each critic believes his opponent mistaken, he need not say nasty things about "critical incompetence," and may even admit a measure of justice in views which he does not fully share. But Carlyle is being discussed quite otherwise. One seems to believe or disbelieve in his genius, as one accepts or rejects a scientific doctrine, refusing compromise, insisting on Tennyson's "clash of Yes and No," deriding or even hating those who take the opposite view with a bitterness almost theological. It is indeed a high tribute to the forcefulness of any writer that he should thus continue to awaken the warmth alike of enthusiasm and of resentment. About most of those whom we criticise there is nothing distinctive enough to raise the white heat of passion either for them or against them. But the violence of this particular debate does more credit to the originality of the man who has been able to provoke it than to the judicial temper of those by whom it has been exhibited.

In this paper I have tried to commend a more moderate attitude. Froude anticipated thirty years ago that when time should have levelled accidental distinctions, and the chief figures of the nineteenth century should be seen in their true proportions, Carlyle would tower above all his contemporaries, and be the one person among them about whom succeeding generations would most desire to be informed. That judgment about him has not been confirmed. Those who can still recall the great days of his supremacy must be impressed by the evidence such a case affords that the fame of the essayist, the critic, the prophet, is written in sand. Curiously enough it was Froude himself who gave the earliest shock to his own idol. Perhaps the most severe criticism upon the biographer's action in publishing *Memorials of Jane Welsh Carlyle* is to be found in that accumulation of gossip, always unpleasant, and sometimes disgusting, which but for him busybodies would have had no excuse for obtruding upon us. Into that matter I have not entered, for it is not with any man's domestic infelicities that posterity is concerned. What I have endeavoured to show is the lasting merit, once no doubt unduly exalted, now no less unduly depreciated, which belongs to a teacher of rare power, with a genius for literary and poetical effectiveness almost unique in its kind, often enforcing one-sided truths as if they were complete, often ignoring other truths that must be sought in the supplementary work of other men, with the defects of his qualities—great just because the qualities were great. The spirit of the prophet was not always subject to the prophet, and the dazzling gift of speech not seldom dazzled the speechmaker himself. But what a spirit and what a gift belonged to him we cannot afford to forget, nor has the slowly formed estimate by our fathers been at all improved upon in the rapid, clear-cut decisions of our contemporary press.

I cannot close without a few words about one aspect of Carlyle which is too much overlooked, and which we in Canada have the best possible reason to remember. It is often assumed that he had no insight into the political future of Great Britain, and that he was unable to deal with constructive problems of statesmanship. How does this condemnation consort with what we know of his references to Canada? Sixty years ago it was the current doctrine in many quarters that a "colony" was a kind of white elephant which the imperial household would be far better without, that it cost far more than it was worth, that in the end such dominions as our own were sure to break away, and that whether Canada drifted under the control of the United States or set up an independent republic for herself the mother country would gain rather than lose by the change. Since our experience of the Great War he would be a bold man who would speak like this again. But is there a Canadian whose pulse is not quickened and whose blood is not stirred as he turns even yet to Carlyle's passages of withering scorn towards those who would have acquiesced in such a breach within the British household? At the time he wrote he seemed to be arguing against what is called "the logic of events," and he was sustained by little more than a sort of intuitive faith. But he saw things far more deeply and far more truly than the "practical" politicians.

"And yet," exclaimed Carlyle, "an instinct deeper than the Gospel of McCroudy teaches all men that Colonies are worth something to a country! That if, under the present Colonial Office they are a vexation to us and to themselves, some other Colonial Office can and must be contrived which shall render them a blessing; and that the remedy will be to contrive such a Colonial Office or method of administration, and by no means to cut the Colonies loose. Colonies are not to be picked off the street every day; not a Colony of them but has been bought dear, well purchased by the toil and blood of those we have the honour to be sons of; and we cannot just afford to cut them away because McCroudy finds the present management of them cost money. The present management will indeed require to be cut away —but as for the Colonies, we purpose through Heaven's blessing to retain them awhile yet. . . . . Because the paltry tatter of a garment, reticulated for you out of thrums and listings in Downing Street, ties foot and hand together in an intolerable manner, will you relieve yourself by cutting off the hand or the foot? You will cut off the paltry tatter of a pretended body-coat, I think, and fling that to the nettles; and imperatively require one that fits your size better . . . . Miserabler theory than that of money on the ledger being the primary rule for Empires, or for any higher entity than City owls and their mice-catching, cannot well be propounded."

These are the words of one who is said to have dealt in sound and fury, signifying nothing, and who needed to be restrained by the calm, thoughtful folk that were above all rhetoric. May Heaven keep up our supply of such furies, lest by too much calm and too much thoughtfulness the nerve of our Commonwealth be paralysed.

and he was sustained by little more than a sort of instinctive faith. But he saw things far more deeply and far more truly than the "practical" politicians.

"And yet," exclaimed Carlyle, "in an instant, rather than the Gospel of McCroudy teaches all men that Colonies are worth something to a country! That if, under the present Colonial Office they are a vexation to us and to themselves, some other Colonial Office can and must be contrived which shall render them a blessing; and that the remedy will be to contrive such a Colonial Office or method of administration, and by no means to cut the Colonies loose. Colonies are not to be picked off the street every day; not a Colony of them but has been bought dear, well purchased by the toil and blood of those we have the honour to be sons of; and we cannot just afford to cut them away because McCroudy finds the present management of them cost money. The present management will indeed require to be cut away—but as for the Colonies, we purpose through Heaven's blessing to retain them a while yet! ... Because the paltry tatter of a garment, reticulated for you out of thrums and listings in Downing Street, ties foot and hand together in an unendurable manner, will you relieve yourself by cutting off the hand and the foot? You will cast off the paltry tatter of a pretended bed-gown, I think, and fling it to the nettles; and imperatively require one that fits you. ... Miserabler theory than that of money on the ledger being the primary rule for Empires, or for any higher entity than City owls and their mice-catching, cannot well be propounded."

These are the words of one who was said to have been all sound and fury, signifying nothing, and who was held to be restrained by the calm, thoughtful folk that were shocked at his rhetoric. May Heaven keep up our supply of such furies, lest by too much calm and too much thoughtfulness the nerve of our Commonwealth be paralysed.

The Attitude of Governor Seymour Towards Confederation

BY HIS HONOUR JUDGE F. W. HOWAY, LL.B., F.R.S.C.

(Read May Meeting, 1920)

The story of British Columbia between 1858 and 1871 is one of continual political changes. To understand the situation in which Governor Seymour was placed in dealing with the question of union with Canada these changes must be remembered; and the heterogeneous population and the reflex action of local animosities upon their feelings towards him constantly borne in mind.

In 1858, on the discovery of gold in the bars of the Fraser, the Colony of British Columbia was created by Act of the Imperial Parliament. Referring to its future Her Majesty, the late Queen Victoria, in her prorogation speech, said: "I hope that the new colony on the Pacific may be but one step in the career of steady progress by which my dominions in North America may ultimately be peopled in an unbroken chain from the Atlantic to the Pacific by a loyal and industrious population."[1]

At that time there had already existed for nine years the Colony of Vancouver Island, which, though containing very few inhabitants and controlled by the Hudson's Bay Company, yet boasted a Legislative Assembly of seven members and a Legislative Council of three members. The two colonies were separate and distinct entities, though having the same governor, James Douglas. He resided in Victoria, where all his property interests were centred and where also the majority of the officials of British Columbia had their homes. All laws for the governance of the mainland colony were promulgated from the capital of the island colony and by the authority of the governor alone. Though this was supposed to be only a temporary measure, necessitated by unique conditions, it continued for five years—1858–1863.

The gold seekers of 1858-9 as well as a large proportion of those who came during the Cariboo excitement, 1861-3, were Americans, or, at any rate, persons, who, having lived for years in California, had distinct American leanings. These inrushes transformed Victoria from a fur trader's post into a bustling town. Some traders settled on the mainland, but the larger merchants located in Victoria. Naturally, the two colonies were thus closely linked with San Francisco,

[1] Watkin's Canada & the States, p. 57.

the nearest American city. The gold of British Columbia found its way to the bankers and wholesale dealers of the neighbouring colony and thence to San Francisco.

To obtain access to the mines of Cariboo, distant some four hundred miles from the head of navigation on the Fraser River, the Colony of British Columbia borrowed about one million dollars, for the construction of the great Cariboo wagon road.[1] To meet this liability the population of the mainland were heavily taxed and all imports bore large customs duties; while the benefits were shared with Vancouver Island, which was a free trade colony. The only real industry on the mainland was gold mining; but in the rugged climate of Cariboo it could not be advantageously carried on except during five or six months in the year. The first fall of snow, therefore, saw an annual exodus of miners, who spent the money drawn from the mainland mines in the more salubrious climate of Vancouver Island, or in sunny California.

From these causes arose a strong feeling in British Columbia, that two changes were absolutely necessary for their prosperity—yea, for their continued existence—a Legislative Assembly to make their laws, and, to administer them, a governor unconnected, in any way, with the colony of Vancouver Island and untrammelled and any interests adverse to their well-being. In 1863, after much agitation, they received a promise that, upon the retirement of Governor Douglas, a separate governor would be granted to them, but, that instead of the Legislative Assembly asked for, they would be given a Legislative Council composed of officials and a small number of elected members. The Duke of Newcastle, then Secretary of State for the Colonies, intimated that he had taken this step because of repeated urgent requests and against his own judgment which was inclined to the view that union of the two colonies and not their separation was the proper course to be adopted.[2] Frederick Seymour was sent out from England to be the first separate Governor of the Colony of British Columbia. His arrival in 1864 was accepted as an earnest of a new and better state of things. Never was governor received with kinder feelings or more genuine delight.

Now was seen the spectacle of two separate colonies whose combined population, exclusive of Indians, did not exceed 15,000 and whose total permanent residents were, perhaps, not more than one

---

[1] The Overland Route, in *British Cclumbian*, April 11, 1868; Appendix, Langevin's Report on British Columbia 1872, pp. 209-210.

[2] Papers relative to the proposed union of British Columbia and Vancouver Island, Part I, p. 1.

half that number, striving against each other in a spirit of jealousy which soon developed into bitter hostility, and each carrying a load of officials suitable for a colony many times greater. Scarcely had this separation been accomplished than Vancouver Island began to clamor for complete union with British Columbia, which, however, strenuously opposed every attempt in that direction.[1] For about three years the Colonial Office was bombarded with resolutions from the former asking for union and from the latter urging continued separation. So keen did the desire of the people of Vancouver Island for union become, that they were willing to abandon both their Legislative Assembly and their free trade policy to effect that object. Governor Seymour, taking his color from his own community, opposed the union, and, in consequence, was greatly disliked on Vancouver Island; but, after his visit to England in 1865, his opinions changed and he swung into line as a supporter of union.

The two colonies were over-burdened with debt; each year showed a recurring deficit. On the mainland the deficit for 1864 was over £55,000; for 1865, $124,435; and for 1866, $170,000. On the island the deficit for 1864 was $134,740; for 1865, $82,698; for 1866 over $70,000.[2] In 1866 the net indebtedness of British Columbia was over $1,000,000; that of Vancouver Island was nearly $300,000; representing a per capita debt of about $250 and $50 respectively. The cost of administering the two governments was about $1,000,000 a year.[3] During these years the output of gold was steadily diminishing; the population as steadily decreasing; in 1866 it had dwindled to less than ten thousand; the burden of the annually increasing debt was becoming more and more grievous. Some drastic step was required. In 1866, without any notification to the colonies' the Imperial Parliament decreed their union under the name of the Colony of British Columbia. It was hoped that their petty jealousies would thus be stifled and, the cost of administration being reduced by approximately one half, the deficits would cease and taxation be lowered. Governor Seymour was appointed Governor of the new colony. It was, indeed, a poor choice, for Seymour was too weak to use the pruning knife unsparingly. Some reductions, it is true, were made (they could scarcely, indeed, have been avoided); but they were rather in the nature of amalgamation of offices than in radical re-adjustment. The deficits still continued: that of 1867 was $130,000; trade languished; population diminished; taxation increased.

---

[1] Id., Part III, p. 1.

[2] Pacific Directory, 1867, p. 158; Yale Convention Report; *The Islander,* April 7, 1867.

[3] Public Accounts, 1866.

The Legislative Council of the old colony of British Columbia had consisted of fifteen members; by the Act of Union the number was increased to twenty-three, but without any distribution of seats. Governor Seymour allotted them as follows: five to members of his executive council; nine to magistrates selected by himself; and nine to persons elected by the people, being five from the mainland and four from the island; all to hold office for two years.[1] It will thus be seen that fourteen of the twenty-three members were directly selected and appointed by the Governor. Thus, in the eyes of the community, the Legislative Council was divided into fourteen "official" members and nine "popular" members. Technically the whole body was appointed by the Governor; but, as regards the popular members, he, in practice, always appointed those who had obtained the majority of votes in the election.

The first session of this Legislative Council was held in January, 1867. In his opening speech Seymour referred to the depressed condition of the colony as "the considerable, though I trust temporary, depression existing in several parts of the colony," and later: "Gloomy as our present position may be, I think we can look to the future with confidence," and yet later: "Great as is the present temporary financial embarrassment"; but in it all he had no suggestion to make for the betterment of the existing condition; he could only "trust" and "hope."[2] Governor Seymour, in truth, was a drifter, not a builder. "Laissez-faire" might well have been his motto. The Quebec Conference in the resolution expressing the desire for federation of the British North American provinces had included the statement "provision being made for the admission into the union on equitable terms of the North West Territory, British Columbia, and Vancouver Island";[3] and after years of discussion the Act was before Parliament; but not one word had he upon the subject.

The people were, however, watching the progress of events, and in public meetings were already considering the abstract question: "Resolved that it is desirable that this colony should be united to the British North American Confederation."

In March, 1867, while the British North America Act was passing through Parliament, Amor DeCosmos, one of the popular members and an early and consistent advocate of union with Canada, introduced into the Legislative Council a motion upon the subject of Confederation. Its consideration was adjourned for one week to

---

[1] Seymours' Letters, January 17, 1867 in Union Papers, pt. III, p. 37.

[2] Union Papers, pt. III, p. 39.

[3] Canadian Historical Review, vol. I, p. 32.

enable a deputation to wait upon the Governor with the request that he telegraph to the Imperial Government asking that provision be made for the admission of British Columbia upon equitable terms.[1] The Governor consented and sent the following telegram—a mere enquiry—"Can provision be made in Bill now before Parliament for ultimate admission of British Columbia into Canadian Confederacy?"[2] The wording is interesting, as giving an indication of Seymour's supineness in the matter from the very outset. On the 18th March, 1867, the resolution passed the Legislative Council by unanimous vote. It stated "That this Council is of opinion that at this juncture of affairs in British North America, east of the Rocky Mountains, it is very desirable that His Excellency be respectfully requested to take such steps without delay as may be deemed by him best adapted to insure the admission of British Columbia into Confederation on fair and equitable terms, this Council being confident that in advising this step they are expressing the views of the colonists generally."[3]

Three days later, in a message acknowledging the receipt of the resolution, the Governor stated that he would "place himself in communication on the subject with the Secretary of State, with Viscount Monck, Governor of Canada, and with Sir Edmund Head, Governor of the Hudson (sic) Bay Company."

The session closed early in April. In his prorogation speech he said: "I am about to communicate with the Secretary of State and the Governors of Canada and the Hudson (sic) Bay Company respecting the wish you have expressed to enter into a confederation with the Eastern Provinces of British North America. I will inform you as a Council, if a Legislative Session is in progress, if not as individual Honorable Gentlemen, of the result of my enquiries."

Despite the terms of the resolution and of his promise Seymour did not communicate with Lord Monck. It is surmised that he did write to the Hudson's Bay Company, for not until the 24th September, 1867—a sufficient time after the passage of the resolution to permit of a reply being received from England—did he transmit the resolution to the Secretary of State. His accompanying dispatch opens out his mind upon the subject. He points out that though the resolution had passed "without opposition" there was "but little warmth felt in its favor." He gives no hint of the meaning of this enigmatic expression. If it refers to the action of the Council it would have been thought that unanimity indicated complete concurrence; if it refers to the

[1] *The Islander*, March 17, 1867.

[2] Confederation Papers, p. 11.

[3] Id.

people it is simply a misstatement. After mentioning the difficulty caused by the Hudson's Bay Company's ownership of the North West Territory, he gives his opinion that the resolution is merely "the expression of a despondent community longing for a change"; it may, however, he adds, awaken in England some interest in the colony. He passes then to speak of the people, most of whom, he says, immigrated with great expectations, but being "men unable to make their way in Europe," failed and laid the blame for their condition "upon other shoulders than their own." This may have been true of the officials, but as regards the rank and file of British Columbians it was as gross a libel as governor ever penned. The population, he states, is becoming alien; it has been already indicated that a large portion of it always was so, in sentiment, if not in nationality. To retain and strengthen the English feeling in the colony, he suggests that some aid must be given to establish connections with Eastern Canada. He concludes: "It is for me merely to state the wish of the people of this Colony and my own for a fusion or an intimate connection with the Eastern Confederation. It rests with your Grace to see if that wish can be carried out. Merely to join the Confederation on the condition of sending delegates to Ottawa, and receiving a Governor from the Canadian Ministry would not satisfy the popular desire."

One might pause here to remark that this dispatch clearly shows that the Governor knew the feelings of the colonists in favor of real union with Canada. The absence of anything resembling the active co-operation requested in the resolution is painfully manifest. Though these remarks are in a "separate" dispatch, in which he might feel free to discuss the pros and cons of the question, it will be observed that not one word is to be found regarding the benefits likely to arise from confederation. Outside of chilling allegations and remarks that are near akin to abuse, it contains only the cold and formal statement of the people's wish. It was common knowledge that the Canadian Government were anxious to add British Columbia to the Dominion, but the Governor does not even refer to the fact.

In November, 1867, the Duke of Buckingham, the Secretary of State for the Colonies, replied that whatever might be the advantages of the proposed union, the consideration of that question must await the time when the intervening territory under the control of the Hudson's Bay Company should be incorporated with the confederation.[1]

Governor Seymour, not having made public either his report or the reply thereto, a public meeting of the citizens of Victoria was

---

[1] Confederation Papers, p. 28.

held on 28th January, 1868, to consider the subject. A lengthy memorial was prepared, setting forth the resolution of the Legislative Council and its approval by the residents of Victoria and Cariboo, the two most influential and populous centres; that the newspapers as a whole supported the movement; that, while a small party favored annexation to the United States, there were others, including the office holders, who opposed confederation; that, so far as could be learned, the Governor had not made any proposition to the Dominion Government relative to the admission of the colony; that the majority of the Legislative Council "consisting of heads of Departments, Gold Commissioners, Magistrates, and others, subject to Government influence, can not be relied upon to urge on Confederation as it ought to be at the present juncture;" and, therefore, that the Dominion Government be asked to request the Imperial Government to issue instructions with as little delay as possible to Governor Seymour to conclude the negotiation along the line of certain terms therein set out. The Mayor of Victoria and six prominent citizens were appointed a committee to interview the Governor and urge him to work actively in the issue.[1]

Thus early in the discussion the opinion became crystallised that the Governor was the great stumbling block; that his hostility, or, at any rate, indifference to the project had caused a change in the views of the official members even before such alteration had become officially known; and that the only method whereby results could be obtained was by direct instructions to him as a colonial officer. That he did on various occasions exercise his influence on the official members to obtain action desired by him is admitted by Seymour in his correspondence.[2]

On 6th March, 1868, the Dominion Government, adopting the suggestion contained in the memorial, recommended that the Governor General "communicate to his Grace, the Duke of Buckingham, a copy of the memorial and resolutions referred to and request his Grace to instruct Governor Seymour to take such steps as may be deemed proper to move the Legislative Council of British Columbia to further action in terms of the Imperial Act."[3]

Two weeks later the session of the Legislative Council for 1868 was opened. In referring to the confederation resolution of the preceding year the Governor said: "Although I could not be blind to difficulties which made me consider the resolution principally as the

[1] *Daily British Colonist*, March 27, 1868.

[2] Union Papers, pt. III, pp. 35, 38, 39.

[3] Confederation Papers, p. 5.

expression of a disheartened community longing for change of any kind, yet the possibility alone of something arising out of it to promote an overland communication with Canada was enough to induce me to support your Resolution. I have received in reply communications on the subject that the consideration of it must, at all events, await the time when the intervening territory now under the control of the Hudson's Bay Company shall have been incorporated with the Confederation."[1] It will be noted that he had received but one letter from the Secretary of State, and none from Ottawa; unless therefore he had been in correspondence with the Hudson's Bay Company, the use of the word "communications" was improper; and further that it was not the consideration of Confederation by the colony, but by the Colonial Office, which must according to the Secretary of State, abide that event.

Commenting editorially upon this lack-lustre statement the *Colonist* said: "Confederation is touched upon in a manner which shows the proposition finds little sympathy with his Excellency . . . . The remark that Confederation is seized upon by a 'disheartened community longing for a change of any kind' is absurd. If such be his Excellency's real conviction we can inform him that he was never more 'at sea' in his life. The people of British Columbia would not welcome Confederation as they would welcome 'any change.' There are many changes they would not accept if they could obtain them; but there is one they will have, and that is restoration of their political rights and the control of the public revenue. Mr. Seymour and his Government may as well know this to-day as to learn it in a different form a few months hence."[2] The Hon. John Robson a popular member of the Council and the proprietor of the *British Columbian*, wrote: "It may however, become the duty of the Legislature to impart to this question a more practical complexion, during the present session; and, if we have been correctly informed as to the present attitude of the Canadian Government upon the subject, such a turn is far from problematical."[3] A few days later arrived the historic telegram from the Dominion Government: "The Canadian Government desires union with British Columbia and has opened communication with the Imperial Government on the subject of the Resolutions (of the public meeting, 28th January, 1868) and suggests immediate action by your Legislature and the passage of an Address to Her Majesty regarding union with Canada. Keep us informed of progress."[4]

[1] *British Columbian*, March 21, 1868.
[2] *Daily British Colonist*, March 23, 1868.
[3] *British Columbian*, March 25, 1868.
[4] *Daily British Colonist*, March 27, 1868.

Following the receipt of this telegram and while the Council was in session there, a public meeting was held at New Westminster, at which a resolution in favour of immediate union upon fair and equitable terms was adopted. Three days later a public meeting at Yale went on record to the same effect.[1] Emboldened by the manifestly increasing interest in Confederation, to which the sympathetic attitude of the Dominion Government had given an impetus, a memorial was presented to the Governor by the citizens of New Westminster stating that immediate admission into the union was earnestly desired by the colonists and requesting him to bring the subject by message before the Legislative Council.[2]

Though fully aware of the sentiment of the colony as voiced by the press and as shown by the various meetings of the past two years and though urged by the memorial to lead the way in a public manner, by bringing the subject by message before the Council, the Governor remained quiescent. He did not even reply to the request. His failure to act, even though his opening speech had indicated his mind, and though the remembrance of his vacillation in connection with the Grouse Creek trouble and the Capital question was still fresh, yet aroused much murmured dissatisfaction. "Surely," said the *British Columbian*, "His Excellency is not going to suppress that Memorial."[3] The *Colonist* referred to the Governor as a man who preferred "his own ease and comfort to the good of the people," and charged him with "an utter indifference to the interests of the Colony." The island had always been opposed to him, and now he was losing the loyalty of the mainland. After waiting for a week for some move on the Governor's part, Mr. DeCosmos, on 24th April, brought before the Council an Address such as had been asked for by the telegram, setting forth, presumably with the authority of the Dominion Government,[4] the proposed terms of union, and praying for the admission of British Columbia under the provisions of Section 146 of the British North America Act.

An amendment was immediately offered by the official members to the effect "That the Council, while confirming their vote of the last session in favour of the general principle of the desirability of the union of this Colony with the Dominion of Canada to accomplish the consolidation of British interests and institutions in North America, are still without sufficient information and experience of the practical working of Confederation in the North American Pro-

---

[1] *British Columbian*, April 8, 1868.

[2] Id, April 22, 1868.

[3] April 29, 1868.

[4] Lytton's Speeches, vol. 2, p. 383.

vinces to admit of their defining the terms on which such a union would be advantageous to the local interests of British Columbia."[1] To one acquainted with Governor Seymour's procrastinating habits the amendment betrays his hand; it might readily be interpreted as deferring Confederation for a decade at least. And now Confederation, which in the preceding session had been unanimously approved could only muster four votes. Its supporters were all popular members. Three of the opponents were also popular members; but two of them were from Vancouver Island, where the annexation feeling and the Hudson's Bay Company's influence were very powerful; the official members presented a solid phalanx in opposition.

The Hon. John Robson, who was one of the four confederationists, spoke out, editorially, saying that the officials (in which term the Governor was included) opposed Confederation as it would end their positions and that they were acting in their own interests and not in those of the colony. Confederation, he told them, would come despite official obstruction and then, woe betide those who had delayed it. He continued: "Even viewed from the low ground of self interest it would obviously be the wisdom, as it would be the true policy, of the present incumbents from the Governor downwards to assist, instead of obstruct, the extension of Confederation to the Pacific. We would respectfully recommend the Governor and his officials to read, mark, learn, and inwardly digest the first nine verses of the sixteenth chapter of the Gospel according to St. Luke."[2]

The cry of the people, which had heretofore been stifled by their respect for the Governor and by certain local questions, was now heard, complaining of the conduct of the Legislative Council, as his mouthpiece, and demanding that, in accordance with his own Paris letter, a larger element of representation be included in that body. DeCosmos, a week after the rejection of his Confederation Address, gave utterance to this feeling in a resolution asking that the Governor be requested to take steps to reconstitute the Council on the basis of two-thirds popular and one-third official members.[3]

In his speech at the close of the session the Governor mentioned the result of the Confederation debate: "I notice that while adhering to your vote of last year in favour of Confederation with Canada, you are of opinion that it is not necessary to take any further steps in the matter. I think your resolution a wise one. The question is by no means slumbering; but the difficulties of the project are seen

[1] Confederation Papers, p. 13.

[2] *British Columbian*, April 29, 1868.

[3] Id., May 2, 1868.

clearer by those who have a wider range of vision than we can possess and without whose material assistance our efforts would be but vain."[1] It thus appears that by some strange telepathy the Legislative Council, fourteen of whom were appointed by him, reflected exactly the Governor's views, and practically reversed the decision of a twelve-month previous. The ground mentioned in his opening address: to wit, the Hudson's Bay Company's rights in the intervening territory was scarcely a safe one, inasmuch as the Dominion Government were moving to obtain the region and the negotiations were even then well in hand; hence the shifting to one that promised to defer the question indefinitely. The Governor is hardly disingenuous. His reference to the question as by no means slumbering would lead the hearers to think that he was taking some action to urge forward the project; but no correspondence from him thereon has been brought to light either in Downing Street or in Ottawa.

Discussing the vote of 1868 against Confederation, the *British Columbian* said: "It must be remembered, however, that should Her Majesty's Government decide on the change, the official members of the Council would, as a matter of course, do as they were bid. It was thumbs down on Confederation last session, because Simon said: 'Thumbs down;' but if Simon says: 'Thumbs up' up the official thumbs must go . . . . Governor Seymour's unique diplomatic papers have puzzled more astute brains than ours before now, and those who build least upon them will be least liable to disappointment."[2] It will scarcely be necessary to add that the "Simon" referred to was Governor Seymour.

In speaking of the proposed change in the constitution of the Council, the Governor said: "Possibly a too violent reaction from an unsatisfactory state of things has taken place. All must admit that the present institution is theoretically unsuited to the government of any large English community. My faith in the future of British Columbia leads me to consider it but provisional. I shall carefully consider the nature of the recommendation, if any, which I tender to Her Majesty's Secretary of State in the matter."[3]

The colonists as a whole had now reached the belief that the only escape from the heavy taxation lay by the road of Confederation. On Vancouver Island, however, owing to the influences already indicated this opinion was not so clearly crystallised. The Governor's remarks upon the suggested alteration of the Council raised the sus-

[1] Id., May 2, 1868.

[2] July 8, 1868.

[3] *British Columbian*, May 2, 1868.

picion that he had no intention of making or recommending the change; so far as careful search can discover he does not seem to have even transmitted the suggestion to the Secretary of State. Thus arose the settled conviction that he feared that a Legislative Council in which the people were predominant would declare in favour of union with Canada. The *British Columbian* spoke out fearlessly, as usual: "The paragraph as a whole is far, very far, from satisfactory. . . . . We fear the concluding sentence leaves us little to expect from Governor Seymour in the direction of more liberal institutions . . . . Mark the words, 'if any.' What do they mean? A Council, two-thirds Government officials passes a resolution asking for a change in the constitution so as to reverse the order of things, and give preponderance to the popular element, and yet the Governor plainly intimates, with as much indifference as possible, that the recommendation is not likely to go beyond his own waste paper basket."[1] The *Colonist* opined that "the apathy, carelessness, indifference, and want of energy of one man, backed though he be by most honorable officials, will not long keep back a country which has such natural advantages as our own; the people must sooner or later have the principal voice in the Government of the country, with or without Confederation."[2]

The favourable resolution of 1867 had lain in the Governor's hands for over six months before he saw fit to forward it to Downing Street; the resolution of 1868, which was antagonistic in fact if not in verbiage, he sent forward within a fortnight after the close of the session. In the accompanying dispatch he used this strange expression: "Desiring on the whole to see the project carried out I can not be blind to the great difficulties which obstruct its progress."[3] Two months later, he, on second thought apparently, transmitted a copy of De-Cosmos' proposed Address embodying tentative terms of union. "The motion, your Grace will see," says the Governor, "was lost. There is, however, a feeling with many persons in this Colony that the best hopes of its progress are to be found in an intimate union with Canada. The difficulties, however appear to me to be in the present state of things almost insuperable and the advantages remote." And this from the man who had, only two months before, expressed himself as upon the whole desirous of seeing the scheme carried out.

Nowhere in his correspondence does Governor Seymour attempt to inform the Home Authorities upon the growth of public opinion in

---

[1] May 9, 1868.
[2] Sept. 15, 1868.
[3] Confederation Papers, p. 13.

favour of Confederation; nowhere does he marshall the facts and arguments on its behalf; nowhere does he urge action by the Imperial authorities or press the settlement of the question; nowhere does he favour its discussion even as preparatory for the day of decision; nowhere does he take the real part of a colonial governor in moulding the views of his people. All must simply drift along, or perhaps wait languidly, and all discussion be adjourned until, first, this obstacle and, then, that shall have been overcome. Little wonder that he was referred to in the press as one of those who *in heart* were opposed to Confederation. The belief had now become firmly fixed, and it was well-founded, that he and his nominees, the official members of the Legislative Council, were determined to balk the popular desire. The main basis of that desire, as has been already hinted, lay in the hope of escape from the annual deficits and the consequent burden of increasing taxation. It is true that the leaders in the movement had vision of a united Canada stretching from sea to sea; but the populace saw in it, chiefly, a relief from their present and pressing pecuniary burdens. Thus it happened that the form of government, the civil list, and the alleged mal-administration of colonial affairs took their places in the Confederation discussion. Seymour gave no sign of re-constituting the Legislative Council in accordance with the resolution; nor even of carrying into effect his own intention, expressed in his celebrated Paris letter, of adding two unofficial members to his Executive Council. From the Governor downward, it was freely conceded by all the officials that the immediate admission of the colony upon the terms set forth in the DeCosmos Address or on some similar terms would be an unquestionable advantage; and one or two were frank enough to admit that the great difficulty in the way was the probable loss of their emolument.[1] The press now began to utter grave warnings to the Governor that as he had the power to reduce the civil list he was expected to do so; that, while thus decreasing the weight of taxation, he must give greater scope for the effective expression of public opinion; and that the colonial business must be administered in the interests of the whole people and not in the special interests of the officials.[2]

During the summer of 1868 public meetings all over the colony pronounced in favour of immediate union; and in many instances went further and passed resolutions condemning the action of the Council and the want of action of the Governor. At such a meeting held in Cariboo on 1st July, Mr. J. S. Thompson, who was later chosen as the

---

[1] *British Columbian*, Aug. 5, 1868.
[2] Id., Aug. 26, 1868.

first member of the House of Commons for the district, expressed the view of the colonists: "There can be no question as to the almost unanimous feeling throughout the colony in favour of Confederation. Public meetings have been held everywhere, from the mountains to the sea, from Victoria to Cariboo. The entire press of the colony, whatever their opinions on other questions may be, holds but one on this. Even the Government has declared in its favour; but though the Legislative Council of 1867 passed a resolution in favour of Confederation, the *official members*, in the session of 1868, annulled that resolution on the ground that delay was necessary. Delay!—delay for what? To enable them to retain their offices a little longer, and stave off, for a year at least, the inevitable event which must seal their doom."[1]

In September, 1868, a convention met in Yale to discuss and take united action upon Confederation and its allied questions. Twenty-six delegates, including three members of the Legislative Council, were present, representing Victoria, Metchosin, Salt Spring Island, Esquimalt, New Westminster, Burrard Inlet, Harrison River, Yale, Lytton, Lac La Hache, Williams Lake, Quesnel, and Cariboo. Their deliberations occupied three days, and covered every phase of colonial affairs. The convention affirmed the terms of union presented by Mr. DeCosmos in 1868 and voted down the official majority. They condemned the existing form of government; the Executive Council, they declared, was "irresponsible or not accountable to the people for the administration of its respective departments and under the present constitution is but an echo of the Governor and generally antagonistic to the well-being of the colony." As regards the Legislative Council the convention stated: "That the officials who form a majority of the Council vote as the Executive intimates whenever required, and that, consequently, the majority of the Council has no real independence, is a sham legislature, the Governor and Executive Council being virtually the Legislature of the colony." The civil list, the administration of the colony, the debt and the increasing taxation were all discussed, and the attitude of the Governor and his satellites severely criticised.[2]

The resolutions of the convention were forwarded to Governor Seymour. "Let not even His Excellency, the Governor, venture to sneer at it (the convention) in his dispatches," said Mr. Robson. The committee, who handed these resolutions to Seymour, requested him "to take such measures as may determine, at the earliest possible

[1] Begg's History of British Columbia, p. 379.

[2] Confederation Papers, pp. 18-26.

period, whether this colony can be admitted on such terms; and that if it can not be admitted on such terms to make public the reasons why such terms can not be obtained, in order to quiet the public mind on the subject."[1] The Governor's reply was that the matters, or some of them, would be communicated by him to the Legislative Council at its approaching session, and that the resolutions would be forwarded to the Secretary of State 'with perfectly respectful comments.' "[2]

In his dispatch accompanying the resolutions the Governor, in spite of all the pressure which had been brought to bear upon him, did not urge action towards consummating the union, or give any support whatever to the movement; nor did he emit one single word to indicate how strong the feeling on the question had become. He contented himself with generalities and platitudes, stating that "all Englishmen desired to see one unbroken Dominion extending from ocean to ocean"; but that the matter "does not rest with the so-called Convention at Yale, but has already occupied your Grace's attention, and that of the Government of Canada." In mentioning the desire for representative institutions and responsible government, he makes the naïve admission: "I have not been able to see a clear path before me." That required vision, decision, action; three factors in which his character was sadly lacking. Others could see that path and point it out, but Seymour either could not, or would not, see it. Constructive ability he had not. It was so very easy to accept conditions as he found them and drift along; and he did. This summarises his record of six years government.

Certain persons in Victoria, where as has been said the Hudson's Bay Company's influence and the annexation movement were strongest, had advertised in the *Colonist* that the delegates to the Yale Convention did not represent their views. The Governor took the trouble to enclose with his dispatch copies of these advertisements. This is noteworthy as the only occasion on which he ever sent any clippings from the press of the colony to the Colonial Office. "It is but right," he says, "that I should state that the proceedings of the Yale meeting did not meet with universal approval. I enclose two notices very respectably signed, protesting against the whole affair." He has nothing to say of the opinion of the rest of the colony, which approved the stand taken by that convention. He then proceeds: "I may add that the more prominent advocates of Confederation were defeated at the last elections in Victoria for members to serve in the Legislative Council."[3] He, however, fails to state that the members

[1] *British Columbian*, Sept. 9, 1868.

[2] Confederation Papers, p. 18.

[3] Confederation Papers, pp. 6-17.

chosen for the mainland at the same election were all well-known and prominent supporters of Confederation; nor does he see fit to explain to the Home Authorities that in Victoria, where the franchise had previously been confined to British subjects with property qualifications, he had by a special order for this election introduced universal suffrage, thus enabling the alien and annexationist element to make its power felt, whereby Mr. DeCosmos, one of the earliest and most energetic workers in the cause, had been defeated.

A new Legislative Council, which contained amongst its fourteen official members eight who had occupied seats in the last House, met in December, 1868. So bitterly had the Governor been attacked in the past year for his inaction, or worse, in the matter of Confederation, that in his opening speech he endeavored to defend his conduct. He stated that one week before the resolution of 1867 had been passed he had telegraphed "to urge that a provision be inserted in the Bill then before Parliament for the ultimate admission of British Columbia into the Eastern Confederacy." The wording of that telegram has been already given; it is difficult to see how it justifies the use of the word "urge"; it was confined to a coldly formal and colorless enquiry. He also omits to state that even this poor action was not upon his own initiative, but was the result of pressure. He then urges that he had been informed that the question must await the settlement of the Hudson's Bay Company's claims upon the intervening territory and its incorporation with the Confederation. It has already been pointed out that it was not the question, but the consideration of the question by the Imperial authorities that must await that issue. He then refers to "some unofficial letters" that he has received from which he judges that the Secretary of State "thinks the obstacles to the scheme extremely formidable." He goes on: "When transmitting formally the Resolution passed by the Legislative Council, I expressed myself desirous of seeing the project carried out, if it were possible." This is almost a *suggestio falsi.* We have seen in what a half-hearted manner he had expressed himself; in fact more in opposition than in support, and certainly not in the language of a person really desirous of seeing the scheme adopted.

Again the question came up in the Legislative Council. The Governor's real sentiments of opposition, which were well known to the official members and more than suspected by the populace, had heartened the opponents and they carried the war into Africa by offering a resolution: "That this Council, impressed with the conviction that under existing circumstances the Confederation of this colony with the Dominion of Canada would be inadvisable, even if practicable, urge Her Majesty's Government not to take any decisive steps towards the present consummation of such union." The supporters of Confederation offered amendments to the effect that until the intervening territory had been incorporated with the Dominion it was premature to express any definite opinion; but the amendment received only five votes; all from the mainland; and the motion was carried by eleven to five. At last the decision that the Governor wished had been reached; and he hurried to convey the good news to London. The resolution was passed on 17th February and on 4th March, about a fortnight before the House prorogued, he forwarded it saying: "With reference to My Despatches noted in the margin respecting the possibility of the union of this colony with the Dominion of Canada, I have now the honour to forward copy of a Resolution passed by the Legislative Council on 17th February antagonistic to the immediate consummation of such a measure." This is the entire letter. The notations on the margin, strangely enough, contain no reference to the favorable resolution of 1867 nor to the accompanying despatch, in which he had according to his opening address expressed himself as desirous of seeing the project carried out.

The supporters of Confederation, though temporarily defeated, were not downheartened. They placed on the journals of the Council a protest pointing out that the body were not representative of the community and did not in this vote reflect its opinions, which they alleged to be strongly in favour of union upon fair and equitable terms. The long standing negotiations for the transfer of the Hudson's Bay Company's rights had just been completed; and at this moment, when superficially in British Columbia the prospects appeared the darkest, the dawn was, in reality, about to break.

The session ended 15th March, 1869. In his closing address the Governor made no allusion, whatever, to Confederation. So far as he was concerned the disturbing topic was dead and buried. And this ends his official connection with the matter. He died, as is well known, on 10th June following, while on a mission of pacification to the northern Indians.

And here I would leave the discussion were it not that in his Recollections Sir Charles Tupper says: "Sir James Douglas, ex-Governor, a prominent figure in the early days of the colony, was opposed to Confederation. Until his eleventh hour conversion ex-Governor Seymour entertained similar views."[1] This statement appears to be based upon a remark in the life of Sir James Douglas to the effect that the promise of an overland communication finally

[1] P. 124, 126.

silenced Seymour's opposition.[1] His earliest despatch mentioned this factor as one which would induce him to support the project, and yet, as I have endeavoured to show, for two years thereafter he was found always upon the opposing side. No hint is to be found in any of the correspondence or in any of the hundreds of newspaper articles on the question to give the slightest colour to the suggestion that Seymour's views ever changed. The intense interest of the public in the question especially during its later stages, would have caused the vaguest hint of such a change in the Governor's attitude to be proclaimed from the housetops.

The letter written by Sir John A. Macdonald in 1869 correctly states the position of Seymour even to the time of his death. In that letter the Premier wrote: "I enclose a letter from a newspaper man [H. E. Seelye] in British Columbia to Mr. Tilley, giving, I fancy, an accurate account of affairs in that colony. It corroborates the statements of Mr. Carrall, whose letter I enclosed you some time ago. It is quite clear that no time should be lost by Lord Granville in putting the screws on at Vancouver Island, and the first thing to be done will be to recall Governor Seymour, if his time is not out. Now that the Hudson's Bay Company has succumbed, and it is their interest to make things pleasant with the Canadian Government, they will, I have no doubt, instruct their people to change their anti-Confederate tone. We shall then have to fight only the Yankee adventurers, and the annexation party proper, which there will be no difficulty in doing, if we have a good man at the helm."[2]

Perhaps the strongest proof of Seymour's influence in blocking Confederation is to be found in that fact that the same Legislative Council, which in 1869 under his guidance voted overwhelmingly against it, in 1870 under the guidance of Governor Musgrave voted unanimously in its favour. As complete a *volte face* as history records. But that, as Kipling would say, is another story.

I have now given you the facts with the manifest inferences. May I now be allowed to theorize? When the resolution of 1867 was introduced Seymour had formed no opinion upon the question. He wrote first to the Hudson's Bay Company, perhaps at the suggestion of some of its officials. The Company's answer raised the question of its rights in Rupert's Land. This afforded a reason for inaction which the Governor at once seized upon. The suggestion of Imperial aid to communication with Eastern Canada, he must have known from the earlier experience of the colony, would afford an extra

[1] Coats and Gosnell, Sir James Douglas, p. 312.

[2] Pope's Life of Sir John A. Macdonald, vol. 2, p. 143.

block. The new regime would mean the jeopardizing of the positions of himself and the other officials. For them, therefore, rather than for himself, opposition was necessary. To save his officials he refused to move in or in anyway aid the effort, and inaction ultimately grew into opposition. His known opinions strengthened the officials in their refusal to be sacrificed.

block. The new regime would mean the jeopardizing of the positions of himself and the other officials. For them, therefore, rather than for himself, opposition was necessary. To save his officials he refused to move in or in any way aid the effort, and inaction ultimately grew into opposition. His known opinions strengthened the officials in their refusal to be sacrificed.

The Legend of St. Brendan

By JAMES F. KENNEY

Presented by DR. A. G. DOUGHTY, F.R.S.C.

(Read May Meeting, 1920)

William Wycestre, a native of Bristol who became secretary to that Sir John Falstaff who gave his name, but nothing more, to Shakespeare's hero, left an *Itinerarium* in which appeared the following entry:

"On July 15, 1480, a ship . . . . of John Jay, junior, of eighty tons burden, began a voyage from Kingroad near the port of Bristol in search of the island of Brasylle, to the west of Ireland . . . . On September 18 news came to Bristol that they had sailed over the sea in the aforesaid ship for about nine months [probably we should read weeks] without finding the island, but in consequence of storms they had returned to a port in Ireland." [1]

On July 15, 1498, Pedro de Ayala, representative of Ferdinand and Isabella of Spain at the court of London, wrote as follows to those sovereigns, in reference to the discovery of land in the west by John Cabot in the preceding year:

"I think Your Highnesses have already heard how the King of England has equipped a fleet to explore certain islands or mainland which he has been assured certain persons who set out last year from Bristol in search of the same have discovered. I have seen the map made by the discoverer, who is another Genoese like Columbus, who has been in Seville and at Lisbon seeking to obtain persons to aid him in this discovery. For the last seven years the people of Bristol have equipped two, three (and) four caravels to go in search of the island of Brazil and the seven Cities according to the fancy of this Genoese." [2]

We can see what a very real connection there was between the popular ideas of mediæval Europe regarding strange islands out in the Atlantic, and the first voyages of discovery to America. These popular ideas were based mainly on two sets of legends, the Spanish legends of the Seven Cities, and the Irish legends of a wonderful land to the west, a land of many names, of which one of the most popular with the geographers of the later middle ages was "Hy Brasil."[3] In Ireland

[1] Nasmyth *Itineraria* (Cambridge, 1778) p. 267: quoted by Henry Harrisse, *Discovery of North America* (London, 1892) p. 659.

[2] H. P. Biggar, *The Precursors of Jacques Cartier* (*Publications of the Canadian Archives* No. 5: Ottawa, 1911) pp.27-28.

[3] *Cf.* T. J. Westropp "Brasil and the Legendary Islands of the North Atlantic" *Proceedings of the Royal Irish Academy*, vol. XXX (1912), sect. C, pp. 223-260; W. H. Babcock "The So-Called Mythical Islands of the Atlantic in Mediæval Maps" *Scottish Geographical Magazine*, May-August, 1915, pp. 261-269, 315-320, 360-377, 411-422.

there were many stories of this western land, but only one, the Legend of the Voyage of St. Brendan, passed into general European literature, because it alone was written in the Latin language. Put in form early in the tenth century, at latest, it was known very soon afterwards to the hagiographers of Brittany. It would appear from a quatrain in the old French *Roman du renard* that there was a *lai* of St. Brendan in the Breton language:

> Je fot savoir bon lai Breton,
> Et de Merlin et de Foucon,
> Del roi Artu et de Tristan,
> De chievre oil, de Saint Brendan.

However, the earliest translation still extant is that written in Norman French about 1121 for Alix, second wife of Henry I of England. Translations followed into Old French, Middle English, Flemish, Dutch, German, Italian, Norse. To the south it became one of the sources which inspired Dante's *Divine Comedy,* to the north, as Dr. Nansen has recently shown,[1] it probably exercised considerable influence on the shaping of the sagas relating to the discovery of "Wineland the Good." For these reasons the Legend of St. Brendan has more than a local interest for students both of history and of folklore.

I

The Historical Brendan

St. Brendan "the Navigator" died, according to the Annals of Ulster, in 577 or 583. The only other annalistic entry relating to him states that he founded the monastery of Clonfert, west of the Shannon river, in Galway county, in 558 or 564.

The earliest document mentioning Brendan, to which an approximate date can be assigned, is Adamnan's Life of St. Columba. Adamnan was abbot of Columba's monastery on the island of Iona, off the west coast of Scotland, from 679 to 704. The Life was written probably about 690. Adamnan mentions "Brendenus mocu Alti" in two places,[2] once when speaking of a monk who was said to have served Brendan twelve years, and again in connection with a visit which Brendan himself, accompanied by three other famous Irish churchmen, paid to Columba in the island of Hinba. Hinba has not been identified with certainty, but was some island on the Scottish coast closely associated

---

[1] *In Northern Mists,* 2 vols. (London, 1911). Chap. ix, "Wineland the Good, the Fortunate Isles, and the Discovery of America."

[2] *Lib.* I, *cap.* xxvi; *lib.* III, *cap.* xvii.

with Iona, possibly *Eileann na naoimh*, or Saints' island, near Scarba.[1] If this positive evidence were lacking, the sojourn of Brendan in the Scottish isles would be a reasonable inference from old Scottish traditions and the several place-names and church dedications associated with him in the islands and on the mainland of Scotland.[2] The Lives of the saint—which are, however, of much later date than Adamnan—give an account of this visit to Britain and state that he founded churches in Heth and Ailech. Heth—in Latin, Ethica—is the modern Tiree, and there is some slight reason to believe that Ailech was identical with *Eileann na naoimh* and Hinba.[3]

Mocu Alti, or Altai, the designation attached to Brendan's name in Adamnan's work and in the genealogies and other early Irish records, is a tribal name indicating that he was one of the Altraige, a division of the Ciarraige, the people from whom the modern county of Kerry derives its appellation. The Altraige lived in the north-west of Kerry, around Tralee.[4] This is the district to which the Lives assign Brendan's origin, and the modern place-names Brandon Bay, Brandon Point, Brandon Headland and Brandon Hill preserve the association.

The historical Brendan was, then, a sixth century churchman, a native of that wild western Irish coast the inhabitants of which have for untold generations looked out across the unbroken Atlantic. The greater part of his life was, doubtless, spent there or in his monastery of Clonfert up the neighbouring river Shannon. At some time during the sojourn of Columba at Iona, that is, within the period 563-597, he visited the equally wild west coast of what is now Scotland, and probably made a stay of considerable length among its many islands.

It was natural that a large maritime element should enter into the *acta* of such a saint. It was equally natural that whenever a Christian, or Christianised, myth of the sea should arise in Ireland it should attach itself to the name of Brendan.[5]

---

[1] W. Reeves *Life of St. Columba by Adamnan*, in W. F. Skene's *Historians of Scotland*, vol. VI (Edinburgh, 1874) app. I; Skene *Celtic Scotland* vol. II (2nd ed. Edinburgh, 1887), pp. 128 *et seq.*

[2] Skene, *op. cit.* pp. 76–78; A. P. Forbes *Kalendars of Scottish Saints* (Edinburgh, 1872) p. 286; P. F. Moran *Acta S. Brendani* (Dublin, 1872), p. viii.

[3] Skene, *loc. cit.*

[4] E. Hogan *Onomasticon Goedelicum* (Dublin, 1910), *s.v.* "Altraige."

[5] The fortuitous manner in which such myth material might find a personality to which to attach itself is illustrated by the story of the "Voyage of Bran, son of Febal," textually the oldest of these Irish "voyage" legends. Bran mac Febail is a name unknown to historical records. Thurneysen has suggested with much probability that it originated in a misinterpretation of the name of a promontory on the coast of Donegal, *Srub Brain*, "Raven's Beak." *Zeitschrift für Celtische Philologie*, vol. X (1915), p. 424.

II

The Historical Background of the Legend

Irish *acta sanctorum*—as other—were, as a rule, the production of a monastery which claimed foundation by the particular saint in question, or the possession of his relics, and of an age removed by several generations, or, indeed, several centuries, from the epoch in which he flourished. The extent and survival of the *acta* serve as an index to the importance of the monastery rather than of the saint. And although genuine historical tradition was usually present, in general the bulk of the matter reflects the age of the composer, not that of the hero. Now Clonfert became one of the great ecclesiastical centres of mediæval Ireland. Accordingly we find that the legend of Brendan was well developed and his *acta* comparatively numerous.

Christianity in early mediæval Ireland was dominated by monastic ideals. The country was organised ecclesiastically into a series of monastic churches and monastic church unions ruled by the successors, the "heirs," of the church founders of the fifth and sixth centuries. The spirit of asceticism pervaded these institutions, and displayed itself in many forms of self-mortification. One of the most general of these penitential practices was that religious exile which is designated in Latin *peregrinatio* and translated into English as "pilgrimage."

The "pilgrim" was not, as in modern usage of the word, one who made a journey to some definite locality in order to perform certain devotional exercises. The Irish "pilgrim" was a man who, from religious motives, left his home or his native land and went to reside for a period of years or for the rest of his life in another locality or in a foreign land. The command of God to Abraham—"Go forth out of thy country, and from thy kindred, and out of thy father's house, and come into the land which I shall shew thee" [1]—was regarded as having an application to Christians, as a counsel of perfection, and, as the call to sacrifice all that the Irish heart held most dear, seems to have exercised a peculiar fascination over the ascetics of the western isle. It is frequently quoted in the literature relating to these ancient religious exiles.[2]

Even in the sixth century men were passing "on pilgrimage" beyond the Irish coasts; in the seventh and eighth centuries this emigration movement grew to vast proportions. Some went east and south—to Britain and the continent; others north and west. Columba's voyage to Scotland and settlement at Iona was, there can be

[1] Gen. xii, 1.

[2] L. Gougaud *Chrétientés Celtiques* (Paris, 1911), p. 136.

little doubt, primarily such a "pilgrimage." Brendan's own sojourn there was, according to one of the Lives, "on pilgrimage." [1]

The voyages were made sometimes by single monks, sometimes by small groups. The vessels used were either wooden merchant ships, or, more often, those skin-covered coracles which are still found on some parts of the Irish coasts. Occasionally voyages may have been entered on in that fantastic spirit of religious fatalism of which a curious instance is related by the Anglo-Saxon Chronicle as late as 891:

> Three Irishmen came to King Alfred in a boat without any oars from Ireland; whence they stole away, because they would live in a state of pilgrimage, for the love of God, they recked not where. The boat in which they came was made of two hides and a half; and they took with them provisions for seven nights; and within seven nights they came to land in Cornwall, and soon after went to King Alfred.[2]

So we find Brendan in the Legend ordering the monks to ship oars and rudder and, leaving the sails unfurled, entrust themselves and the ship to the will of God.[3] Such a procedure was not unique, but must have been quite exceptional. The usual course was to travel in normal fashion to a destination already determined upon, or, if a hermitage among the islands of the west and north was sought, to make a carefully prepared exploring expedition in search of a suitable locality. That already in Adamnan's day, and probably in Columba's, such voyages were often of long duration and not always successful must be inferred from passages in Adamnan's work in which he tells of the experiences of one Baitan, who after long wandering, abandoned the attempt to find a suitable desert island, and of Cormac úa Liathain, who made three such fruitless voyages.[4]

Cormac was one of the three ecclesiastics who were with Columba and Brendan in the island of Hinba. His story as told by Adamnan has the appearance of a historical narrative just passing into legend, and we may assume that the Legend of Cormac was one of the forerunners of the Legend of Brendan. On one of these voyages, in which he spent several months, he visited the Orkneys and there owed his life to the intervention of the local king, to whom he had been recommended by Brude, king of the Picts, at the request of Columba. One voyage was a failure because, according to Columba, he took with him a monk who had left his monastery without the consent of the abbot. Analogous features of the Brendan story will be noticed. On the third attempt he sailed northward for fourteen days and was forced to turn

---

[1] Moran, *op. cit.*, p. 13.

[2] Ingram's translation.

[3] Jubinal's ed., p. 8.

[4] *Vita S. Columbae* I, vi, xx; II xlii.

back through encountering vast numbers of marine animals—a shoal of jelly-fish, say some commentators.

Archæological remains of the early anchorites are still in existence on many of the Irish and Scottish islands. Some of these retreats may well have been in the mind of the author of the *Navigatio Brendani* when he was describing the extraordinary islands which his hero found in the midst of the western ocean. Skellig Michael, which lies off the Kerry coast, about thirty-six miles south-west of Brandon Hill, was, as we know from the annals, an abode of religious in 824, when it was ravaged by the Northmen. It is a rocky mountain which rises to a height of 704 feet above the sea; on an artificial plateau at an elevation of 545 feet are the beehive shaped stone cells and oratories of the anchorites. The plateau was reached by a stairway cut in the rock, of which 620 steps remain. Away to the north of Brandon Hill, on the coast of Clare, is the rock known as Bishop's Island, or, to give the literal translation of the Irish name, the Island of the Starving Bishop. Its sides are perpendicular or over-hanging cliffs rising about 250 feet, and the top a barren expanse of about three quarters of an acre. Access to the top can be effected only after a long period of fine weather, and then with the greatest difficulty; yet on this barren top are some of the most interesting early Christian archæological remains.[1]

It has been seen that, according to Adamnan, writing about 790, Irish anchorites had reached the Orkneys before the end of the sixth century. In Adamnan's own time, or soon after, they had pushed on to the Faroes, and in another hundred years, before the end of the eighth century, they had discovered Iceland.

Dicuil, Irish geographer at the court of Charlemagne, is the chief source for these discoveries. Writing in 825, and speaking, it would seem certain, of the Faroes, he says:

> There are many other islands in the ocean north of Britain, which can be reached from the northern British Isles in two days' and two nights' direct sailing with full sail and a favourable wind. A certain conscientious priest told me that he had reached one of these islands by sailing for two summer days and a night in a small vessel with two benches for rowers. These islands are for the most part small, and are divided from each other by narrow straits. On them have dwelt for nearly a hundred years hermits who proceeded thither from our own Ireland. But now they are once more—as they were from the beginning—deserted by the anchorites, on account of the Northman pirates, but are filled with innumerable sheep and a great number of different kinds of sea-birds. We have never found these islands spoken of in written books.[2]

---

[1] Wakeman's *Handbook of Irish Antiquities* (3rd ed. by J. Cooke, Dublin, 1903), pp. 279 *et seq.*, gives a brief description of some of these islands.

[2] *De Mensura Orbis Terrae* VII iii.

It is to be noted that the Norse name Faroes also means Sheep Islands.

Of Iceland, which he identifies with the Thule of classical writers, Dicuil says:

It is now thirty years since I was told by certain Irish ecclesiastics, who had been on that island from the 1st of February to the 1st of August, that not only at the time of the summer solstice, but also during the days before and after, the setting sun at evening hides itself as if behind a small mound, so that it does not become dark for even a very brief space of time. . . . . A day's sail northward from it they found the frozen sea.[1]

Dicuil is an interesting personage. He was an Irishman who probably entered the monastery of Iona before 772, and went to the continent before 810, perhaps fleeing before the Viking raids on Iona of 802 and 806. He became closely associated with the Frankish court and may have been a teacher in the palace school. He wrote several books, of which the most famous is his geographical treatise, *De Mensura Orbis Terrae*.[2] Although mainly a compendium of classical sources, it contains an amount of original information and personal observation which for the time is truly remarkable. From it we learn that this man who had conversed with anchorites from Iceland and the Faroes had also, when a youth, listened to the narrative of one of a band of Irish monks who had visited Egypt and Palestine before 767, and himself in France had seen the elephant which Harún al Raschid, Calif of Bagdad, had presented to Charlemagne in 804. The recital of these facts is sufficient to make clear the possibility that streams of influence many and varied beyond immediate apprehension may have entered into the composition of the *Navigatio Brendani*.

Dicuil's testimony as to the residence of Irish monks in Iceland is corroborated and expanded by that of the Norsemen. The oldest antiquarian of Iceland, Are Frode Thorgilsson, in the *Islendingabok*,[3] written about 1130, after speaking of the first Norse settlements in the island, says:

There were Christians here whom the Norwegians called 'papar;' but they went away afterwards, because they would not be here with pagan men; and they left behind them Irish books, and bells, and croziers, from which it could be learned that they were Irishmen.

Similar statements are to be found in other passages of early Icelandic literature.

---

[1] *Ibid.*VII ii.

[2] Edited by Walckenaer (Paris, 1807); Letronne (Paris, 1814); and Parthey (Berlin, 1870).

[3] Published with English translation in Vigfusson and Powell's *Origines Islandicae* (Oxford, 1905), vol. I, pp. 279–306.

Did the Irish anticipate the Norse also in the discovery of Greenland and America? It is possible, but there is no evidence of weight. Dicuil's friends *may* have sailed beyond Iceland until stopped by drift ice, and others of whom no record has survived *may* have escaped the ice and come to land in the western hemisphere. Several passages in the Icelandic sagas indicate that there came into the Norse world, through their brethern who settled in Ireland in the days of the great Viking expansion, stories of a land to the westward which Norsemen, and possibly Irishmen, called "White Men's Land" and "Ireland the Great."[1] It was in the neighbourhood of "Wineland the Good," of which also, as Nansen has pointed out, the earliest knowledge displayed in northern literature seems to have come from Hiberno-Norse sources. But, as will be seen, there were other descriptions of lands lying out in the western ocean which were current in Ireland in the ninth and tenth centuries besides any authentic records of the discoveries of the anchorites.

III

The Versions of the Brendan Legend

The story of the voyage of Brendan is extant in many manuscript versions, almost all of which, however, can be classed as derived from one or other of two texts, a *Navigatio Brendani* which has been preserved fairly pure, and a *Vita Brendani* which has, in almost every manuscript, been contaminated by additions from the *Navigatio*. Sufficient material is available however, to make possible a very full restoration of the original *Vita*.[2]

The date of composition cannot be accurately determined. There is at least one tenth century manuscript of the *Navigatio*,[3] and it is manifestly a copy of an earlier *Vorlage*. Two Lives of the Breton,

---

[1] Landnámabók, Eyrbyggja Saga, Eiriks Saga Rauda. In Landnámabók the story of Ireland the Great is traced back to a certain "Ravn Hlymreks-farer," a Northman who had dwelt in Limerick for a long period, apparently about the beginning of the eleventh century.

[2] The Rev. Charles Plummer has published important studies on the relationships between the different versions of the legend in *Zeitschrift für Celtische Philologie* vol. V (1905), pp. 124–141, and in the introduction to his *Vitæ Sanctorum Hiberniæ* (Oxford, 1910). Critical studies of value are to be found also in Carl Schröder's *Sanct Brandan Ein lateinischer und drei deutsche Texte* (Erlangen, 1871); Gustav Schirmer's *Zur Brendanus-Legende* (Leipsic, 1888); Heinrich Zimmer's "Brendans Meerfahrt" in *Zeitschrift für deutsches Alterthum*, vol. XXXIII (1889), pp. 129–220, 257–338; and Alfred Schulze's "Zur Brendanlegende" in *Zeitschrift für romanische Philologie*, vol. XXX (1906), pp. 257–79.

[3] British Museum Addit. 36737, formerly of the Abbey of St. Maxim at Treves.

St. Malo,[1] originally written in the ninth century, contain considerable matter drawn from the Brendan Legend in both its forms, but this matter may well be interpolated, and therefore not much older than the earliest manuscripts, which are of the tenth century. It can be inferred that the *Navigatio Brendani* was composed not later than the first half of that century. The voyage portions of *Vita Brendani* seem older than the *Navigatio*, and it is very probable that those sections were themselves an interpolation into a still older *Vita* which contained no voyage matter except the account of the journey to Britain found in the later chapters. There can be little doubt, then, that the Brendan Legend had taken form at latest in the ninth century.[2]

The place of origin undoubtedly was Ireland. It is possible that the *Navigatio Brendani* may have been composed by an Irishman on the continent. Schröder thought he could trace its centre of dissemination in Europe to the lower Rhine valley, a region in which Irish scholars and ecclesiastics were numerous in the ninth and early tenth centuries.

In the *Vita Brendani* the saint's oceanic adventures are divided into two voyages, the first unsuccessful, the second successful.

The First Voyage[3] takes place soon after Brendan's ordination to the priesthood. He remembers the command to Abraham, is filled with a great desire to go on pilgrimage, and prays the Lord to show him a hidden land to which he may retire. He is told in sleep that his wish will be granted. Ascending a high mountain, he sees a beautiful island, and hears a voice saying: "As I promised the land to the people of Israel, and was their help that they should attain it, so do I promise you the island which you have seen, and will make good the promise in deed." Brendan then builds three skin-covered coracles, each holding thirty men, and sets forth.

---

[1] Edited by Dom F. Plaine and Arthur de la Borderie in *Bulletin de la Société archéologique d'Ile et Vilaine*, vol. XVI (Rennes, 1884), pp. 138–312.

[2] That is, more than one hundred years before the date at which Leif the Lucky is said to have discovered America.

[3] The following are the principal versions of *Vita Brendani:*

Two versions in *Codex Salmenticensis* (*s.* XIV), published by C. de Smedt and J. de Backer *Acta Sanctorum Hiberniae ex Codice Salmanticensi* (Edinburgh, etc., 1888) cols. 759–772, 113–154.

Version in the Irish language in the *Book of Lismore* (*s.* XV) and other MSS: Whitley Stokes *Lives of Saints from the Book of Lismore* (*Anecdota Oxoniensia:* Oxford, 1890) pp. 99–115, 247–261, 349–354.

Version in the Bodleian MSS. Rawlinson B485 (*s.* XIII or XIV) and B505 (*s.* XIV): C. Plummer *Vitae Sanctorum Hiberniae* (Oxford, 1910) vol. I, pp. 98–151.

Version in *Codex Kilkenniensis* (*s.* XIV): P. F. Moran *Acta Sancti Brendani* (Dublin, 1872), pp. 1–26.

John of Tynemouth's version in *Nova Legenda Anglie:* edited by Carl Horstman (Oxford, 1901), vol. I. pp. 136–153.

Version in the Irish language in various MSS. of the fifteenth century and later: R. Thurneysen *Zeitschrift für Celtische Philologie*, vol. X (1915), pp. 408–420.

They sail over the waters for five years, and see many islands, but not the one sought. They are nearly engulfed by a whirlpool, but Brendan calms it. [The Irish were, of course, familiar with the whirlpools resulting from tidal movements among the Irish and Scottish islands; that between Rathlin and the coast of Antrim is frequently mentioned in the early literature.] The devil alights on the mast and shows Brendan the mouth of hell; one of the monks asks to see it, and dies at the sight. Brendan revives him, but, we are assured, not without great labour. On a seacoast they find a dead girl of a stature of one hundred feet. Brendan brings her to life and baptizes her, after which she once more expires. [Resuscitation for the sake of baptism is a commonplace of hagiography, but the other elements of the episode bring into the Brendan legend the myth of the *muirgeilt*, "sea-wanderer"—an Irish variation of the mermaid story—who, according to the independent form of the myth, was baptized by Brendan's contemporary and friend, Comgall of Bangor.[1]] At length they come to an island with high, perpendicular sides [we are reminded of Bishop's Island], on which they see a church whence wonderful singing is heard. After they have long attempted in vain to land, a tablet is let down to Brendan telling him that it is not the island he seeks, and that he is to return home. This he does.

The Second Voyage follows soon after the first. Brendan visits St. Ita, who had reared him when he was a child, and is told by her that the cause of his failure is that he sought the sacred island in the skins of dead animals. He will find it in a ship built of planks. He acts on this lesson in contagious magic, and builds his ship. Sixty persons are taken on board, among them the carpenters and smiths—as we proceed we find there was only one smith, and probably only one carpenter—and a herald, or buffoon. They set out from St. Enda's monastery on the Aran islands in Galway bay. [This is probably a Connaught version, which had been modified when ocean going ships of the Viking model began to take the place of coracles on the west coast. As will be seen the *Navigatio* harmonizes the Connaught and Kerry versions, but ignores the wooden ship.] They come to an island where they are attacked by mice as large as cats. The buffoon sacrifices himself—we have all heard of the faithful serf—and receives heaven as his reward. The smith dies at sea, but what became of the carpenter, who in the original form of this version must also have been disposed of, we are not told. They come to an island filled with demons in the shape of pigmies, on which no one can land except him who has waged war and shed blood. Having anchored off it for seven days, they lose their anchor. Brendan blesses the hands of a priest, who then makes a perfectly good anchor—a magical acquisition of technical skill not unknown elsewhere in hagiography and folklore. They find an island where dwells an old hermit, the survivor of twelve who had come from Ireland. At his warning they fly from a monstrous cat which pursues them; Brendan prays, a beast rises from the sea, engages the cat, and both sink. The cat had developed from a "very friendly little cat" brought by the pilgrims at their first coming. [This also is an adaption of another Irish story which has independent existence.[2]] The old man shows them how to reach the land they sought, and then, after receiving the viaticum, expires. So the goal is finally attained. Here too they are welcomed by an old man, this one clad in feathers as clothes. He has been here for sixty years

[1] *Aided Echdach maic Maireda* in Standish H. O'Grady *Silva Gadelica* (London 1892), vol. I, pp. 233–327, II, 265–269. *Cf. Anecdota from Irish Manuscripts*, vol. III (Halle and Dublin, 1910), p. 10; *Annals of Ulster s. a.* 572.

[2] *Scéla an trir maccléirech*, published by Henri Gaidoz in *Mélusine*, vol. IV (1888), pp. 6–11, and by Whitley Stokes in *Lives of Saints from the Book of Lismore* pp. viii–x. See also Plummer in *Zeitschrift für Celtische Philologie* V 128 n.1.

and has awaited Brendan's arrival. He is fed by a bird which on this occasion brings half a loaf and part of a fish for each. [This is the only passage in the *Vita* dealing with the food problem, a problem which troubled at least one redactor. The author of the *Navigatio* makes a special point of solving the difficulty.[1]] After giving good precept and example to Brendan he bids him abandon his desire to spend the remainder of his days on the island, and return to teach the way of life to the Irish. His relics and those of his monks will be brought hither seven years before the day of judgment. [The final resting place of a saint's relics is always a matter of importance in Irish hagiography. The author has in mind the belief, which finds expression in the Book of Armagh,[2] written early in the ninth century, that Ireland would sink beneath the sea seven years before the judgment]. The hermit dies and is buried, and Brendan and his companions sail for home.

It would appear that we have here two traditions which have become attached to Brendan's name, one of an unsuccessful voyage in search of a place of hermitage, such as those of Baitan and Cormac úa Liathain, and the other a semi-Christianised myth of an expedition made in accordance with certain magical formula to a wonderful supernatural land lying in the ocean. These stories, decked out with Christian ideas regarding hell and the devils, and some accretions drawn from other sea myths, and the whole rather crudely joined together, were adopted by the monks of the churches which claimed Brendan as founder and inserted in his Life, partly because the fame of their patron was thereby exalted, partly, perhaps, because of the authority this imparted to their monastic rule, which would be the permanent record of that "way of life" to teach which Brendan had been ordered back from the supernatural land.

The *Navigatio Brendani* is a very different composition. It manifestly is a version of the same legend, but has been worked up to produce another result. Several of its episodes are evidently doublets of incidents occurring in the *Vita*, but for the greater part the details of the two narratives are quite distinct. The *Navigatio* is the work of a literary artist of high merit. The theme is the voyage only, not the life, of the saint, and the plot is much simpler and better worked out, while the narrative is enriched with an amplitude of incident and detail quite unknown to the other versions. Even yet the story has sufficient literary power to hold the reader's interest; in its own day this tale of the wonders of the sea—then to all minds the region of mystery and terror—told in a simple and free-flowing style, with its matter-of-fact tone and unfaltering resourcefulness of imagination, must have been most impressive. The author—or authors—drew freely from the resources which the geographical knowledge, the

[1] *Acta Sanctorum Hiberniae ex Codice Salmanticensi* col. 767.

[2] Edition by Dr. John Gwynn (Dublin, 1913), p. 30. Also in Whitley Stokes *The Tripartite Life of Patrick*, Part II (Rolls Series: London, 1887), p. 331.

literature and the folk-lore of Ireland and of western Europe offered, and shaped all with care to his own purpose. But that purpose was not solely, nor indeed primarily, to describe the wonders of the ocean. As we note the meticulous care with which he elaborates the precepts of Brendan, and the rules of life, the devotions, the method of observing the canonical hours, the psalms sung, the prayers said, the penances observed among the inhabitants, human and superhuman, of the oceanic islands, we come to realise that the author is painting a picture of the ideal monastic life. The *Navigatio Brendani* is the epic —shall we say the Odyssey— of the old Irish Church.

The *Navigatio Brendani*[1] opens with an account of a visit paid to Brendan at Clonfert [in the *Vita* the voyage is placed before the founding of Clonfert] by an abbot Barinthus [perhaps in Irish Barrfind] who is returning from a visit paid to a disciple of his, named Mernoc, the head of a community of anchorites, on an island, apparently in Donegal bay. He relates how Mernoc had taken him to a wonderful country, the "Land of Promise of the Saints" (*terra repromissionis sanctorum*). After his departure, Brendan and fourteen chosen monks decide to seek that land. They visit first Enda at Aran and then Brendan's native district in Kerry, where a coracle is built, apparently at Brandon Headland. [Here follows our best description of the construction of these skin-covered ships.] As they are about to depart three monks arrive who have followed from the monastery, and are allowed to come on board. After getting safely beyond geographical control by the device of a night wind that drives them they know not in what direction, they come to a lofty island, on which they are able to effect a landing only after three days. A dog guides them to a town and a wonderful palace where no living person is seen, but a banquet is miraculously set before them each day of their stay. [All this, of course, is part of the stock fairy lore of almost all lands.] When leaving one of the supercargo monks attempts to steal a silver bridle. At Brendan's upbraiding he confesses his fault, the devil is driven out of him in the form of a small Ethiopian, and he dies penitent. Next they come to the Isle of Sheep. [The name, at any rate, was doubtless derived from reports of the Faroes.] Here they are met by a man who provides them with food, and continues to do so at regular intervals during the whole period that they are on the sea. Easter eve and morning they spend on a neighbouring island. When they light a fire for the morning meal the island begins to move, and they escape just in time before it submerges. It is Jasconius, the largest of marine creatures. Next they come to the Paradise of Birds, where they ascend a river to its source, a sleep-producing fountain. Here they remain till the octave of Pentecost. Vast numbers of birds sing psalms and hymns to them at the canonical hours. They are fallen angels who, not having shared in sin, are permitted to remain here in this form. [A similar explanation is given by modern Irish folk tales of the origin of the fairies.] Next they come to the Island of the Family—that is, the religious community—of Ailbe. On this island are fountains of hot and cold water, and a monastery and church of remarkable construction. Twenty-four brethren have

[1] The most important editions of the original Latin text are: Achille Jubinal *La Légende latine de S. Brandaines* (Paris, 1836), pp. 1–53; Carl Schröder *op. cit.*; P. F. Moran *op. cit.* There is a critical examination of the manuscript texts by C. Steinweg, "Die handschriftlichen Gestaltungen der lateinischen Navigatio Brendani," in *Romanische Forschungen*, vol. VII, pp. 1-48.

lived here for eighty years, since the time of the saints Patrick and Ailbe, supernaturally supplied with food, and leading a life of the strictest monastic discipline. [There are several allusions in Irish sources to this overseas family of St. Ailbe. According to one of these, he wished himself to go to the island of Thule, but being prevented sent a band of his monks into exile over the ocean.[1]] In the church Brendan sees the candles lighted by a miraculous fire that enters through a window. Brendan and his people remain here from Christmas to the octave of the Epiphany. Throughout the whole seven years of their voyage they spend the same holy seasons at the same places, Holy Thursday and Good Friday at the Isle of Sheep, Easter on the back of the sea monster, Pentecost at the Paradise of Birds, from Christmas to Candlemas at the island of the Family of Ailbe.

At the beginning of Lent in the second year they visit another island having a soporific fountain, and soon after come to a place where the sea is coagulated. After leaving the Paradise of Birds they are pursued by a monster which threatens to swallow them, but is killed by another. Later they obtain a supply of meat from the body, all except Brendan, who never touches animal food. Some time later they discover a land variously named the Island of Anchorites, of the Three Choirs, or of Strong Men, where live three groups of religious, one boys, the second young men, and the third old men, who spend their whole time in devotional exercises. The second of the three supernumerary monks remains in this place. The next discovery is the Isle of Grapes, of which they have foreknowledge by a bird which brings them a branch loaded with huge grapes. [The grapes of Escol, and the dove returning to the ark, will be recalled.] The island is covered with trees which are heavy with the vintage, and has an abundance of edible herbs, and six springs of water. An adventure with a griffin, a creature otherwise little known to Irish myth, follows, and has an outcome similar to that with the sea monster in this narrative and with the cat of the *Vita*.

The author now passes over several years to bring us to the final adventures. Once, on the feast of St. Peter, the water was so clear that the bottom of the ocean and all the monsters of the deep could be seen. Hearing the voice of Brendan saying mass, they rise to the surface, to the great terror of the monks, but remain respectfully at a distance. Later they come to an immense column of crystal standing in the ocean and surrounded by a canopy of silver colour. With difficulty an entrance is effected, and four days are spent sailing under the canopy. [This seems to be in part based on some confused knowledge of icebergs, in part on the folk tale of the island supported on columns, usually on four columns, which is the number given in the *Vita*.[2]] The pilgrims are now approaching the confines of the infernal regions. They come first to the Island of Smiths, hairy and horrible creatures who, after hurling masses of fiery rock from their workshops at the visitors, give the whole island to flames. [The *goba*, or smith, is in Irish legend a person of magical, and sometimes of diabolical, attributes.[3]] Next they approach a volcanic island where the third supernumerary monk is dragged off by demons who are invisible to all but Brendan. Then follows what is, perhaps, the most remarkable product of the author's imagination, the description of Judas Iscariot sitting on a rock, buffeted by wind and water, where, partly because of certain slight acts of kindness performed

---

[1] *Cf.* Reeves *The Life of St. Columba Written by Adamnan*, p. 168, and Plummer *Vitae Sanctorum Hiberniae*, vol. I, p. clxxxiii.

[2] Moran *op. cit.* p. 23.

[3] *Cf. inter al.*, St. Patrick's Hymn.

by him when living, he receives a respite on Sundays and some holy days from his torments in the fiery mountain. The incident ends with Brendan successfully defying the demons and extending Judas' leave for some hours.

We are nearing the end. A lofty island is visited whereon dwells a hermit named Paul, an old man clad in white hair, who, having been a disciple of Patrick, came here by that saint's direction and has remained for ninety years, being miraculously supplied with food. [Variations of certain elements of the *Vita* will be recognised.] Paul tells them they are at the end of their wanderings. They spend the paschal season as in previous years, except that the sea beast Jasconius, as a farewell courtesy, carries them on his back to the Paradise of Birds. After forty days' sailing they pass through a dark cloud and land in a beautiful country, full of fruits and gems, where there is always sunshine. At the end of forty days they come to a great river which they may not cross. A youth of resplendent countenance appears and tells Brendan that this is the land he sought and that he had not found it sooner because the Lord wished to reveal to him the secrets of the ocean. [We may be certain that in an earlier form of the Legend this land could be attained only once in seven years. There is, or was, a tale told on the coast of Clare of a land which could be seen every seven years.[1]] He bids Brendan return home, assuring him that this land will be shown to his successors when the time of tribulation for Christians is at hand, and to all the elect when the Almighty has subjugated the peoples to Himself. They depart, pay a visit to the island called "of Delights,"[2] and arrive home, where Brendan soon after dies.

IV

The Background in Literature and Folk-Lore

The sources of many of the elements entering into the Brendan Legend have been indicated in the running analysis or can be readily deduced from what has been said as to the historical conditions amid which it arose. Irish churchmen would know from the experiences of their anchorite brethren, possibly also from their Norse enemies, of rocky islands, whirlpools, icebergs, perhaps of drift ice, volcanic eruptions, and small, shaggy beings who could serve on occasion as demons. The common stock of European folk-lore and saint-lore would furnish food bringing birds, talking birds, angels in bird form, banquets spread forth miraculously without human agents, supernatural food, sleep-producing fountains, dogs that guide strangers.

The sea-monster Jasconius is of more remarkable texture. The name is Irish—from *iasc*, still the usual word for fish. He is described as the largest creature of the deep, who is continually trying to join his head to his tail, traits which seem to identify him with the *Midgardsworm* of Scandinavian mythology. The facts that such a creature seems otherwise unknown to Irish myth, and that from the

---

[1] *Cf. Proceedings of the Royal Irish Academy*, vol. XXX (1912), Sect. C, pp. 251, 257.

[2] This seems to designate the island occupied by Mernoc and his monks.

ninth century onwards Irish associations with the Norse were very close, make the northern origin of these elements most probable, although it must be remembered on the one hand that Norse borrowings from Irish are being found to be much greater than hitherto had been suspected,[1] and on the other that the monster who lies in the outer ocean forming a circle around the world is one of the oldest of oriental ideas, going far back into early Babylonian mythology. The other element of the story, the mistaking of the monster for an island, until he alarms his visitors by beginning to move, seems to be of purely eastern origin. We know it through the story of Sinbad, but it is said to be found in Persian sources long antedating the Arabian Nights.[2]

From the east may also have come the idea of the miraculous fire lighting the candles in the church of the Family of Ailbe. It bears a suspicious resemblance to the Sacred Fire in the Church of the Holy Sepulchre at Jerusalem. And the volcanic phenomena, if not of Icelandic, are probably of Mediterranean provenance.[3]

Of literary sources the most obvious is the Bible: probably the Apocalypse of St. John was especially familiar to the author of the *Navigatio*. Heinrich Zimmer has shown that Vergil's Æneid served as a model to Irish authors of voyage literature, and may have been a direct inspiration for the story of Brendan. It would seem probable also that in some way a slight knowledge of the *Vera Historia* of Lucian and of the wanderings of Odysseus had reached early Christian Ireland. In any case, the classical ideas of the Fortunate Isles, the Islands of the Blest, were familiar, if not from older writings, then from the *Etymologies* of Isidore of Seville, the favourite encyclopædia of the Irish as of other mediæval peoples.[4]

But the chief immediate sources and models of our legend were undoubtedly the tales, in the Irish language, and largely pagan in origin, known as *immrama*, "voyages." [5] In pagan Ireland there must

[1] *Cf.* Nansen, *op. cit.;* Sophus Bugge *The Home of the Eddic Poems* (London, 1899); Alexander Bugge "The Origin and Credibility of the Icelandic Saga," *American Historical Review*, vol. XIV, no. ii (Jan., 1909), pp. 249–261; C. W. von Sydow "Tors Färd till Utgard," *Danske Studier*, 1910.

[2] Blochet *Sources orientales de la Divine Comédie*, par. iv, noticed by Plummer.

[3] Other elements possibly oriental in origin are noted by M. J. de Goeje "La Légende de St. Brandan" in *Actes du Huitième Congrès internationale des Orientalistes, 1889* (Leiden, 1891).

[4] *Cf.* Nansen *op. cit.*, vol. I, p. 345.

[5] Such as the tales designated "the Voyage of Bran, son of Febal," "the Adventures of Connla the Fair," "the Adventures of Cormac in the Land of Promise," and portions of "the Sick-bed of Cuchullain."

have been a widespread belief in a happy oversea land where divine beings dwelt and whither they sometimes invited mortals. Thither in pursuit of fairy women went Connla son of the High King Conn, and Oisin son of Finn, and Bran son of Febal. It was known by many names—the "Land of the Young," "Land of the Living," "Happy Plain," "Great Strand," and in more modern documents *Hy Brasil* and *Tir na Fer Fionn.* This last would be the exact equivalent of the Norse "White Men's Land," but it has not been shown to have been in use in mediæval times. Heinrich Zimmer, who made an elaborate study of the Brendan Legend, elucidating in particular its associations with Irish saga-literature, has pointed out that by the eighth century the term *tir tairngiri*, "Land of Promise," the Christian Irish designation of the Land of Canaan and of the Heavenly Kingdom, was getting itself associated with the other title, *tir innambeo*, "Land of the Living Ones," which meant the overseas pagan elysium. Such an association is behind our "Land of Promise of the Saints," and behind the whole conception of the Christian voyage literature.[1]

There are three such voyage tales in the Irish language each containing many passages identical in substance with parts of the Brendan Legend—"the Voyage of Maelduin," "the Voyage of the Húi Corra," and "the Voyage of Snedgus and Mac Riagla." The last two are of much later date, and the resemblances in their case may be due to direct borrowing. The relations between the Brendan and the Maelduin story are not so clear. It seems certain that in the main the Maelduin legend is older than that of Brendan: Zimmer has argued that it was the model upon which and the quarry out of which Brendan's Voyage and the later *immrama* were constructed. But it appears probable that there was also a re-action, and that the Voyage of Maelduin, which was evidently a pagan, or at least secular, tale which passed through a Christianising development, contains in its present text passages that are really later interpolations from the Brendan story.

The following brief summary of the more strikingly analogous incidents in the romance of Maelduin will make clearer what has been said:

Maelduin[2] wishes to go in pursuit of the murderer of his father, who lives in an island near the Irish coast. He consults a druid and receives precise directions as to how his ship is to be built. It is a coracle of three hides, and is to carry exactly

[1] A feeling of the need of reconciliation between the two ideas evidently inspired some of the opening passages of the "voyage" section of *Vita Brendani.*

[2] The prose version of *Immram Curaig Maileduin* was published, with translation, by Whitley Stokes in *Revue Celtique*, vol. IX (1888), pp. 447–495, X (1889) 50–95, 265. There is a French translation by Ferdinand Lot in Arbois de Jubain-

sixty men. Unfortunately Maelduin breaks the magical formula by taking on board at the last minute his three foster-brothers. Because of this they are driven out to sea by a storm. After various adventures they come to a palace where a meal is spread out for them. When they leave one of the foster-brothers attempts to steal a neck-band, and is slain by a little cat. They come to an island where everyone is weeping, and the second foster-brother, landing, begins to weep also, and cannot afterwards be distinguished. The third brother is lost in a like manner on the island of laughter. Other passages to be noted are the description of the island of singing birds; of the old hermit clad in white hair who is fed by angels; of the island of smiths; of the transparent sea; of the silver pillar with canopy of silver; of the island supported on one pillar; of the bird that carries a branch laden with large, grape-like fruit; of the old hermit who, like Paul of the *Navigatio*, had been a grave-digger, and now tells Maelduin that his voyage is at its end.

It is evident that we have in Maelduin and Brendan two elaborate, and intimately related, literary developments, the one in Irish, the other in Latin, of the folk-lore and mythology of ancient Ireland, gathered around the central theme of a "happy otherworld" situated in the western ocean. Of that central theme Alfred Nutt published an extensive study in connection with Kuno Meyer's edition of "the Voyage of Bran son of Febal."[1] The relationships he thought to find with the elysium beliefs of other races seem in some cases far-fetched, but his conclusion is, perhaps, sufficiently conservative: "The vision of a Happy Otherworld found in Irish mythic romances of the eighth and following centuries is substantially pre-Christian; it finds its closest analogues in that stage of Hellenic mythic belief which precedes the modification of Hellenic religion consequent upon the spread of the Orphic-Pythagorean doctrines, and with these it forms the most archaic Aryan presentment of the divine and happy land we possess."

---

ville's *Cours de littérature celtique*, vol. V: *L'Epopée celtique en Irlande* (1892), pp. 449-500. An English translation, not very close, was published by P. W. Joyce in his *Old Celtic Romances*, and was used, he tells us, by Tennyson as the basis for his poem on the subject. The version in verse has been edited by R. I. Best and Kuno Meyer in *Anecdota from Irish Manuscripts*, vol. I (Halle and Dublin, 1907), pp. 50–74, and by Kuno Meyer in *Zeitschrift für Celtische Philologie*, vol. XI (1916), pp. 148-165.

[1] *The Voyage of Bran son of Febal, to the Land of the Living An Old Irish Saga edited and translated by Kuno Meyer, With Essays upon The Irish Vision of the Happy Otherworld and the Celtic doctrine of Re-birth by Alfred Nutt*, 2 vols. (London, 1897).

Humours of the Times of Robert Gourlay

By WILLIAM RENWICK RIDDELL, LL.D., F.R.S.C., Can.

(Read May Meeting, 1920)

Robert Fleming Gourlay the Neptunian and Banished Briton was a man thoroughly in earnest; his high sense of public duty, his devotion to the cause of the poor, his absolute truthfulness, his perseverance in the path of what he considered right all recommend him to serious respect while his shameful treatment at the hands of the authorities of Upper Canada a century ago, his unmerited sufferings, his spirited if misguided conduct throughout the disgraceful prosecution move our sympathy and ensure our regard. We forget his self centredness, his egotism, his jealousy of anyone else occupying the stage and receiving the attention of the country, his unreason and wrong headedness in his search for justification. So much so that there has grown up a Gourlay myth—he is the father of Responsible Government who publicly cried "Responsible Government; what has that effected? An unblushing waste of public money and a monstrous debt.—"[1] the forerunner of William Lyon Mackenzie and the protagonist of political reform—he who despised Mackenzie and lampooned him as a monkey, who dubbed him the "self styled Patriot Hero of Navy Island and Prince of Mischief makers"[2] and who had no thought of reform anywhere but in the economic field[3].

Serious as he was, seriously as he was considered by the authorities of the Province, serious as were his wrongs and his sufferings, his career was not without its humorous accompaniments and these or some of them it is the object of this paper to state.

Born in the ancient "Kingdom of Fife" and with more than usual perversity[4], he left his native land after a quarrel with the Earl of Kellie over what he took it into his head to consider a deadly insult, which, when investigated boils down to the simple fact that the Earl being in the chair of a public meeting adjourned the meeting when Gourlay was speaking—whereupon Gourlay wrote and circulated a vicious pamphlet against him.[5] He went to England and rented a farm from the Duke of Somerset; he got into a mass of litigation with his landlord to compel him to give him a lease which Gourlay had himself refused to sign when offered to him. While he won some of his litigation he was deprived of costs because before the Lord Chancellor he jeered at the Duchess as wearing the breeches.[6]

Then he came to Canada; intending to return in six months,[7] he was bitten by mosquitos so badly that he was laid up two months and so prevented from returning.[8] Thus he was detained in Upper Canada to become a storm centre for two years.

His early Addresses to the people of the Province were, *bonâ fide*, to obtain economic information, but the foolish opposition of the official set forced him into politics. It is not proposed to go into his campaign efforts here; the story can be read in his several writings.[9] Only certain matters which have elements of humour will be referred to.

Travelling in the eastern part of the Province holding public meetings in support of his schemes, he passed through Brockville "outwardly a delightful place, and when it contains as much honesty as pettifogging law will be truly enviable"[10], at Johnstown a Justice of the Peace, Duncan Fraser by name, made a violent and unprovoked assault upon him; pleading guilty of the assault the Magistrate was fined 40 shillings ($8) while one Grant, a by-stander, who had tried to keep the peace, but struck back when Fraser struck him was fined £5 ($20) and imprisoned for one month!![11] At Kingston he got into controversy with Christopher Alexander Hagerman, a lawyer of note, and afterwards Attorney General and Justice of the Court of King's Bench. Hagerman said Gourlay "must have a Dolt's head," a friend of Gourlay's replied referring to Hagerman's "false, foolish and impertinent letter," and Gourlay thinking honours were easy let the matter drop for a time—he was right, however, and the lawyer was wrong in the law[12]. But he soon published a statement that Hagerman's brother was a felon and had been hanged, excusing himself afterwards by the grotesque explanation "that he had reason to thank me for openly declaring what was said of him that he might at once put an end to the story . . . by making his appearance." Hagerman horsewhipped him, and a magistrate put an end to the affray[13]. The original recognizance requiring of Hagerman to keep the peace for a week is now at the Canadian Archives at Ottawa.[14]

Returning to York, Toronto, he in July, 1818, attended a meeting of the "Friends of Enquiry," *i.e.*, those who supported his scheme of petitioning the Prince Regent (the Home Government) to enquire into the affairs of the Province. The proceedings of the "Convention" (as it was unfortunately called) are duly recorded by Gourlay.[15] and they are serious enough. But there happened to be in York shortly after the time a "well known character" from Kingston, Amos Ansley, "Yeoman Ansley," living on Lot No. 12 in the First Concession of the Township of Kingston; he was a chronic "kicker," rather more than eccentric. We find him complaining to William Dummer Powell, "Chief Justice in the Province of Upper Canada," of Thomas Markland not putting in their proper place the monuments marking the limits of the lots in that Township "to the Great Damage of the Inhabitants and the Total Subversion of the King's Peace"—worse than that, "he sanctioned the Act of a Rebellious Mob who had laid Violent hands on the Body of Amos Ansley, the said Ansley Being in the Peace of God and the King alone, and in Quiet on the Kings Highway in 1812 and Committed him to Prison without an oath and without a Trial. No eye to pity No Hand to Save."

The Judge not granting relief, Ansley had applied to the Church and wrote to "the Reverend George Okil Stuart" in the name of God requiring him to admonish Thomas Markland to order Mr. James Nicol to set the monuments so as to "protect His Majesty's Subjects in the Land that was allotted to them when this Country was a howling wilderness," and if Ansley is not settled with "when the Grand Jury is sworn it will Be to Late—there Has Been as Great Men as Him Indicted for f. and H.T."[16]

Notwithstanding the adjuration, "Remove not the ancient Land Marks which they fathers Have Set Proverbs cXX v 20 Deuteronomey XIX, 15, 16, 17, 18, 19, 20, 21, c XXXII, 17"—the appeal to the clergyman seems to have been unsuccessful. Thereupon Ansley sent it to Sir Peregrine Maitland, "Governour," for the attention of His Majesty's Attorney General. As he endorsed the words "Sleepy and Lazzy Priests that Nither Serve God Nor the King," it is not wholly astonishing that the Attorney General endorsed the paper "From Amos Ansley Transmitting some very ridiculous papers."

Some wag seeing Ansley in York wrote and printed a travesty of the proceedings of the Convention and a copy was handed to Ansley by Ezekiel Benson at York, July 22, 1818. This "skit" endorsed by Ansley, "We Never Ware Rebels and we Never will Be"—"This is a Liebill published in the Town of York for which the Yorkers shall Be Indicted for publishing the said Scandalous Libill," was also sent in to the Governor for the Attorney General. And when one reads it, one cannot think that Ansley is too emphatic when he calls it a Libill.

It reads thus:—[17]

"At a Meeting of the Representatives from the different Townships, assembled in General Convention, for the redressing of all public grievances in the Province, held at York, at Mr. Forest's Hotel, on Monday, the 6th of July, 1818:

PRESENT,

Robert Gourlay, Lewis Ketchum, John Clap, George Hamilton, William Brushum, Peter Hogboom, John Wright, Abel P. Forward, Robert Hamilton, Henry Segar, David Damwood, Benoni Wells, Adam Dills, Daniel Washburn, George Yocum, William Kerr, John Rose, John Clark, John Dickhout, Hugh C. Thompson, Peter Snitzer, Lieut. Col. Richard Beasly.

RESOLVED, that the thanks of this assembly are due to Mr. Gourlay for all he has done and suffered in the great cause; for the industry with which he has circulated his calumnies, and the patience with which he has borne chastisement for them,

RESOLVED, that for the perfect security of the public money, collected for the defraying the expences of the Commissioners to and from England, it be placed in the hands of our right trusty friend Barnabas Bidwell, Esquire; who shall proceed with the Commissioners as their travelling Treasurer. And it is farther resolved that the said Barnabas Bidwell be particularly advised, for certain reasons, not to proceed with it to England through the United States.

RESOLVED, that Mr. Amos Ansley, as the most respectable in appearance of our body, be selected to present the petition to his Royal Highness the Prince Regent, at the foot of the Throne. And that before the said Amos Ansley proceed on his mission, a commission of Lunacy be appointed, to enquire whether there are any immediate symptoms of approaching madness.

RESOLVED, that Mr. Robert Hamilton, Mr. John Clap, Mr. William Kerr, Mr. Peter Hogboom, Mr. John Clark, Mr. George Yocum, and Mr. George Hamilton son of the late Hon. Robert Hamilton, be a committee to accompany the said Amos Ansley, and that they be particularly careful for the creidt of the Representatives, that the said Amos Ansley do not run naked about the streets of London, blowing horns or trumpets, as he has been occasionally wont to do.

RESOLVED, that the Convention being rather short of grievances, will defer sending home their Petition, for two months, during which time, any person who will furnish them with any general grievance, or with any particular lie against any person in office (or otherwise respectable,) sufficiently scandalous to be unanimously adopted by the representatives, shall be paid Twenty Dollars out of the Public Fund, so long as it lasts; and if the said particular lie shall concern the Reverend Dr. Strachan, they shall be paid five dollars additional —or any of his pupils, two dollars and a half.

RESOLVED, that Mr. Gourlay shall be at liberty to make up a contingent account for plasters and bandages, and shall be allowed

3s, 6d. for every kicking, and 5s for every horsewhipping: and it is further Resolved, that an Address of condolence be presented to our loyal and patriotic captain George Hamilton, for the additional loss recently sustained in the wreck of his curricle, on the road between Belleville and little York, from want of his horses having the accomplishment he so elegantly recommends "of giving a long pull, a strong pull and a pull both together" which deprived this committee of the benefit of his transcendant abilities, and himself the opportunity of displaying his dignified oratory.

RESOLVED, that it is proved to the satisfaction of this meeting, by the evidence of Mr. Gourlay, and by inspection of his person, that the inhabitants of the Midland, Johnstown and Eastern Districts, are violent friends to their King, Country and Constitution, and therefore deserve the marked disrespect of every well wisher of our great cause.

RESOLVED that it is a grievance that our streets are not paved—that we have no city as large as New-York—that all our English and Scotchmen are not Yankees—and that Canada is not somewhere in the Genesee country.

RESOLVED, that little York is a great nuisance.

RESOLVED, that it is a grievance that all the people of the lower Districts have not more money and less wit.

RESOLVED, that it is a grievance that the government is administered in the manner it is—upon which it was moved in amendment by Mr. Gourlay and voted by acclamation as the unanimous sense of the Representatives, that it is a much greater grievance, that there is any government at all.

RESOLVED, that it is the opinion of this meeting, that the Attorney General has been guilty of gross derelection of duty, and brought down upon himself the odium and contempt of the most respectable body of the community, and particularly of the members comprizing this convention, in assuming the power of proceeding ex officio against the first and only champion of Democracy, Liberty and Equality, that has appeared since the time of our much lamented friends, WILCOX, MALLORY and MARACLE.

RESOLVED, that it is a grievance, that there are no more grievances.

RESOLVED, that for the redress of all these grievances, and particularly of the last, His Royal Highness be specially requested by Amos Ansley to appoint him Lieutenant-Governor, Mr. Barnabas Bidwell Receiver-General, Mr. Casey Chief-Justice, Mr. Washburn Attorney-General, Mr. Patrick Strange Secretary of the Province, Mr. James Durant Inspector of Public Accounts, and Mr. Gourlay Superintendent-General of all Departments, with a general exemption from all prosecutions for all felonies, treasons, libels and seditions.

RESOLVED that the Rev. Dr. Stachan be commanded to desist from instilling into the minds of the Youth of this Province the pernicious principles of loyalty and attachment to the Constitution, and that Mr. Amos Ansley, Mr. Hamilton and Mr. Kerr be directed to afford such encouragement as their friends will warrant, to Mr. Hone, to return with them to this Province to bring up our Children in the way of piety and virtue.

That Amos Ansley make it a point with His Royal Highness the Prince Regent that little York shall be blown to atoms—that Major Simons' half pay shall be struck off and transferred to Captain William Kerr as a matter of Justice—that Mr. Gourlay's letters from his dear wife be forwarded by a Special Messenger once a week, and that henceforth to preserve purity of morals and decency, order and decorum throughout the Province, Mr. Robt. Gourlay have absolute control over the Press, that nobody's lies, and scurrility may be published but his own, or that of his intimate friends."

The Meeting then adjourned to Tuesday.

Endorsed by Ansley.

"Received this from the Hands of Ezekel Benson at York, U.C., this 22d day of Feby. 1818.

AMOS ANSLEY.

We Never were Rebels and Never will Be.

We wish to reap the frutes of Our Labour and keep the King's peace.

AMOS ANSLEY.

Kingston,
August the 2d 1818

Let us pass over a score of years—Gourlay had been banished, had gone to the old Land, deluged King and Parliament with Petitions, horsewhipped Henry Brougham in the Lobby of the House of Commons, remained in prison at Cold Bath Fields for many months because on principle he would not give bail or allow his friends to bail him, worked on the road as a pauper where he had been a prosperous farmer, contemplated suicide but compromised by some more petitions, returned to this Continent the Neptunian and Banished Briton, repudiated Mackenzie and all his works, and came to Upper Canada in 1838 to see Lord Durham, then on his mission of enquiry and conciliation. Failing to see Lord Durham he consoled himself by writing a lampoon on him.

"A brief but sufficient and very faithful history of the Durham Administration—written a few days after receiving the above trifling letter from Couper,[18] October, 1838,"

A Durham Ox came o'er the sea
And landed at Quebec;
Canadians all were on their knee
And instant at his beck.

The Durham Ox moved up the burn
To see the muckle Falls.
The Buffaloes, on Erie's bank,
Thought he was come to balls.*

They asked if he would feed with them
And said their grass was good;
But the Durham Ox turned round his tail
And down the burn he stood.

The Durham Ox, now tethered fast
Upon Victoria's lea,
Bade Yankees come from every town
His mightiness to see.

The Durham Ox looked smooth and sleek
The Yankees, they seemed wondrous meek,
But yet were very pawkie
And after all the shows he made
They thought him but a gawkie.

And now the truth is wholly out;
Nor need we any longer doubt
So all the world may fairly laugh,
To think the Ox was but a Calf.

*It will be remembered that Lord Durham gave a ball to the gentry of Buffalo and they in turn expected him at a civic feast (Gourlay's note).

Perhaps Durham never saw this effusion and if he did he probably despised it.

The next year Gourlay thought "the church itself wholly militant. Episcopalians maintaining what can never be established. Presbyterians more sour than ever contending for right where they have none whatever.[19] Methodists so disunited that they cannot even join in a respectable groan and Catholic Priests wandering about in poverty because their scattered and starving flocks yield not sufficient wool for the shears": and when he came to the Legislature in Toronto and when the Members of the House of Assembly refused to hear him at their Bar, he sought comfort by breaking out into verse again:[20]—

A monkey once sprung up aloft
And gibbered in the trees:
The bears and wolves began to dance
And bum went all the bees.

A shot or two being fired at Pug
Away the creature scampered
And truly it made unco speed,
With bulk being little hampered.

Arrived at Jonathan's outpost
And perched up in the playhouse
A farce began which, right to scan
No man could say it was douce

Douce, did I say?—hoot man away;
'T was really sad and sadder
For men to Buffaloes were turned
And they grew mad and madder.

They gored the ground; they cocked their tails;
They flung up the dust; they trod down rails
And nothing could withstand them;
Till great Van Renssellaer stepped forth
And said he would command them.

To Navy Island quick they marched,
And quick were in possession.
Quick ran the news across the land
To Parliament in session.

Sir Francis said "My dear McNab,
Rise from the chair, mount any cab,
And rouse the men of Gore;
Now I'm awake, good care to take
That no one else shall snore.

When I sprung out of Romney March
Just like a little spunkie
I never dreamt of aught so harsh,
As fighting with a monkey.

But since it is my knightship's fate,
Do you go forth and thunder,
That you may rise, in royal eyes,
And then, we ne'er shall sunder.

Sir Francis, I—Sir Allan you—
The Yankees we will humble
And this cursed ugly monkey now
Out o'er the Falls we'll tumble."

Britannia's flag you now may see,
From Drummond's Hill to Fort Erie
While thousands range around;
With shot and sheel the trees they fell
And make a mighty sound.

—Fifean.

Edinburgh Castle, May 6, 1839.

A similar want of success in 1840 drove Gourlay again to rhyme—he already drank as became his time and country—nascetur ridiculus mus[21]

Good lauk, what next!—a boat unfixed—
The little Caroline
Cut from the ice; and all so nice
Now on the lake doth shine.

A spec!—a spec!—a glorious spec!
The Buffaloes roar out,
Victoria's wealth is all our own,
And Canada no doubt.

We'll moor the boat—we'll store the boat,
With "*articles of freight*"
And when our flag is hauled aloft
We'll swear the whole is right.

For trade is free to all the free,
And we're the sons of freedom,
We'll freedom take, there's no mistake
Nor need we longer dread 'em.

Ah, Jonathan! Ah, Jonathan!
Thou art a boastful loon;
But there's a God above, I trow
Will make you change your tune.

Snug in your port, you deem it sport
To laugh at human woe;
But God above will you reprove
And that you soon shall know.

It matters not what are His means,
Or what you call the deed.
The whole is rightly ordered, man,
Your wickedness to feed.

To make you stamp, to make you swear,
To show you off a good long year,
That all the world may know—
Till human nature better is
You have no right to crow.

Look back to Malden and Pelé,
The Short Hills interlude;
Look back to Prescott's bloody field,
And Windsor, still more rude.

All villainous—most villainous!
Not one redeeming act,
Historians cannot better it.
Nor e'er dispute the fact.

But when we think upon the thing
That led you on to war;
A monkey vile chock full of bile,
It beats the Globe by far.

The monkey first made you to thirst,
For acres and for dollars;
And now in cage, it spends its rage
On Uncle Sam's tight collars.

Robert F. Gourlay.

Edinburgh Castle, Feb. 5, 1840.

NOTES

MEMO:—In these notes the contraction

"Gour" is used for my work "Robert (Fleming) Gourlay as shewn by his own Records," Ont. Hist. Soc., Toronto, 1916.

"Nep." "The Banished Briton and Neptunian," No. 1, or "The Neptunian," Nos. 2–39.

[1] "Mr. Gourlay's Case/ Before the/ Legislature/ with His/ Speech/ Delivered on Wednesday, July 1, 1858/ In Two Parts/ Toronto/ Printed at the Globe Book and Job Office /1858."

This 8vo pamphlet of 29 pages contains Gourlay's speech before the Legislative Assembly of Canada, July 1, 1858, in his own behalf—a real *Apologia Vitae* which he was permitted after much opposition to make, something he had been long striving for—it is rather a poor performance evidencing "either complete loss of control of himself or a marked weakness, bodily or mental." See Gour., pp.112, 126.

[2] Gour. 83, 91. 122: Nep. No. 2, 6; No. 7, 72.

[3] Gour. 17.

[4] I have often heard Scotsmen—generally of other parts of Scotland, be it said—assert "a' Fifeshire folk are a bit cracked": my own experience has been that they are more than usually astute, perhaps "pawkie" is a better word.

[5] Gour. 8, 55, 56.

[6] Gour. 10, 56; 83; Gourlay v. Duke of Somerset (1812) 1 Vesey & Beames' Chancery Reports, p. 68.

[7] Gour. 14, 56; Nep. No. 1, p. 15; No. 17, p. 180.

[8] Gour. 15, 57; Nep. No. 25, p. 305, n. 6, p. 308 n.; Nep. No. 22, p. 238 n.

The critics—mali homines—will no longer allow us to read the "Culex" as Vergil's: and the "cana culex" of Plautus they say is an old rascal of a lover; but one feels like saying "eho tu . . . . cantrix culex" to our native songstress.

[9] My life, "Gour" gives an abstract of most of these—those interested are referred to that volume for a full account of Gourlay's extraordinary life.

[10] Gour. 27.

[11] Gour. 28, 29.

[12] Gour. 29, 59.

[13] Gour 29.

[14] Canadian Archives, Sundries, U.C. 1818.

[15] Nep. No. 30, p. 427; "Chronicles of Canada, 1818," pp. 17–20. See note 17 (infra).

[16] Of course "Felony and High Treason," a phrase in very wide use in those days against all who expressed their discontent against the Government, however mildly.

[17] The fact that the meeting was called a "Convention" was used by the Government party to compare it to the "Conventions" of the French Revolutions and so to discredit it as being republican and anti-British. I give an abstract of the meetings taken from "Chronicles of Canada, 1818," pp. 17–20.

Meetings of the Upper Canadian Convention of Friends to Inquiry, York, Monday, July 6, 1818.

For the	*Present.*
District of Niagara	Robert Hamilton, Esq. John Clark, Esq. J. P. Dr. Cyrus Sumner (Major William Robertson reported absent from sickness)

District of Gore	Richard Beasley, Esq. J. P. Mr. William Chisholm.
London District	Mr. Calvin Martin.
Western do	Mr. Roderick Drake.
Midland District	Daniel Washburn, Esq. Mr. Davis Hawley. Mr. Paul Peterson. Mr. Thomas Coleman, Esq.
District of Newcastle	Mr. Robert J. Kerr.
Johnstown District	Mr. Nathan Hicok
Ottawa do	....
Home do	....

(Gourlay addressed the Convention at their request but was not a member.)

Richard Beasley J.P. in the Chair.
William J. Kerr Secretary and
Daniel Washburn Assistant Secretary.

Board of Management met at Ancaster, July 21, 1818; and drew up a Petition to the Prince Regent.

Present Richard Beasley,
William Kerr,
William Chisholm,
John Clark,
George Hamilton
and Roderick Drake.

The Board of "Permanent Committee" met again at St. Catharines, August 1, 1818; had the Petition engrossed, signed and ordered to be transmitted to England.

Present Richard Beasley,
George Hamilton
Roderick Drake
William Kerr
and John Clark.

It will be seen that the eastern part of the Province which had been canvassed by Gourlay himself was poorly represented.

Some of the persons named in the parody may be more particularly referred to here.

Barnabas Bidwell, the father of the more celebrated Marshall Spring Bidwell, had been guilty of defalcations as Treasurer of the County of Berkshire in Massachusetts—hence the suggestion that he should be Treasurer and keep out of the United States on hls way to England.

George Hamilton was the founder of the present City of Hamilton; I do not know the occasion of the wreck of his curricle.

The antics of Amos Ainsley were notorious but I cannot find that he actually ran naked at any time.

Gourlay had been entrusted in May, 1818, by the Niagara Committee to look after the Midland, Johnstown, Eastern and Ottawa Districts—he had little success and by the time he reached Cobourg on his way west he was clearly in bad odour. Gour. pp. 26 sqq.

The Attorney General was John Beverley Robinson, who, apparently indifferent at first to Gourlay and his movement, soon became satisfied that he was a dangerous demagogue. It seems reasonably certain that he was influenced by the Reverend Dr. Strachan, whom Gourlay attacked without mercy and whom he affected to despise. The Information *ex officio* referred to is one of the most discreditable proceedings of the time. Gourlay's Address headed "Gagg'd-Gagg'd by Jingo" was published in the *Niagara Spectator*, December 3, 1817; Isaac Swayze laid an information against Bartimus Ferguson, the editor of the paper, and Ferguson was arrested and placed in Niagara Gaol. But this prosecution dropped and he was released. June 28, 1818, Gourlay sent another article to the *Niagara Spectator* which published it—it is said in the absence of the editor; the article attacked the Members of the House of Assembly, sycophants around the Governor who was making a fortune out of the taxes of Canada, spoke of "poor Peregrine . . . . a thing called Excellency a British General who forgets the laws of honour, of prudence, feeling, justice," etc., etc.

The House, July 5, voted this a "scandalous, malicious and traitorous libel" and requested the prosecution of author, printers and publishers. Gourlay was let alone, but Bartimus Ferguson, the editor, was prosecuted on an Information *ex officio*. He was arrested at Niagara, brought to Toronto, produced before the Full Bench of three Judges and sent to Niagara for trial. Tried at the Niagara Assizes, defended by Thomas Taylor, our first Law Reporter, he was convicted and sent to gaol. In the following term he was brought to York and sentenced to pay a fine of £50 and to imprisonment in the Common Gaol at Niagara for 18 months, to stand in the pillory for four hours, and to give bonds for good behaviour for 7 years, remaining in prison until the fine was paid and security given. Ferguson made a humble submission and part of his punishment was remitted. Gour. 39, 50.

"Wilcox, Mallory and Maracle" were Joseph Willcocks and Abraham Marcle, members of the House of Assembly who deserted to the enemy in the War of 1812 and were expelled from the House, February 19, 1814—and Benajah Mallory, also accused of treason at the same time.

Daniel Washburn was struck off the Rolls in 1820 "for conduct of a highly disgraceful and criminal nature," which had already become common property; it was in his office that Barnabas Bidwell was managing clerk—and there Marshall Spring Bidwell began his professional training.

Mr. James "Durant" was James Durand, Member of the House of Assembly, a Reformer but not a friend of Gourlay's. Gour. p. 49. He was quite falsely accused of using for his own purpose certain public money given him to expend on roads.

"Hone" was William Hone, the well-known author and publisher; he began in 1817 publishing satires on the Government of Britain John Wilkes' Catechism and the like. He was prosecuted on an *ex officio* Information for publishing John Wilkes' Catechism, December 18, 1817, before Mr. Justice Abbott (afterwards Lord Tenteden) and acquitted. The Chief Justice Lord Ellenborough determined to preside himself at the next trial, which he did, December 19—an *ex officio* Information for publishing Hone's own "Political Litany," but Hone was again acquitted. The next day, December 20, Hone was again put on trial on an *ex officio* Information for publishing "The Sinecurists' Creed." Lord Ellenborough again presided, and again Hone was acquitted.—these prosecutions and their result killed Lord Ellenborough. Hone defended himself with extraordinary skill, vigour and learning, proving himself quite too much for Judge and Crown Counsel.

The best account of these three trials is to be found in William Tegg's "Three Trials of William Hone," London, 1876—more foolish, unfair and futile proceedings never were taken in any Court—the Trial is well worth reading as showing the lengths it was a century ago thought fair to go to destroy an agitator. The political invective of to-day or yesterday is but gentle remonstrance compared with that of a century ago. Major Simons was Titus Geer Simons, whose tarring and feathering at Dundas of George Rolph was the cause of the action of Rolph v. Simons, which resulted in the "amotion" of Mr. Justice Willis in 1828.

Gourlay's practice of publishing letters to and from his wife is well known—many such letters are to be found in "The Neptunian"—he seemed not to understand that there was any impropriety or indelicacy in the practice—Mrs. Gourlay had no reason to be ashamed of her letters.

[18] The Secretary of Lord Durham, who had written simply informing Gourlay that Lord Durham had received his communications—Gourlay looked upon this as a slight—"The Durham Ox" will be found Nep. No. 2, p. 26; Gourlay seems to have been proud of this and his other doggerel.

[19] The Episcopalians (or some of them) claimed to be the Established Church of Upper Canada; some of the Presbyterians claimed a share of the Clergy Reserves. The language quoted is from Gourlay's "Address to the Resident Land Owners of Upper Canada," of January 10, 1839. Gour. p. 89.

[20] Printed in Nep. No. 7, p. 72.

The monkey was William Lyon Mackenzie, who, indeed, was neither tall nor handsome.

"Pug," a pet name for a monkey.

"Jonathan's outpost" was Buffalo; and the playhouse the local theatre where an enthusiastic public meeting was held the night after Mackenzie's arrival in Buffalo—Monday, Dec. 11, 1837—on his flight from Upper Canada.

"Douce," Gourlay informs us, means "sedate, sober, decent".

Van Rensselaer was Rensselaer Van Rensselaer who took command of the Sympathisers; he had more ambition than brains and was more devoted to brandy than to tactics.

Navy Island in the Niagara River was the camping ground of the Sympathisers

The Third Session of the Thirteenth Parliament of Upper Canada (I Vic.) sat from December 28, 1837, till March 6, 1838.

"My Dear McNab" was Allan Napier MacNab, who roused "the Men of Gore" District during the Rebellion to some purpose.

"Romney Marsh"—Francis Bond Head was Assistant Poor Law Commissioner in Kent, and living at Cranbrook, when he was to his great astonishment made Lieutenant Governor of Upper Canada—a worse selection could scarcely be made—he was knighted at the same time.

Allan Napier MacNab was knighted in 1838 for his services during the Rebellion.

Edinburgh Castle was an Inn in Toronto, much frequented by Members of the House of Assembly.

[21] Printed in Nep. No. 7, p. 72.

The Steamer Caroline was laid up at Buffalo but being chartered by Sympathisers, she was brought down to the River through a channel cut in the ice and taken to Fort Schlosser, opposite Navy Island, on the American shore. She took supplies including one cannon from the New York side of the River to Navy Island, but on the night of the 29th December, 1837, she was boarded by a Canadian expedition and set on fire.

In the diplomatic correspondence the Americans claimed that the Caroline carried only "articles of freight."

At, or near, Malden the Sympathisers, *i.e.* American invaders, were defeated and their General, Theller, and others were taken prisoner. At Point Pelé there was a short battle; the Short Hills west of the Niagara River was the scene of the latest attempt in that region against the Crown, resulting in death to nine, penal service to others; at the Windmill near Prescott, the unfortunate Pole, Von Schoultz was taken prisoner; he afterwards was hanged at Kingston with some of his followers; at Windsor, Col. John Prince met and defeated the invaders, killed some in battle, shot some after the battle and sent some to Toronto as prisoners.

The "monkey chock full of bile" was, of course, William Lyon Mackenzie; his rage against "Uncle Sam's tight collars" was due to the fact that convicted for an offence against the law of the United States in organising an expedition against Canada he was confined in the Gaol at Rochester for eleven months.

"The Globe" was *not* "The Toronto Globe."

Some Unpublished Documents Relating to Fleury Mesplet

By R. W. McLACHLAN, F.R.S.C.

(Read May Meeting, 1920)

The Archives of the Court House of Montreal, are to the student of Canadian History an undeveloped gold mine, in which many a nugget of historical fact may be unearthed. So far the surface has only been scratched. Thus it was that Mr. E. Z. Massicotte, the archivist in chief, in looking over the records of Peter Lukin, Notary, found a document relating to Mesplet, and, knowing that I had written a communication on this subject, which appeared in the proceedings of this Society, in which were given all the documents on the subject then known to me, he called my attention to it.[1]

This document, which is dated the 29th of August, 1792, when divested of its redundency of legal verbiage, may be read as follows:—John Jacob Astor of the City of New York, merchant, and Fleury Mesplet of Montreal, Printer, agreed, that the said Astor, should collect a claim of Fleury Mesplet, upon the Congress of the United States, for £3,543 12 0, Pennsylvania currency less the sum of 400 Spanish dollars already paid, and to enable Astor to make this collection, Mesplet had a power of attorney drawn up by the same Notary, which he handed to Astor.

By this document they further agreed that Astor was to receive half the amount collected, but nothing for legal, travelling or other expenses, whether he was able to collect anything or not.

This document was also countersigned by Alexander Henry, the well-known fur merchant of Montreal, as bondsman. It also stipulated that Mesplet was to give no power of attorney to any one else, to collect this amount from the Congress, during nine months for which the agreement was signed.

That Astor was unsuccessful in this effort is proved by a document annexed to the agreement, signed by the same Notary which states that "the power of attorney . . . . and also other papers he has furnished him, to endeavor to obtain his claim upon the Congress

[1] "Fleury Mesplet, the First Printer of Montreal," Transactions of The Royal Society of Canada, 1906, 2nd series, vol. 12, sec. II, p. 197.

which he could not effectuate;" were returned by Astor and the agreement cancelled.[1]

While hunting for the power of attorney which is mentioned in the agreement, I came across another agreement between John Jacob Astor and Phillip Liebert, made four days earlier—by which Liebert commissioned Astor to collect from the people of the United States his claim for $1,000.00 "for services . . . performed during the late war between Great Britain and America," consisting of arrerage of pay and "with a legal claim for pension due to him for seven years back, at the rate of $20.00 per month, having been wounded in the service." This will clearly indicate that Mesplet and Liebert were friendly[2] and that he had informed Mesplet of his having given his claim to Astor to collect on his behalf, and advised Mesplet to do the same.

A power of attorney is mentioned in this act as having been made out and given to Astor, but as the original of this is also missing in the record, we come to the conclusion that they were both made under "brevet" and handed to Astor.

The fact that Alexander Henry signed both acts as bondsman for Astor, shows much intimacy between these two great fur traders.

Another fact learnt from this document is that there were four different currencies. There was the Pennsylvania currency in which Mesplet made his claim on the Congress of the United States, which was worth seven shillings and sixpence to the dollar. The old currency of France in livres, Mesplet's own money, which was worth six livres to the dollar; Halifax currency a new Canadian money worth five shillings to the dollar and the Spanish "milled dollars" which was the medium through which exchanges of the different currencies were effected.

Two other documents have been discovered. One was a petition asking for the calling of a family council for the appointment of a curator to the vacant estate of Fleury Mesplet, by his widow, and in default of relatives seven friends were called and Louis L'hardy was appointed.

The other was a letter written by Ch. Gratiot, addressed to Mesplet, eighteen months after his death, sending an advertisement

---

[1] It was not likely that a government which repudiated its promises to pay in the shape of current bills, would honour a problematical claim like Mesplet's. Even Astor did not consider Mesplet's claim as good as Liebert, because he was to receive fully half of what he could collect of the former in comparison with two-fifths of the latter

[2] They were probably "drouthy cronies."

to be inserted in the *Gazette*, Montreal, of which Mesplet had been printer.

Documents from the Archives of the Court House, Montreal. P. Lukin N.P.

Before the underwritten Public Notary for the Province of Lower Canada, residing in the City of Montreal, Personnally came and were present, John Jacob Astor, late of the City of New York, Merchant, at present in Montreal, on the one part; & Phillip Liebert, late a Major, in the service of the united States, now in Montreal aforesaid of the other part. Who voluntarily confessed and declared, that they had made, agreed and concluded, and by these presents do make, agree and conclude by and between them, the following articles of agreement as follows.—

That the said Phillip Liebert, having given unto the said John Jacob Astor, two Certain Powers of attorney bearing equal date with these Presents, which the said Astor doth hereby acknowledge to have received specially enpowering him the said Astor, in the name of the said Liebert, to ask and receive of and from the Congress of the united States, two respective Claims he hath upon the People of the united States for services done rendered & performed during the late war between Great Britain & America to wit, His arrearages of Pay amounting as he declares to the best of his knowledge and information to a Sum of Three Hundred and Ninety Silver Spanish Dollars together with a legal Claim, for Pension due unto him for seven years back at the rate of twenty dollars pr. month having been wounded in the service of the said United States. Now it is hereby agreed by and between the said Parties, that if the said Astor shall at any time within the space and term of Twelve Calendar Months from the date of these Presents at his diligence and Costs, take all legal steps to pursue and recover the aforesaid Claims, and that he shall have recovered the same or only the seven years back Pension at the rate of Twenty Dollars as aforesaid, then and in that case, & not otherwise the said Astor hereby binds & obliges himself His Heirs Executors & administrators to pay or cause to be paid unto the said Phillip Liebert, his lawful attorney, Heirs Executors and administrators, the sum of One Thousand Silver Spanish Dollars, for which payment well and truely to be made & paid, Mr. Alexander Henry of Montreal aforesaid Merchant, present & consenting doth become responsible & for the purpose becometh a party—hereunto testifyed by his signing these Presents, Hereby Binding and obliging himself His Heirs Executors and administrators, for the due payment of the One Thousand Silver Dollars to the Sd. Phillip Liebert, His Lawful Attorney Executors & administrator for and in the name & behalf of the said Astor on the Conditions aforesaid nevertheless, it is agreed by and Between the said Parties and it is the true intent and meaning of these Presents, that if the said Astor shall not recover the amount of the Herein before mentioned Claims or the amount of that which relates to the Pension at the rate of Twenty Dollars pr. Month as aforesaid, within the space of Twelve months as aforesaid then & in that Case the said Astor & Alexander Henry his Respondant his Heirs or either of their Heirs Executors & administrators shall be and they are hereby exonerated from the Payment of the said One Thousand Dollars to the said Phillip Liebert, this clause becoming null and void, as if these Presents had never been made notwithstanding anything to the Contrary hereinbefore expressed, but that the said Astor, or for him & in his name the said Alexander Henry his their or either of their Heirs Executors and administrators shall well and truly pay or cause to be paid unto the sd. Liebert his lawfull attorney Heirs Executors & administrators, Three fifths of all and every such sum or sums of money as the said Astor shall have and receive of and from the Congress of the united States, in the name & behalf of him the said Phillip Liebert for what reason or cause soever & the other two fifths, shall belong & appertain unto the said Astor as Compensation for His trouble & Expences in prosecuting the recovery of the same and in case the said Astor shall not Receive any sum or sums of Money whatever in the name and behalf of the said Liebert Nevertheless the said Astor shall not be Entitled to any cost or disbursments whatever particular clause without which the said Phillip Liebert would not have Consented to this present Agreement.

And lastly the said Astor, hereby Binds & obliges himself to warrant defend & keep harmless the said Phillip Liebert, against the persons of Robert Allice & Nathan White or either, of them to whom the said Phillip Liebert declares he hath given a Power of attorney, provided and it is hereby understood no further indemnification than that the said Astor shall Refund unto the sd. Allice & White any reasonable expence which they may have been at & incured in Endeavouring to Receive any monies in the name & behalf of the sd. Liebert by virtue of the Power of Attorney by him given unto them as aforesaid. For thus was agreed between the said[1] Parties who for the better fulfilling of all & every Clause and conditions herein contained & the due Execution of these Presents, have fixed their domiciles or places of residence to Wit, the said Astor, & Alexander Henry at the dwelling House of sd. Alexr. Henry in this City Notre Dame Street, & the P. Liebert at his usual place of abode, near the Court House

[1] Respective J. J. A. P. Li A. H. J. W. D.

of this City, at which places &c notwithstanding &c. obligeing &c. promissing &c. consenting &c.

Done and passed at Montreal Province of Lower Canada aforesaid at the office of P. Lukin one of the subscribing notary's In the year One Thousand seven Hundred & ninety Two, The Twentyfifth day of August in the forenoon & have the sd. Parties signed these Presents with us Notary's.

JOHN JACOB ASTOR
PH. LIEBERT
ALEXANDER HENRY

P. LUKIN
N.P.

1792
JOHN WILL. DELISLE
N.P.

And on the Twenty-Fourth day of November[1] of the same year, personnally came and appeared Before the subscribing Notary's Public, for the Province of Lower Canada, residing in the City of Montreal, the within named, Phillip Liebert, Who voluntarily Confessed and declared, to have had and received of and from the within named Alexr. Henry of Montreal aforesaid Merchant Before the executing of these Presents two Certain Letters or Powers of Attorney bearing date the Twenty fifth of August of this present year, being the same which He the said Phillip Liebert had given unto Jacob Astor of New York, Merchant also named in the foregoing deed, together with a Certain Commission & Surgeins Certificate[2] the said Jacob Astor to recover a Certain Claim He the said Phillip Liebert had upon the American States, which the said Jacob Astor hath not been able to effect; Wherefore and in Consideration of his Sd. Letters or Powers of Attorny & Papers, being returned, He the said Phillip Liebert Hereby exonerates and discharges the said John Jacob Astor & Alexander Henry of all and every obligation or obligations they or either of them were liable and bound to by Virtue of the[3] written deed for the payment of any Sum or Sums of Money of all which he freely and absolutely acquits them by these Presents to which the said Alexander Henry present and accepting as well for Himself, as for and on behalf of the Sd. John Jacob Astor doth Consent and agree to; of all Which the Sd. Parties have required of us Act to them instantly granted, to serve against all events. *Thus* done and passed at Montreal Province of Lower Canada aforesaid at the office of

[1] In the afternoon, P. L.
[2] To enable P. L.
[3] Foregoing P.L.

P. Lukin one of the Subscribing Notary's the day & year first above written and have the sd. Phillip Liebert & Alexr. Henry Signed these Presents with us sd. Notary's the same being first duly read and interpreted/[1] words in the margin approved one word obliterated null/

PH. LIEBERT.

Before the underwritten Public Notarys, of the Province of Lower Canada, residing in the City of Montreal, personnally came and were present John Jacob Astor, of the City of New York, Merchant, at present in Montreal aforesaid, on the one part, and Fleury Mesplet of the sd City of Montreal, Printer of the other part, who voluntarily declared and confessed that they had made agreed and concluded, and by these presents do make agree and conclude by and between them the following articles of agreement as follows.

Whereas the said Fleury Mesplet hath declared that he has a claim upon the Congress of the United States to the amount of three thousand five hundred & forty three pounds twelve shillings Pensylvania Currency, from and out of which sum he has received an amount by the order of sd. Congress, the sum of four hundred Spanish dollars, and having by a certain power of attorney, executed before P. Lukin one of the subscribing notaries, bearing even date with these presents, delivered into the Hands of the said John Jacob Astor, by the said Fleury Mesplet, which the said John Jacob Astor doth hereby acknowledge to have had and received, He the said Fleury Mesplet hath empowered the said John Jacob Astor, for him and in the name and behalf of the said Fleury Mesplet, to ask demand and receive of and from the said Congress of the United States, the full amount of the said claim with the deduction aforesaid. Now these Presents doth witness, and it is the true intent and meaning of the said parties, that if the said John Jacob Astor shall at his diligence and costs take all legal ways and means soever, in the name and behalf of the said Fleury Mesplet to secure and receive of and from the Congress of the United States aforesaid, the claim aforesaid, and that the said John Jacob Astor shall so receive the full sum of three thousand five hundred & forty-three pounds twelve shillings Pensylvania currency aforesaid with the deduction of the four hundred dollars aforesaid, whether in money or state securities within the space and time of nine calenders months from the day of the date of these presents, then and in that case, and it is the true intent and meaning of these presents, that the said John Jacob Astor, shall and will, & thereby binds and obliges

[1] Six—P. L.

Himself, His Heirs Executors and Administrators, to pay or cause to be paid unto the said Fleury Mesplet his lawful attorney their Executors and Administrators, the full and just sum of twenty-thousand Livres ancient Currency of the sd. Province, equal to eight hundred & thirty-three pounds six shillings and eight pence. . . . Halifax currency, for which payment will and truely to be made & paid, Alexander Henry of Montreal, merchant, present and consenting testifyed by his becoming a party & signing these presents, doth become responsible, & for and in the name of the sd. John Jacob Astor, doth hereby bind and oblige himself his heirs executors & administrators to pay or cause to be paid unto the said Fleury Mesplet, the said sum of twenty thousand Livres Ancient currency equal to eight hundred & thirty-three pounds six shillings & eight pence. . . Halifax currency aforesaid, upon the conditions aforesaid—Provided allways & it is the true intent and meaning of these presents, that if the said John Jacob Astor, within the said term of nine calender months shall not receive the whole of the aforesaid claim, but only part thereof, then and in that case, & it is the true intent and meaning of the sd. parties, that the sd. John Jacob Astor & his security Mr. Alexr. Henry aforesaid will not be held liable to the payment of the sd. sum of twenty thousand Livres on the contrary they and either of their Heirs Executors and Administrators, shall and they are hereby exonerated from the payment of the same notwithstanding anything herein before said to the contrary.— Nevertheless it is agreed by and between the said parties, that in case the said John Jacob Astor shall at any time within the space of nine calendar months aforesaid, receive any sum or sums of money in the name and behalf of the said Fleury Mesplet for what reason or cause soever, of and from the Congress of the United States, then and in that case and it is the true intent and meaning of these presents that the said John Jacob Astor, shall and will well and truly pay or cause to be paid, one just half of all such, not deducting any cost whatever for or by reason of the recovery of the same, for which just half so to be paid to the said Fleury Mesplet the said John Jacob Astor & Alexr. Henry His security, they and either of their Heirs Executors & Administrators are hereby bound for the same.—And lastly if at the expiration of the said nine Calendar Months the said John Jacob Astor shall not have received any sum or sums whatever of and from the Congress of the United States in the name and behalf of the said Fleury Mesplet, then and in that case, these present articles of agreement shall cease and finish and be of no effect whatsoever as if the same had never been done or made, & the said Jacob Astor shall yield and give up unto the said Fleury Mesplet his sd. Power of Attorney[1] have furnished unto him to enable him for the recovery of the sd. claim—and also the said Fleury Mesplet shall not at any time within the space of nine calendar months' aforesaid give any other Power or Permission to any person whatsoever to receive any monies in his name & on his behalf, on pain of all costs charges damages etc. For thus was agreed by and between the said parties, who for the better fulfilling all and every the clauses and conditions herein contained, have fixed their respective domiciles & places of residence to wit, the said John Jacob Astor, & Alexr. Henry at the House of the said Alexr. Henry in Notre-Dame street, & the said Fleury Mesplet at his usual place of abode also in Notre-Dame Street, at which places etc, notwithstanding etc, promissing etc, obliging etc. Thus done and passed at Montreal & Province aforesaid at the office of P. Lukin, one of the subscribing notaries, in the year one thousand seven hundred and ninety-two ,the twenty-ninth day of August in the afternoon & have the said respective parties to wit, John Jacob Astor, Alexr. Henry & Fleury Mesplet signed these presents with us Notary's the same being first duly read & translated.

(signed) JOHN JACOB ASTOR
" FLEURY MESPLET
" ALEXANDER HENRY
" JOHN WILLM. DELISLE, N.P.
(1792) " P. LUKIN, N.P.

And on the twenty-second day of August in the afternoon, in the year one thousand seven hundred & ninety three personnally came and appeared before the underwriten Public notaries, for the Province of Lower Canada residing in the City of Montreal Fleury Mesplet named in the above and aforegoing deed, who voluntarily confessed and declared, to have had and received from the within name John Jacob Astor present and accepting, the Power of Atty. in the sd. aforegoing deed mentioned and also other papers he has furnished him, to endeavour to obtain his claim upon the Congress, which he could not effectuate & declared the sd. parties that they cancelled the sd. agreement in toto, that the same may be of no effect, whatever as if the same had never been made or concluded upon of which they require of us an act which was at the same time granted them, for thus, etc.

---

[1] Or any papers he may from time to time.

Done and passed at Montreal, aforesaid in the office of Lukin, one of us the sd. notaries the day and year first above written, & have the said parties subscribed their names to these presents the same being first duly read.

(Signed) F. MESPLET
" JOHN JACOB ASTOR
" P. LUKIN N.P.

Endorsed (1793)

150

August 29th. 1792

ASTOR & MESPLET

ARTICLES OF AGREEMENT

1st. Copy to Mesplet

P. LUKIN, N. P.

Province du Bas Canada }
District de Montréal }

AUX HONORABLES JUGES DE LA COUR DES PLAIDOYERS COMMUNS &c. &c. . .

Qu'il plaise à vos Honneurs—

Supplie humblement Marie Anne Tison demeurante en sa maison sise en cette ville, rue Notre Dame, veuve de Fleury Mesplet, Imprimeur Et a L'honneur de vous Exposer.

Que par acte d'hier Vingtième février Courant, receu devant Me. Jean Guillaume Delisle & son confrère, notaire elle auroit renoncé à la Communauté de biens qui a Cy devant existé entre elle et le dit défunt son Epoux, Comme lui étant plus onéreuse que profitable.

pourquoi elle supplieroit respectueusement Vos honneurs Lui permettre de faire approcher par devant vous a Tels Jour Lieu et heure qu'il vous plaira indiquer, Le amis des dits Fleury Mesplet, a défaut de parents de son coté, pour sur Leur avis etre procédé a la Nomination d'un Curateur a la ditte Succession Vacante, afin qu'elle puisse, ainsi que les autres créanciers, diriger les actions qu'ils se proposent d'intenter, Contre la ditte Succession, Et Ferez Droit.

Montréal, le vingt-un février, mil Sept cent quatre Vingt Quatorze.

(signé) Marie-anne tison, veuve Mesplet.

Viennent les Amis
dudt défunt aux fins
de la présente requete
à Montréal, le 21e fev. 1794.

A. Panet J.P.C.

Jn. Guille, Delisle Ls. l'hardy Chs. Lusignan JBte. Tison Beaupere Francois Desrivières Louis Charles Foucher Ecuier pierre Fisette	amis faute de parens

Elu Louis L'hardy pour curateur—
A.P.

Endorsed —21e fevr 1794—

Requete de Dame

Marie A. Tison

veuve Mesplet

CURATELLE

Enregistrée, J.R.

St. Louis le 30 avril 1795e

Mons F. Mesplet
Imprimeur à Montréal.

Monsieur

Cy joint un avertissement que je vous prie de vouloir insérer dans votre gazette aussitôt la réception de la présente, vous priant de vouloir bien la donner au public traduitte dans les deux langues pour l'intelligence de ceux à qui il appartiendra par trois publications de Suitte, vous priant de me faire parvenir aux Illinois par la première occasion sur les gazettes dans lesquelles vous les aurés publiées; Vous avez cy inclus un ordre pour le remboursement de vos frais.—Vous obligerés très parfaittement.

Monsieur Votre très humble serviteur

(signé) Ch. Gratiot

AVERTISSEMENT

C'est pour donner avis à toutes personnes qui pourroient être porteur de quelques créances contre la Société d'Abraham & Gratiot cy devant à Montréal, de vouloir bien en donner connaissance au terme de douze mois après la publication de la présente au soussigné, résidant à St. Louis des Illinois, sans quoi ils seront déchû de tous droites et titres quils pourroient avoir contre lui; déclarant a quiconque il appartiendra que dès aujourd'hui et pour toujours il renonce à la ditte Société, ne voulant être responsable pour aucun acte, obligation, billets, lettres de change ou aucune dette de quelque nature quelle puisse être faite au nom de la ditte Société ou par procuration que le soussigné auroit pu donner au dit Sr. Abraham.

St. Louis le 30 avril 1795e

(signé) CH. GRATIOT.

Dépose pour minute En L'office de Jean Guill. Delisle, L'un des notaires soussignés à la requisition de Sr. Louis Lardy, Curateur à la succession vacante de feu Fleury Mesplet, Imprimeur, Montréal le deux juillet mil sept cent quatre vingt quinze.

P. LUKIN, N.P.

JEAN GUILL. DELISLE.

Endorsed

No. 1087

Le 2e juillet 1795

Dépot de la lettre de M. Ch. Gratiot adressé à Fleury Mesplet

(adressée)

A MONSIEUR MESPLET

Imprimeur à Montréal

Avertissement

C'est pour donner avis à toutes personnes qui pourroient être porteur de quelques créances contre la Société d'Abraham et Gratiot cy devant à Montréal, de vouloir bien en donner connaissance au terme de douze mois après la publication de la présente au soussigné, résidant à St. Louis des Illinois, sans quoi ils seront déchû de tous droites et titres quils pourroient avoir contre Elle; declarant a quiconque il appartiendra que dès aujourd'hui et pour toujours il renonce à la ditte Société, ne voulant être personnelle pour aucune [illegible] [illegible], billets, lettres de change ou aucune dette de quelque [illegible] quelle puisse être faite en nom [illegible] te Société ou par [illegible] que le soussigné auroit pu donner [illegible] Abraham.

St. L[illegible] 0 avril 17[illegible]

CH. GRATIOT.

Déposé pour minute [illegible] Jean Guill. [illegible] des notaires soussignés à la requisition [illegible] Louis Lard [illegible] à la succession vacante de feu Fleury [illegible] Imprimeur [illegible] le deux juillet mil sept cent quatre [illegible]

P. Lukin, N.P.

[illegible] Dr. [illegible]

Endorsed

Le [illegible]

[illegible] de la lettre de M. Ch. [illegible] à [illegible]

A Monsieur [illegible]

[illegible] Imprimeur [illegible]

A Plea for Coriolanus

By WALTER S. HERRINGTON, K.C., F.R.S.C.

(Read May Meeting, 1920)

It is not the purpose of this paper to seek to establish that our hero was by any means perfect or that he pursued a wise and politic course; but to present some arguments in his favor that may have a tendency to mitigate the sentence too frequently pronounced upon him by the ordinary reader, who has not given the play that study that it merits.

It is true that Shakespeare drew his material for the play from North's translation of Amyot's Plutarch; yet the Coriolanus with whom we are familiar has been so retouched and quickened that he has taken on a new personality, and I refuse to believe that the great dramatist did not intend that we should admire this, one of his grandest creations. He did not gloss over his faults, but painted them in their darkest colors, thereby challenging our sense of justice in our estimate of his character.

We should always bear in mind that Coriolanus made full atonement and paid a heavy penalty for his folly. Such prominence is given to this in the play that we need not feel it incumbent upon us to lay any particular stress upon his shortcomings through fear that they might escape notice. Shakespeare has relieved us of any such responsibility, and has seen to it that the purpose of the tragedy has been faithfully fulfilled and that the hero has fallen a victim of his own weakness. The fact that Coriolanus did come to such a tragic end, thereby rendering it certain that the evil that he did shall live after him, imposes a greater obligation upon us to see that the good shall not be interred with his bones. Let us therefore enquire dispassionately and sympathetically into his character and the motives and impulses of his actions and see if we cannot find some palliatives for his many alleged misdeeds.

First impressions are often quite erroneous and, when once formed, most difficult to eradicate. Our first introduction to Coriolanus was under circumstances not calculated to create a favorable impression. A fit of anger ill-becomes anyone; but we might overlook it in an old friend; but not so readily in the case of a new acquaintance. It behooves us therefore to enquire carefully into all the surrounding circumstances before we form our judgment. Menenius, who appears to have wormed himself into the good graces of the plebeians, entertained no better opinion of them than did Coriolanus. When he first met a mutinous company upon the street he coolly reasoned with them and, in language that certainly could not be construed as complimentary, told them that

> "Rome and her rats are at the point of battle"

and, in telling them, he left no doubt in their minds as to the identity of the "rats." Shortly after, when commenting upon their conduct, he declared

> "For though abundantly they lack discretion,
> "Yet are they passing cowardly."

This from the man "that hath always loved the people" and spoken coolly and deliberately must be taken at its face value. What comment then might we naturally expect from one of the temperament of Coriolanus, who

> "has been bred in the wars
> "Since he could draw a sword and is ill school'd
> "In bolted language."

Our first glimpse of Coriolanus is his meeting with this same clamorous mob. Such a turbulent scene in itself was enough to arouse the anger of a soldier. He had just come from another part of the city, where he had witnessed the humiliating spectacle of the senate yielding to the threats of just such a mob, whereby there were granted to them five tribunes of their choice. It was not from any personal animosity that he was so violently opposed to such a step; but because he feared that it was the thin edge of the wedge that would in time divide the power exercised by the nobility and create that condition he had in mind when he said—

> "When two authorities are up,
> "Neither supreme, how soon confusion
> "May enter 'twixt the gap of both and take
> "The one by the other."

He conscientiously took the same stand towards the granting of this power to the plebeians that the statesmen of the United States and Canada are taking to-day towards the rise of Bolshevism upon this continent. He was sincere and honest in his belief and advanced the same arguments that are being used in the prosecution of Bolshevists in our courts to-day.

> "It will in time
> "Win upon power and throw forth greater themes
> "For insurrection's arguing."

He was justly indignant when he saw the type of men appointed to the newly created offices, men whom worthy Menenius styled "a brace of unmeriting, proud, violent, testy magistrates."

Is it any wonder then that he flew into a towering rage when, a few minutes later, he ran into this mob demanding that the senate give to them at their own rate the corn that had been providently stored up to meet the demands of a possible famine? It is here that the reader is likely to fall into his first error and contrast the coolness of Menenius with the uncontrollable heat of Coriolanus, much to the prejudice of the latter.

We have had many opportunities during the past few years of witnessing the attitude of the soldier towards his fellow citizen, who had not shewn the same eagerness to get into uniform as he had. We can picture what might occur, if a veteran of our war came in contact with a crowd of such unpatriotic citizens, who with threats of violence were demanding from one of our governing bodies that they be accorded more power and that the government stores be thrown open to them. It would not surprise us to learn that "dissentient rogues," "curs," and "fragments" would be considered mild epithets, when compared with what we might expect to hear upon our own streets under such circumstances.

It was under just such but more aggravating circumstances that Coriolanus found himself when confronted with this unruly mob in the streets of Rome. He felt that they were not entitled to any consideration as they had proven themselves unworthy of it.

> "They know the corn
> "Was not our recompense, resting well assur'd
> "They ne'er did service for't. Being pressed to the war,
> "Even when the navel of the state was touch'd,
> "They would not thread the gates."

When we, therefore, are disposed to severely criticise the impatience and impetuosity of Coriolanus, let us bear in mind that our own Canadian boys, during the past few months, have many times displayed the same outburst of passion and used language just as intemperate and we have generously overlooked their offences. There is no reason why we should not accord to Coriolanus the same fair treatment, for in his case the provocation was just as great.

If he had displayed a little more tact and prudence when soliciting the votes of the people in the market place, he might have escaped all the unpleasantness that followed. The people were not difficult to deal with and he might easily have overcome the evil influence of the tribunes, if he had been more upon his guard and not left himself open to charges they brought against him. It is very easy to sit down in an armchair and point out the mistakes made by some one else under circumstances that precluded the possibility of the exercise either of his free will or cool deliberation.

Coriolanus spoke the truth when he said:

> "I had rather have my wounds to heal again
> "Than hear say how I got them."

If he entertained such an aversion to hearing his "nothings monstered" by others, we can readily conceive how utterly abhorrent to him was the thought of displaying his many wounds and boasting how he had obtained them. Yet this is what was expected of him by the people, whom he despised:—"For, if he show us his wounds and tell us his deeds, we are to put our tongues into those wounds and speak for them." He begged that he might be excused from observing this ceremony, but his friends urged him on:—

> "Pray you, go fit you to the custom and
> "Take to you, as your predecessors have
> "Your honour with the form."

He most reluctantly yielded to their solicitations, but, even as he took his place, he had no confidence in his ability to carry the matter through, and despairingly exclaimed to Menenius:—

> "Plague upon't ! I cannot bring
> "My tongue to such a pace."

How could he in such a frame of mind do what was expected of him? That he should leave himself open to the criticism and attacks of the tribunes was the most natural thing in the world. He could no more control himself under the conditions in which he was placed, than the weather-vane can in a wind storm. And it was not altogether to his discredit that he was unable to act the part. His reasoning was sound and his declaration sincere:—

> "Better it is to die, better to starve,
> "Than crave the hire which first we do deserve."

Hundreds of the best men in every civilized country to-day take precisely the same stand that Coriolanus did. We need not seek far to find many good men, who have, time and again, been solicited to allow their names to be placed in nomination for some public office and who have consistently and persistently declined for no other reason than they would not go through the humiliating custom of soliciting the votes of the electors. If the electors whom they would be called upon to canvass were a class to be despised how much greater would the humiliation appear. They would most heartily endorse the position taken by Coriolanus:—

> "Rather than fool it so,
> "Let the high office and the honour go
> "To one that would do thus."

He should not receive our censure but our sympathy and, I might with justice add, our admiration because he could not cringe before men he knew were not his equal. If left to themselves it is not at all likely that the Roman people would have created any disturbance over the choice of Coriolanus as Consul. It is true that they were not very enthusiastic in yielding him their voices; but were content when the ceremony was concluded to join in a general benediction:—

> "Amen, amen,—God save the noble consul!"

and that too in the face of the schooling they had received from Brutus and Sicinius. These two worthies lost no time in persuading them that they had been flouted and that they should demand the privilege of revoking their election. They well understood the temperament of Coriolanus and the effect that such a proceeding would probably produce. They hoped to be able to provoke him to commit some act of folly that would give to them the opportunity of exercising their authority and wreaking their vengeance upon him. Brutus gloatingly looked forward to this culmination of their plot:—

> "If as his nature is, he fall in rage
> "With their refusal, both observe and answer
> "The vantage of his anger."

Distasteful as it was to him, Coriolanus yielded to the solicitation of his mother and consented to appear again before the people. His friends misjudged his power of self-control; not so his enemies. Brutus rested his whole case, not so much upon what Coriolanus had done, as upon what he hoped to provoke him to do, knowing full well that:—

> "Being once chaf'd he cannot
> "Be rein'd again in temperance."

His friends should have foreseen the outcome of this meeting and planned some means to avoid it. They made no attempt to reason with the people and to undo the mischief of the tribunes. They saw that he was unnerved and still wavering which way to turn. His manhood rebelled against the deception he was urged to practise and he warned them against pressing him too far:—

> "You have put me now to such a part which never
> "I shall discharge to the life."

Up to this point he had been largely swayed by what he conceived to be the well-being of the state but now the battle rages about himself. His honour is challenged and his pride is assailed. Shall he sacrifice the one and swallow the other? An awful struggle is raging within his breast. His patriotism once more asserts itself and stands victor over self:—

"Well I will do it;
"Yet were there but this single plot to lose
"This mould of Marcius, they to dust should grind it
"And throw't against the wind."

It is here that we see him at his best, yet, so skillfully is this picture drawn, that no matter which way he turned, we would have been disposed to give him full credit for having chosen well, although we would have been better pleased if he had not been forced to choose at all.

The last words spoken by him before he met his accusers were a fervent invocation to the Gods to keep Rome in safety; yet the step he was taking was at the cost of his own self-respect:—

"Away, my disposition and possess me
"Some harlot's spirit."

Was a man ever placed in a more trying situation? To us the difficulties in his way may appear slight, but we are not dealing with abstract principles but with a human being, a man, whom we cannot mould and fashion as we would; a man, moved by conflicting foibles and passions. Above all he was proud and well he might be. Proud, but not vain. Would we have him less so? When we make all due allowance for his environment can we up to this stage in his history point to a single act of his and say that it was unnatural and not just what we might have expected? Has he in any particular so transgressed that we would care to condemn him? I think not. Then bearing in mind what he has already endured in one short day; bearing in mind that he has, at what seemed an awful price to him, kept the good of Rome foremost in his thoughts and remembering the manner of man who stands before him as his accuser and judge, what would we expect from Coriolanus in answer to the charge of treason from such a source? He intended to be mild and hold himself in check; but this was more than human nature could endure. It was the most natural thing in the world that he should forget his promise and hurl back defiance at the head of the tribune. Then followed the inevitable as had been planned and rehearsed by his enemies. Rome for which he had lived and suffered, that Rome, for which he had stifled his honour and self-respect suffered him to be banished from her gates. Blinded with anger, humbled, crushed, defeated and disgraced, he turned his back upon the city that had cast him off. For the first time he realized that Rome owed a debt to him and that he was entitled to the protection of the city. It was his home, for which he had fought and bled, and it owed him an asylum. How had his services been requited? Banished! Banished, it is true, by those whom he despised; yet they were the recognized representatives of the city, in whose hands Rome had placed the authority to deal thus with him and Rome did not intervene to save him. He could not dissociate them from the city:—

"Despising
"For you, the city, thus I turn my back."

For a moment his thoughts turn tenderly towards his loved ones, the faithful but helpless Menenius, his mother, his wife; but soon they too are swallowed up in the city—Rome—that Rome that had cast him off. As he got well beyond its walls and the outlines of the city grew fainter and fainter his very loneliness intensified the agony of his soul. The one thought that possessed his being was the base ingratitude of the multitude. The echos of the plaudits that greeted him upon his triumphal entry and march to the capital had scarce died away when the same voices joined in a chorus of approval of the sentence of banishment. Every sound seemed to spell out that one word, disowned! disowned!

What next? He had been schooled to render blow for blow. In his service of a lifetime in the cause of Rome his sword had been his strongest argument and the propriety of its use had never been questioned. But could he raise his hand against Rome? Why not? Rome had not spared him. The common people had clamored for his blood and the nobles had cruelly forsaken him at the one crisis in his life when he needed their support. Menenius confesses as much—

"We lov'd him; but, like beasts
"And cowardly nobles, gave way unto your clusters,
"Who did hoot him out o' the city."

If Rome had dealt unjustly with him could she complain that he in settling the differences between them used the same instrument that had so often seen service in his hands on her behalf? It was by this process of reasoning that he committed what has been styled his greatest mistake.

"O world, thy slippery turns! Friends now fast sworn,
"Whose double bosoms seem to wear one heart,
"Whose house, whose bed, whose meal and exercise,
"Are still together, who turn as 'twere in love
"Unseparable, shall within this hour,
"On a dissension of a doit break out
To bitterest enemity."

It does not rest with us to judge him too harshly when the Romans themselves had not the courage to do so.

"Who is't can blame him?
"Your enemies and his find something in him."

said Cominius; and when it was suggested that they appeal to him for mercy the general continued:—

"Who shall ask it?
"The tribunes cannot do't for shame; the people
"Deserve such pity of him as the wolf
"Does of the shepherds."

We cannot do otherwise than pay some heed to the views of Menenius, who although a warm friend of Coriolanus has throughout the play shewn that he was not blind to his faults and has not hesitated to correct him where he thought the occasion warranted it. The old man seemed to regard the action of Coriolanus as the natural sequel to his banishment.

"If he were putting to my house the brand
"That should consume it, I have not the face
"To say 'Beseech you, cease,"

and again

"If he could burn us all into one coal
"We have deserv'd it."

Even the tribunes, with all their bitterness and hatred towards him could not muster the courage to utter one word of reproof. Their only thought was to fall upon their knees and crave his mercy.

While we may regret the course of events and wish that they had been otherwise, can we after all say that Coriolanus made so many mistakes as are charged against him? Weighing all the circumstances can we not at least give him credit for honesty of purpose and conclude that he was more sinned against than sinning?

Transactions of the Royal Society of Canada
SECTION III

SERIES III MAY, 1920 VOL. XIV

PRESIDENTIAL ADDRESS

BY DR. A. S. EVE, F.R.S.C.

Relativity

(Read May Meeting, 1920)

There is a relativity with which man and animals have been in practice long familiar. A hawk swooping at its prey, a savage shooting an arrow at a moving quarry, a boy striking at a moving ball, make due allowance for relative motion with a precision not less remarkable than that of a gunner on a modern battleship, or a torpedo officer on a submarine, when he allows for the velocity of his swift-moving target relative to his own ship.

A notable exception is the curve of pursuit of a dog running to his moving master. The dog does not take the quickest path or line of least action, as does a good fielder intercepting a ball at cricket or baseball. The aberration of light, the slanted umbrella, the delusion that your train has started when really an adjacent train has moved, the fact that if you travel with the wind, and at the same pace, to you there is no wind, the relative acceleration in elevators, are all familiar instances of relative motion which have long been appreciated.

Possibly too in the realms of Philosophy the relativity of our knowledge has been consciously or subconsciously recognized in the search for truth.

There appears to be a craving in the mind of man for fixed points of reference. In Time this has been achieved, at least apparently, by an event. The Interval between two events has been considered, until recently, a concise and measurable quantity. It is now known to be elusive. The terms "before" and "after" an event are capable of inversion owing to the time required for transference of light signals. Time can be apparently accelerated by rapid approach to a clock, or delayed by recession from it. The moving picture, worked backwards, familiarizes us with at least a conception of the reversal of time.

The desire for a fixed frame of reference in space has been no less marked. The first conception was a flat and stable earth with heaven above, the "excellent canopy the air, the brave o'erhanging firmament, the majestical roof fretted with golden fire," so that the "floor of heaven was thick in-laid with pattens of fine gold." Beneath the earth, the abode of demons!

This idea was followed by a round but stable earth around which the sun, moon, planets and stars rotated. A relative velocity of rotation with a vengeance!

The heliocentric theory perhaps assumed a stable sun, almost certainly fixed stars. To-day every particle of matter moves. There is neither absolute place, nor time, nor velocity, and we are led to expect that the quest for them is as futile as perpetual motion.

One hope further did until recently remain. If æther was a compacted plenum filling all space, then whether material or electromagnetic it might afford a standard with reference to which absolute velocities could be obtained.

This idea was dominant in many able minds. It was destroyed by experiments, such as that of Michelson and Morley.

The explanation of Fitzgerald, worked out by Larmor and Lorentz, that matter no less than electrons was flattened by velocity through space, suffices to account for the null experiments. Physicists were content with so moderate a demand, involving with the earth's speed, but a few inches in its diameter of 8,000 miles. The æther survived, and it might yet be stagnant!

In 1905 Einstein accepted the transformation equations of Larmor and Lorentz, but enunciated a great principle.

All linear motions are independent of any frame of reference. Light travels at the same speed to all observers, and is independent of the velocity of the source. This broad generalization was incapable of verification, but the wideness of its scope brought the principle into wide-spread favour. Incidentally some curious results followed from the general position now achieved. Two bodies or waves approaching each with velocity of half that of light would come together with a velocity apparent to an observer with each, not as the velocity of light but as 4/5 of the velocity of light. If each moved towards the other with velocity c, relative to some object, then their relative velocity to a massless traveller with either would still be c and not 2c as ordinary kinematics might suggest. The Fitzgerald shortening still held good, and the transformation equations of Larmor and Lorentz were consistent in their application to Maxwell's Electromagnetic equations and to leading phenomena, such as Doppler's effect, pressure of light, etc., resulting from the equations.

But if Einstein's principle of relativity was accepted for linear velocities, it was impossible for linear acceleration, which is merely rate of change of velocity, to escape analogous treatment. Furthermore the change of mass with velocity, at least for electrons, had been demonstrated and measured in experiments such as Bucherer's.

Einstein saw a man fall off a house. It started him on the question of the Theory of Equivalence. It is noteworthy that Newton considered the fall of a traditional apple as a preliminary to the Law of Gravitation, but Einstein required the fall of a man from a roof in order to formulate his theory of gravitation, the only theory so far stated which has led to results which are verifiable, and have to some extent been remarkably confirmed.

The latest forms of Einstein's theory of Relativity and Equivalence are to many physicists and mathematicians obscure, more particularly as they involve a mathematical treatment with which few have made themselves familiar.

To a man going with the wind and at the same pace there is no wind. To a man falling freely there is no gravity. A system moving upward with acceleration g, when there is no gravity, is indistinguishable from a system without acceleration, when there is a gravitational field with acceleration g.

These ideas lead to the First Stage of the Final Form. The results lead to a bending of light round the sun, but of magnitude but one half of that foretold by the Second Stage, and verified by eclipse observation.

Consider that all phenomena must be independent of the observer and of the system of axes. Use four dimensional space, x_1 x_2 x_3 x_4 being coördinates, and follow out relentlessly the invariants arising from transformations. Translate your results into x, y, z, ct where t is the time, and c the velocity of light. On translating your four dimensional analysis into analogy with our three dimensional space experience, there is a result indicating that in a gravitational field of varying intensity light travels along a geodesic. The available path is curved. Just so a sailor goes from Liverpool to New York not by the shortest or straightest line, for it is not open to him. He is confined to the surface of the sea and travels along a geodesic. His whole geometry is that of great circle sailing. Of straight lines he knows nothing, for there is no plane open to him. So I take it that to light near the sun, in addition to the bending due to gravitation, expected from the First Stage, there is an extra and equivalent bending of light due to the quasi-bending of space. It was this forecast of this double bending of the light of a star passing near the sun which was so marvellous an achievement of Einstein.

As to the properties of space, there is to-day a great confusion of mind. There are those, who like Planck, stoutly maintain that "the æther is a superfluous hypothesis, and should be abolished." Larmor considers such an idea "repugnant to commonsense."

Space must be a plenum or a void. Electromagnet phenomena, wireless, radiant heat, light, X and gamma rays have an immense range of frequency and of intensity, but their velocities are alike c, and they are waves, capable certainly of interference.

The light from a star may spread outward on a sphere of as much as 2,000 light years' radius. It is useless to think of quanta or bundles of energy in such cases. Hence we are tied to an undulatory theory, and a void can scarcely be expected to undulate. Indeed the properties of space are those set forth in Maxwell's Electro-magnetic Equations. Can a space warp? Can it be Euclidean or non-Euclidean? These concepts originate and end in the human mind. The resulting ideas can be checked by experience and observation. The mechanical æther is dead; an electromagnetic æther is permitted, but not "explained." Perhaps it is crude thinking which makes us prefer to have undulations in a medium entirely unrealized, than to have undulations completely mysterious in a void.

Once again mathematical reasoning starting from experience has carried us forward into regions, faithfully portrayed by mathematical symbols, whose physical characters are beyond our powers of thought. So Maxwell preconceived wireless waves, Planck found his fundamental constant h, and now Einstein brings us into a strained space wherein not only does light bend, but the sun holds its planets in their orbits.

There is one point in the principle of relativity to which perhaps sufficient attention has not been directed. Faraday appears to have thought of lines and tubes of magnetic and of electrostatic force or induction as having physical reality. The views of Sir Joseph Thomson has emphasized such conceptions. Must we not now consider them as conceptions with no physical reality?

An electron travelling past you is an element of current, carrying with it a magnetic field. Travel, however, with the electron and to you there is no magnetic field.

A charged sphere shot past you has magnetic lines around it. Now keep the sphere "stationary" and go past it with reversal of relative velocity, and that sphere has to you a magnetic field around it.

Indeed if I go past it swiftly in one direction and you pass it swiftly in the other, then the magnetic lines are to us two in opposite directions. They are relative phenomena, so that the generation of magnetic lines by moving charges has no absolute significance nor can the line be said to have absolute value or existence in space or æther.

As regard such phenomena, however, Maxwell's equations are capable of verifying and predicting results. The load, so to speak, is adjusted correctly between magnetic and electric, for all velocities.

May I now present some further oddities which result from the Principles of Relativity and Equivalence, principles which modify in so profound a manner our outlook on the general scheme of the universe.

Let us assume that there is a genuine bending of space in the neighbourhood of the sun, or other matter, so that Euclidean space away from matter becomes non-Euclidean in its neighbourhood; so that the ratio of circumference to diameter of a circle is no longer π; so that Mercury no longer returns on its previous orbit but advances its perihelion; so that light is no longer bent Newtonian-wise, but to double that extent. Supposing all that, what happens inside matter?

The answer is given concisely enough. The analogy is fairly close to the difference between the nature of the gravitational potential or electrostatic potential, in matter or an electrically charged space, when $\nabla^2 V = -4\pi\rho$ (Poisson) in place of $\nabla^2 V = \varrho$ (Laplace), where the density of matter or charge is ρ or ϱ respectively. Inside water the radius of curvature of space is 570,000,000 kilometres. Eddington adds "Presumably, if a globe of water of this radius existed, there would not be room in space for anything else."

On which Lindemann comments "I regret the tendency to emphasize the metaphysical rather than the physical interpretation of Einstein's equations. Thus the statement that a sphere of 5.7x10^{13} cm. would occupy all space appears to me wrong. That an observer on such a sphere would believe it to occupy all space I agree, but we are not bound to accept his conclusion."

Undaunted, however, Eddington declares in the Second Edition of his excellent report "Matter does not cause the curvature of space-time; it is the curvature."

The mass of our Stellar system is estimated at a thousand millions of our suns; each spiral Nebula may be such a system, and the number of such nebulæ may be a million.

Hence all matter is guessed at a thousand billion (English) suns. Such a mass would apparently give us but a small space, 10^{15} kilometres, with a radius less than that of the distance of several naked-eye stars. Too small, in fact! Eddington concludes that "Einstein's hypothesis demands the existence of vast quantities of undetected matter which we may call world-matter."

He adds "If all matter were abolished, the radius of space-time would become zero and the world would vanish to a point. There is something rather fascinating in a theory of space by which the more matter there is, the more room is provided."

Einstein appears unwilling to admit that a thinkable space without matter could exist. But Eddington agrees with de Sitter in being unwilling to assent to vast quantities of world-matter which "fulfils no other purpose than to enable us to suppose it not to exist."

To those of us advancing in years the following recipe may be of interest, though hard of achievement:

"If you wish to achieve immortality and eternal youth, cruise about space with the velocity of light. You will return to the earth after what seems an instant, to find many centuries have passed away." Time has been stationary to the traveller!

There is a further elusive speculation. If light rays are bent in space, "apart from absorption of light in space we should see an anti-sun, at the point of the sky opposite to the sun equally large and equally bright, the surface-markings corresponding to the back of the sun" . . . . "not of the sun as it is now, but as the sun as it was when it emitted the light perhaps millions of years ago, when it was at another part of the stellar system." "We regret being unable to recommend the rather picturesque theory of anti-suns and anti-stars" (Eddington).

To conclude. Are these theories real and stable ? In some form, almost certainly, Yes! Modifications will no doubt be made, but the essentials have the aspect of lasting truth.

Practical affairs remain unmodified, but there has been achieved a permanent revolution in thought. What is that revolution ?

"It is impossible by any conceivable experiment to detect uniform motion through the æther ?" (Eddington) and "We have assumed fixed axes where nothing is fixed" (Jeans) and

"Henceforth space and time in themselves vanish to shadows, and only a kind of union of the two preserves an independent existence" (Minkovski).

Lastly, "All laws of nature shall be invariant as regards different sets of orthogonal axes in the continuum" (Jeans).

There is a story in the Arabian Nights that a crew landed from their ship on an island. When they kindled a fire the island proved to be the back of a whale!

Science has kindled a fire which has detected the whale, but it continues so closely to resemble an island that the bulk of mankind will continue their existence with little modification of their practical experiences. But the few will have acquired a profound alteration in their intellectual outlook.

Anemometric Tests with the Kata Thermometer

By L. H. NICHOLS, B.A.

(Presented by DR. A. S. EVE, F.R.S., F.R.S.C.)

(Read May Meeting, 1920)

(SUMMARY)

The Kata Thermometer[1] as designed by Dr. Leonard Hill and used for the determination of the cooling and evaporative powers of the atmosphere, consists of a large cylindrical bulb and a stem graduated from 95° to 100°F. The heat loss from the bulb in millicalories per square centimeter per second at its average temperature can be determined by dividing the time of cooling into a calibration factor for the instrument.

The great value and accuracy of the instrument under indoor conditions have been satisfactorily confirmed by many independent observers, but for outdoor work certain unexplained variations have reduced considerably the limits of the precision obtainable.

It is important to note therefore that the object of the anemometric tests is not so much to demonstrate its rather limited application as an anemometer as to check the theory of the instrument under practical conditions where the air circulation is rapid and irregular, and the incident radiation uncertain.

At the suggestion and with the advice of Dr. A. N. Shaw of McGill University, the writer has made a series of trials with the dry bulb used as an anemometer in the open air. These tests consisted of comparisons with three standardized anemometers, the Robinson Cup, the Hicks Turbine, and the Pitot Tube. The accuracy of observation and sensitiveness to gustiness of the two former instruments were greatly increased by improved recording mechanisms.

The Kata Thermometer has indicated values for wind velocities which were in some cases as much as 60 per cent greater than the average of those obtained by the standard anemometers mentioned. An analysis of the results on many different days confirms the fact that gustiness and radiation from the surroundings have a marked effect which varies with the conditions.

---

[1] Hill, Griffith and Flack, "The Measurement of the Rate of Heat-loss at Body Temperature by Convection, Radiation, and Evaporation." *Phil. Trans .Roy. Soc., B., Vol. 207, p. 201* (1915).

Hill, F., and Hargood-Ash, D., "On the Cooling and Evaporative Powers of the Atmosphere as Determined by the Kata-Thermometer." *Proc. Roy. Soc., B., Vol. 90, pp. 438–447 (1919).*

Experiments have been performed also with Kata Thermometers directly exposed first in the free air and then in vacuo under circumstances of controlled convection and radiation. In this way it has been possible to consider separately the effects of natural convection, independent air currents, and radiation.

The corrections necessary on account of gustiness and radiation for the formula which is applicable under the conditions of wind tunnel experiments have been found to have a value of the same order as that of the discrepancies obtained in comparisons with the anemometers.

The formulation and checking of these corrections over a large range of conditions is at present in progress.

McGill University.

On the Absorption and Series Spectra of Lead

By PROFESSOR J. C. McLENNAN, F.R.S., and R. V. ZUMSTEIN, M.A.

(Read May Meeting, 1920)

SYNOPSIS.

1. Absorption spectra of lead.
   The paper describes experiments which enabled the absorption of non-luminous lead vapour to be determined and it also gives a list of the reversals obtained in a lead-carbon arc.

2. Series spectra.
   Some suggestions are put forward for grouping into a principal series, two subordinate series and a combination series, certain prominent wavelengths in the spectrum of lead. Considerations are also presented in support of the view that three of the wavelengths in the spectrum of lead constitute members of an enhanced series.

I. INTRODUCTION

Up to the present no progress appears to have been made in classifying the wavelengths in the spectrum of lead into series except in the region of the X-ray characteristic radiations. Several observers have pointed out wavelengths in the spectrum of this element with constant frequency differences and some observations have been made by Purvis[1] with the Zeeman effect on the wavelengths in its spectrum which should prove useful in identifying series.

The studies made by De Watteville[2] on the flame spectrum of lead and of its salts should also aid in picking out those wavelengths, at least, which constitute fundamental series. With a number of the elements it has been found that the quantum relation $Ve = hn$ enables one when the resonance and ionisation potentials are known to pick out the first and the last members of the principal singlet series $n=(1\cdot5,S)-(m,P)$. As regards lead, Mohler, Foote, and Stimson[3] have recently shown by direct experiments on the ionisation of lead vapour that the resonance and ionisation potentials are respectively $1\cdot26$ volts and $7\cdot93$ volts.

Assuming the use of the quantum relation indicated above to be valid for the case of lead it would follow that the first member of the series $n=(1\cdot5,S)-(m,P)$ should be one or other of the strong lines $\lambda=10291$ A°U or $\lambda=10500$ A°U, which are both present in the lead spectrum. It would also follow that the last member of this series

[1] Purvis, Proc. Camb. Phil. Soc., Vol. 14, p. 216, 1907.
[2] De Watteville Phil. Trans. A375, p. 139, 1904.
[3] Mohler, Foote and Stimson, Phys. Rev. 14, p. 534, 1919.

should have approximately the frequency 64400 and the wave length $\lambda = 1558$ A°U. The experiments of Dearle,[2] however, have shown that with mercury vapour a resonance potential probably exists which corresponds approximately to $n = (2 \cdot 5, S) - (2, P)$, the frequency of the first member of the series $n = (2 \cdot 5, S) - (m, P)$. It may very well be then that the resonance potential found by Mohler, Foote, and Stimson for lead viz.: 1·26 volts, corresponds to the spectral frequency $n = (2 \cdot 5, S) - (2, P)$ for this element.

Some additional light has been shed on the problem of identifying spectral series for lead through some observations made by McLennan, Young, and Ireton on the spectrum obtained from lead when vapourised in the carbon arc. In these experiments a number of reversals were obtained, and from the character and positions of these the above named investigators were led to put forward tentatively certain groupings of the wavelengths as possible ones for series.

The following paper contains the results of an attempt to follow up these suggestions.

II. Absorption Experiments

Some experiments were made to determine if possible the absorption spectrum of non-luminous lead vapour. Considerable difficulty was experienced at first in obtaining any results on account of the fact that, although lead melts at a very low temperature, it does not vapourise to any great extent, even in vacuo, until a temperature is reached approximately the same as that at which quartz softens. An absorption spectrum was, however, finally obtained by using a quartz tube of special design and heating it in an electric furnace, provided with a coil of stout nichrome wire.

The tube was made of opaque fused quartz about 5 inches in length and one inch in diameter, and into its ends there was sealed two plates of plane parallel clear fused quartz. This tube stood up to the high temperatures required and these were obtained by forcing large currents through the stout nichrome wire. For the purpose of the experiments some lead was obtained from the Bureau of Standards at Washington which was considered to be of very high purity. About 50 grams of this lead was placed in the quartz tube and the latter was then highly exhausted and sealed up.

The wavelengths at which absorption was found are given in Table I, and with them are given the wavelengths which showed reversal in the experiments of McLennan, Young, and Ireton. The photographic plates used were either of the Ilford panchromatic type or those of the Schumann type prepared by The Adam Hilger Co.

Absorption in the infra-red was investigated with one of Hilger's Infra-red Spectrometers, and in the visible and ultra-violet region by Hilger's Quartz Spectrograph of types A and C. Reproductions of the photographs of the absorption spectrum of non-luminous lead vapour are shown in Fig. 1.

TABLE I

Lead Absorption Spectrum

Reversals obtained by McLennan, Young and Ireton			Absorption obtained by The Authors	
Sharp Reversals	Diffuse Reversals	Other Reversals	Absorption	Remarks
4058 A°U	2833 A°U	2115 A°U	2833 A°U	Marked absorption.
2614 "	2400 "	2088 "	2288 "	Faint absorption probably due to cadmium.
2247 "	2170 "	2054 "	2139 "	Faint absorption probably due to zinc.
2060 "	2015 "	2051 "	2170 "	Very strong absorption.
1973 "	1938 "	2049 "	2053·83"	Strong absorption
1925 "	1911 "	2023 "	2022·64"	Faint absorption.
1900 "	....	....	....	

The faint absorptions found at $\lambda = 2288$ A°U and $\lambda = 2139$ A°U were probably due to traces of cadmium and zinc present as impurities in the lead, as no radiations of these wavelengths were found in either the arc or spark emission spectra of lead.

No absorption was observed either at $\lambda = 10291$ A°U or at $\lambda = 10500$ A°U, but it is probable that if any did occur it was masked by the strong radiations of these wavelengths emitted by the furnace.

The first spectrum shown in Fig. 1 is that of the aluminium spark in air. The second is that obtained with a panchromatic plate of the light from the aluminium spark in air after passing through the lead vapour. The third is the same as the last except that it was taken with a plate of the Schumann type. The fourth is the spectrum of the lead spark in air and the fifth that of a carbon-lead arc in air. From these photographs it will be seen that absorption is well marked at $\lambda = 2833$ A°U and at $\lambda = 2170$ A°U. It should also be noted that the wavelength $\lambda = 2203 \cdot 57$ A°U was strongly enhanced in the spark spectrum.

III. Series Spectra

An attempt was first made to select wavelengths which might possibly belong to the series n = (1·5,S) − (m,P) by using the strongly absorbed wavelength $\lambda = 2170$ A°U in combination with the wavelengths given respectively by the resonance potential 1·26 volts, and the ionisation potential 7·93 volts. It was not found possible to select a series of wavelengths which would fit exactly to a simple formula, but the following grouping appeared to merit some consideration:

Table II

Principal Series

n = (1·5, S) − (m. P)
(1·5, S) = 64311

Wavelength	Frequency	Member No.	n = (M, P)
λ = 10500 A.°U.	9,521	2	54,790
λ = 2170·5	4,6072	3	18,239
λ = 1796·5	55,664	4	8,647
λ = 1682·5	59,435	5	4,876

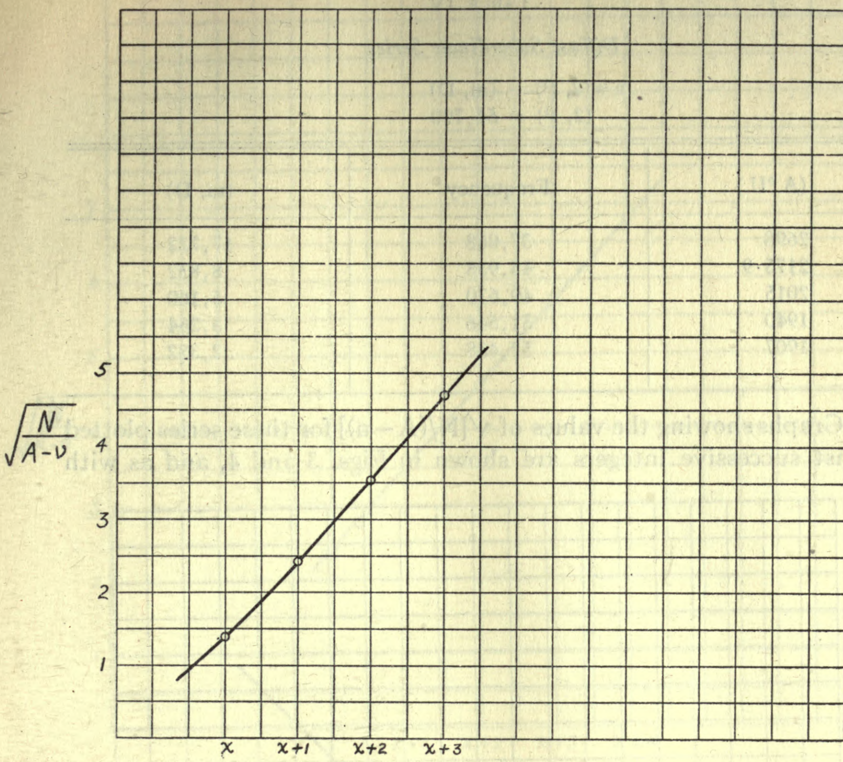
The third and fourth numbers of this series were calculated by applying the method of Savidge and Nicholson,[1] and using the wavelengths of the first two members of the series as given in the table as a basis. A graph, Fig. 2, was drawn showing the values of $\sqrt{[N/(A-n)]}$ for the series plotted against successive integers. The fact that it is regular and nearly linear shows that the series fits in fairly well with a formula of the Ritz-Rydberg type. This is especially interesting when it is considered that the first wavelength lies in the infra-red region and the second well down in the ultra-violet.

The wavelengths in this series all appear with strong intensity in the spark emission spectrum of lead[2] in air, but it will be noted that the only one shown to be absorbed by non-luminous lead vapour is $\lambda = 2170 \cdot 5$ A°U.

Assuming the above wavelengths to accurately represent the principal series n = (1·5,S) − (m,P) one can readily calculate the wavelengths of corresponding sharp subordinate and diffuse subordinate series. This has been done and the wave lengths are given in Table III and Table IV.

[1] Savidge and Nicholson. Phil. Mag. p. 563, 1915.

[2] McLennan, Ainslie and Fuller. Proc. Royal Soc., A. 95, p. 316, 1919.



PRINCIPAL SERIES

Figure 2

TABLE III

Sharp Subordinate Series

$$S = (2, P) - (m, S)$$
$$(2, P) = 54{,}790.$$

(A.°U.)	Frequency	n = (m, S)
10500	9,521	64,311
2873	34,802	19,988
2247	44,504	10,286
2060·5	48,532	6,259
1971·9	50,712	4,078
1925·9	51,924	2,866
1898·7	52,066	2,121

TABLE IV

Diffuse Subordinate Series

n = (2, P) − (m, D)
(2, P) = 54,790

(A.°U.)	Frequency	(m, D)
2698	37,068	17,722
2175·9	45,958	8,832
2015	49,630	5,160
1940	51,546	3,244
1907	52,438	2,352

Graphs showing the values of √[N/(A−n)] for these series plotted against successive integers are shown in Figs. 3 and 4, and as with

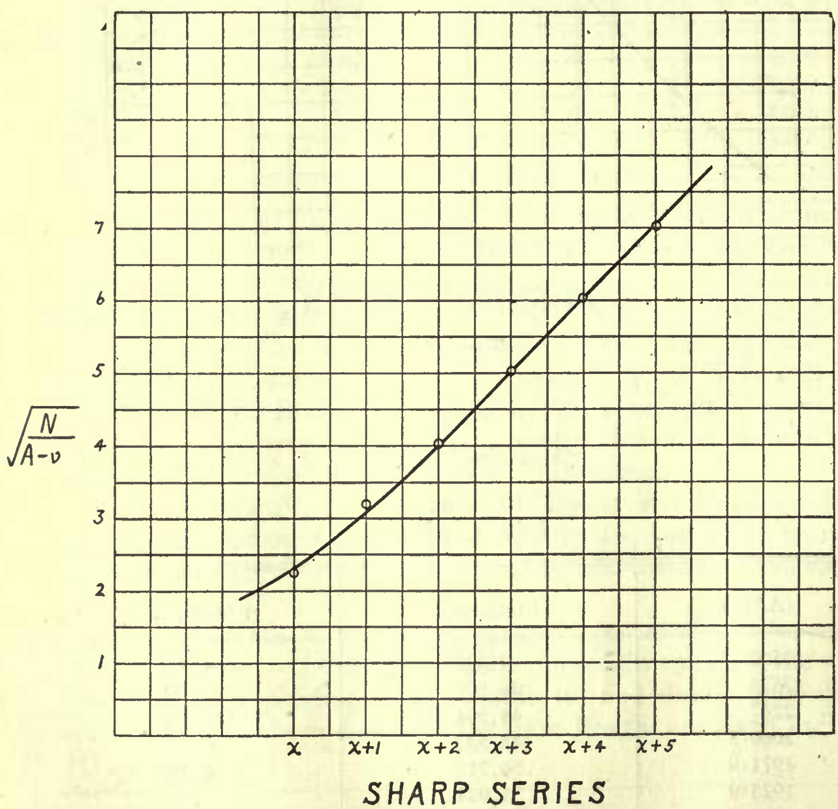


Figure 3

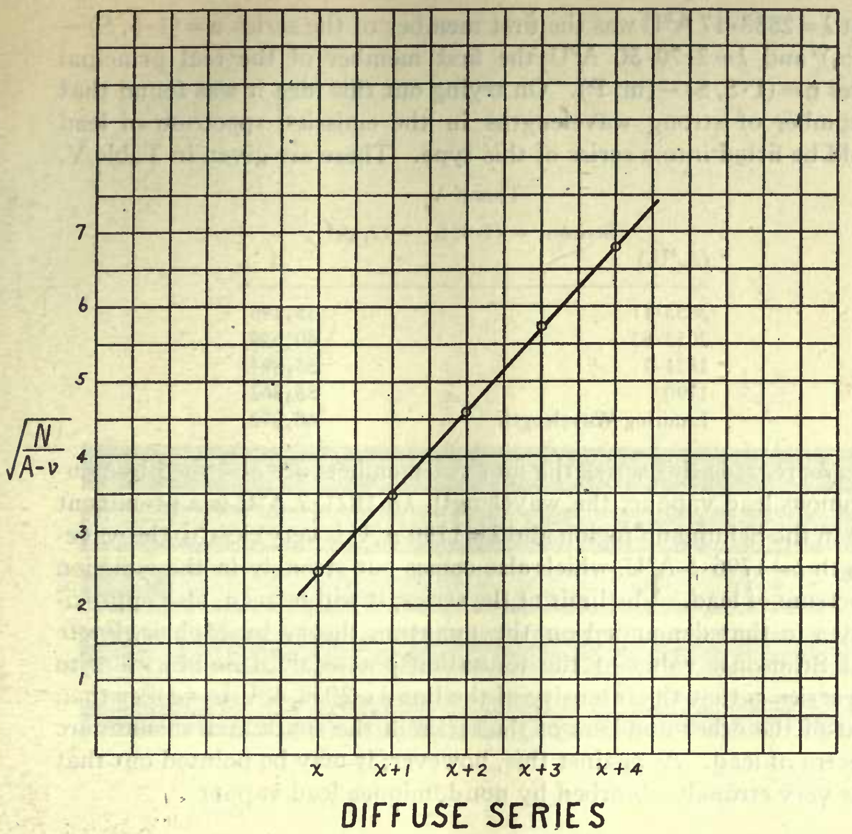


Figure 4

the principal series they show that the wavelengths selected are fairly well represented by a Ritz-Rydberg formula. All the wavelengths given in Tables III and IV correspond very closely to wavelengths found in the emission spectrum of lead and most of them showed reversal in the experiments made by McLennan, Young, and Ireton.

In the series which have been given above no provision is made for the wavelength $\lambda = 2833 \cdot 17$. This line it will be noted was strongly absorbed by non-luminous lead vapour, and it consequently should appear in some series which possesses fundamental characteristics.

Having in mind the series spectra of mercury, zinc and cadmium it was thought that possibly on later investigation the wavelength $\lambda = 10500$ A°U might turn out to be the first member of a series n = (2·5, S) − (m,P) instead of being the first member of the series n = (1·5, S) − (m, P). In this case one would naturally turn to the view that $\lambda=2833 \cdot 17$ A°U was the first member of the series $n=(1 \cdot 5, S)-(2, p_2)$ and $\lambda=2170 \cdot 50$ A°U the first member of the real principal series $n=(1 \cdot 5, S)-(m, P)$. On trying out this idea it was found that a number of strong wavelengths in the emission spectrum of lead could be fitted into a series of this type. These are given in Table V.

TABLE V

Series $n = (1 \cdot 5, S) - (2, p_2)$

(A.°U.)	n
2833·17	35,296
2053·83	40,689
1821·7	54,894
1790	55,862
Limiting Wavelength	60,072·

As regards this series the first two members are absorbed by non-luminous lead vapour, the wavelength $\lambda=1821 \cdot 7$ A°U is a prominent one in the Schumann region and $\lambda=1790$ A°U is very close to the wavelength $\lambda=1796 \cdot 5$ A°U, which also comes out strongly in the emission spectrum of lead. The limit of the series, it will be seen, also approximates to that demanded on the quantum theory by Mohler, Foote and Stimson's value of the ionisation potential. One objection to the series is that the intensity of the line $\lambda=2053$ A°U is weaker than that of the other numbers of the series in the spark and vacuum arc spectra of lead. As against this, however, it may be pointed out that it is very strongly absorbed by non-luminous lead vapour.

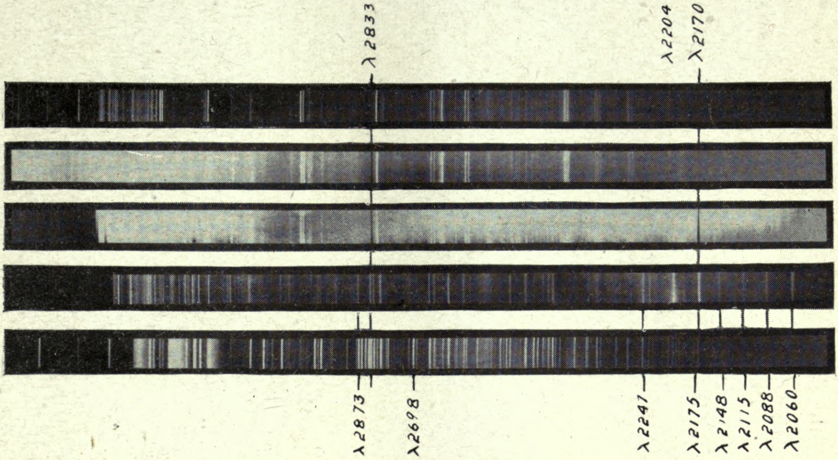
ENHANCED SERIES

Reference has been made above to the fact that the wavelength $\lambda=2203 \cdot 57$ A°U is strongly enhanced in the spark spectrum of lead. The work of Fowler on the series spectrum of magnesium suggests that this wavelength may possibly belong to a series of the 4 N type. A search was therefore made for other wavelengths which exhibited enhancement in the spark. Two others were found, and these are given in Table VI. It will be seen that these wavelengths fit in very well with a formula of the type $n = A - \frac{4N}{(m+p)^2}$

TABLE VI

Enhanced Series

(A.°U.)	n
2203·57	45,381
1726·2	52,930
1555·8	64,276



LEAD

Figure 1

The series given above are put forward tentatively in the hope that they may prove of service in drawing attention to a subject which in the light of Mohler's, Foote's, and Stimson's experiments on ionisation requires to be cleared up.

The Physical Laboratory,
University of Toronto.
May 15, 1920.

On the Mobilities of Ions in Helium at High Pressure

By PROFESSOR J. C. MCLENNAN, F.R.S., and MR. E. EVANS, M.A.

(Read May Meeting, 1920.)

SYNOPSIS

1. Absence of metallic conductivity.
   The experiments described in the paper shew that pure helium at high pressures does not exhibit any appreciable metallic electrical conductivity.

2. Mobilities of ions in helium at high pressures.
   The mobilities of positive and negative ions produced in helium at a pressure of 81 atmospheres by alpha rays from polonium have been shewn to be respectively $2 \cdot 52 \times 10^{-2}$ cms. per sec. per volt per cm. and $4 \cdot 26 \times 10^{-2}$ cms. per sec. per volt per cm. It has also been shewn that the mobilities do not vary inversely with the pressure at high pressures.

I. INTRODUCTION

It has been shown by Franck[1] that when argon, helium, and nitrogen are carefully purified, and especially when they are freed from oxygen and water vapour, there exists in them even at atmospheric pressure negatively charged particles having such high mobilities that one is led to conclude that they are free electrons. The values recorded are 206 cm/sec. per volt/cm. for argon, 500 cm/sec. per volt/cm. for helium, and 120 cm/sec. per volt/cm. for nitrogen. Haines[2] has confirmed this observation in so far as nitrogen is concerned, and he has also shown that the same result can be obtained with hydrogen if it be highly purified. Wellisch,[3] too, has shown that even in thoroughly dried air, free electrons can exist, at least for pressures as high as 10 cms. of mercury.

Quite recently a considerable supply of helium became available to the writers, and in view of the results recorded above, it was thought advisable to investigate the conductivity of this gas at very high pressure.

It appeared that if free electrons could exist in pure helium at high pressures in any considerable amount, the gas would exhibit in a measure something similar to a metallic conduction, and it would consequently be suitable in special cases for high resistances or other similar purposes. Some experiments were therefore made in this direction, and the results are given in the following note.

---

[1] Franck, Ber. d. Deut. Phys. Ges. (1909).

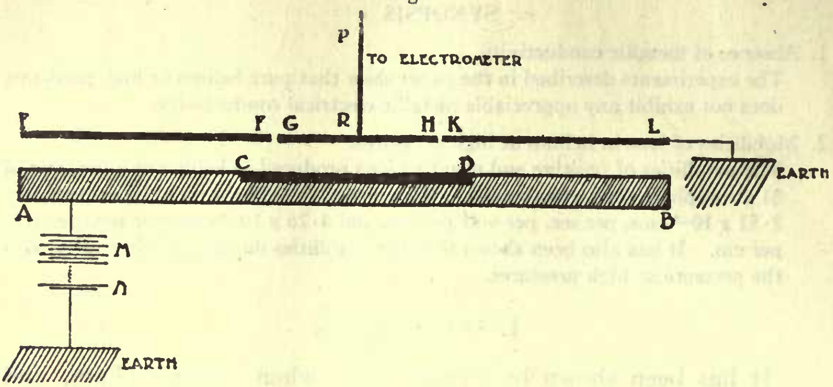
[2] Haines, Phil. Mag. Oct., 1915.

[3] Wellisch, Am. Jour. Sc., Vol. XXXIX. May, 1915.

II. Apparatus

The apparatus used in making the measurements was the same as that used by McLennan and Keys[1] for measuring the mobilities of ions in air at high pressures. It is shown in Figs. 1 and 2. AB was a

Fig. 1.



thick circular plate of brass about 8 cm. in diameter. GH was a circular brass plate 2 cm. in diameter, and EFKL was a guard plate surrounding GH. The plate GH was held firmly in position by an amber plug QX (see Fig. 2), with its lower face in the same plane as that of the guard plate EL. The plates AB and EL were kept at a distance of 1 cm. apart by ebonite supports, and the clearance between GH and the guard plate EL was about one-half a millimetre. A leading-in wire PR was attached to GH, and passing through the amber plug, QX, it made electrical connection with one of the pairs of quadrants of a Dolezalek electrometer. A leading-in wire attached to AB enabled one with an earthed battery of storage cells to charge the plate AB to any desired voltage. This ionisation chamber was placed in a strong steel cylinder, shown in Fig. 2, which had a capacity of about 1·5 litres. The wires leading from the plates AB and GH were passed through the walls of the cylinder, but carefully insulated from it. The leading wires and the ebonite plugs were tapered where they passed through the walls of the cylinder to withstand pressure without leakage, and soft black wax was melted into depressions above the tapered surfaces. This was found to be more resilient and satisfactory under high pressure than the harder forms of wax. The guard plate EL was electrically connected to the cylinder, and the latter was earthed.

---

[1] McLennan and Keys. Phil. Mag., vol. XXX. Oct., 1915.

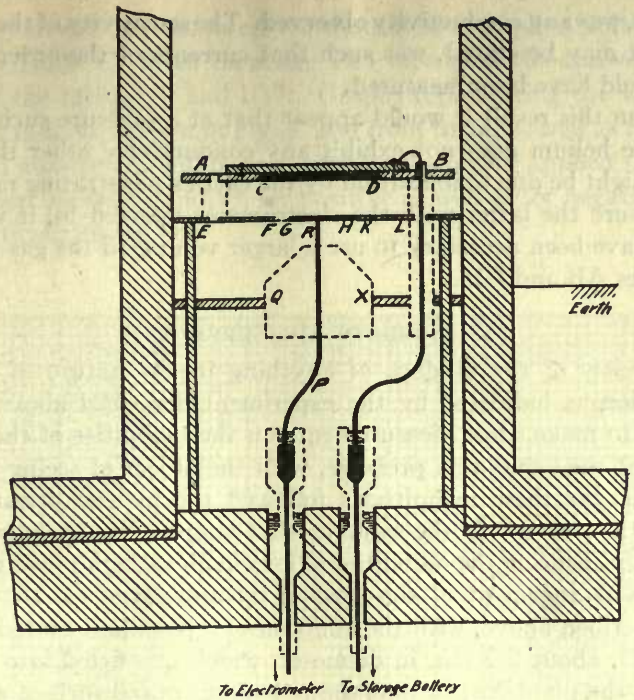


Fig 2

III. Purification of the Helium

The gas which was used in the experiments was purified by passing it through three stout copper tubes filled with cocoanut charcoal and maintained at the temperature of liquid air. From these it was passed into the steel cylinder which had been highly exhausted previously, and when the desired pressure was reached, a carefully constructed gas-tight valve was closed. Attached to the steel chamber was a fourth copper tube filled with charcoal. This was then surrounded with liquid air for some hours in order to remove any oxygen or nitrogen which might have come away from the walls of the cylinder, after the gas had been introduced to the latter. Finally, this latter was also cut off by closing a well-fitting valve, and measurements were then made on the conductivity of the gas.

IV. Conductivity Measurements

In making the conductivity measurements on the gas, various positive and negative potentials up to 80 volts were applied to the plate AB, the pressure of the gas being 81 atmospheres. In no case, however, was any conductivity observed. The sensitivity of the electrometer, it may be stated, was such that currents of the order of 10^{-5} e.s.u. could have been measured.

From this result it would appear that at a pressure such as that used, the helium does not exhibit any conductivity other than that which might be due to ionisation by the earth's penetrating radiation. To measure the latter with the electrometer referred to, it would of course have been necessary to use a larger volume of the gas between the plates AB and GH.

V. Mobility Measurements

In view of the absence of anything in the nature of metallic conduction as indicated by the experiment described above, it was decided to make some measurements on the mobilities of the ions in helium at the same high pressure, with the object of seeing whether with this gas these magnitudes followed the inverse pressure law. The method used was the same as that adopted by McLennan and Keys[1] in measuring the mobilities of ions in air at high pressures.

The arrangement of the parts of the apparatus was the same as that described above, with the addition of a polonium-coated, copper plate CD, about 2·5 cm. in diameter, which was fitted into a recess made in the plate AB, so that the polonium-coated surface was flush with the surface of the latter. The chamber was then filled with helium, purified in the same manner as that described for the preceding experiments.

As the range in helium of the alpha particles from polonium has been found by T. S. Taylor[2] to be 16·70 cm. at atmospheric pressure, the range at the pressure of 81 atmospheres would be, assuming the inverse pressure law to hold, 0·21 cm. By the arrangement indicated, therefore, an intense ionisation would be produced close to the polonium-coated surface, and confined to a layer of the gas about 2 mm. in thickness.

By applying various voltages between the plates AB and GH, and measuring the current passing to the plate GH due to the passage of the ions, the mobilities of the ions, assuming the ionisation to be confined to a very thin layer, can be found from the formula given by Rutherford[3].

$$(1) \quad K = \frac{32\pi d^3 i}{9 V^2} \quad \text{cm/sec. per 300 volts/cm.}$$

i and V being expressed in e.s.u.

---

[1] McLennan and Keys. Phil. Mag., vol. XXX. Oct. 1915.

[2] Taylor. Phil. Mag., vol. XXVI, p. 402 (1913).

[3] Rutherford. Phys. Review. Vol. XIII, p. 321 (1901).

The currents as measured for the different applied voltages are shown in Table I. With them are also tabulated the corresponding values of the ratios i/V and i/V^2. Graphs representing the values of the latter ratio are shown in Fig. 3, and from them, as well as from the tabulated numbers, it will be seen that for the higher applied voltages, the relation between i and V^2, for positive as well as for negative ions, was practically linear.

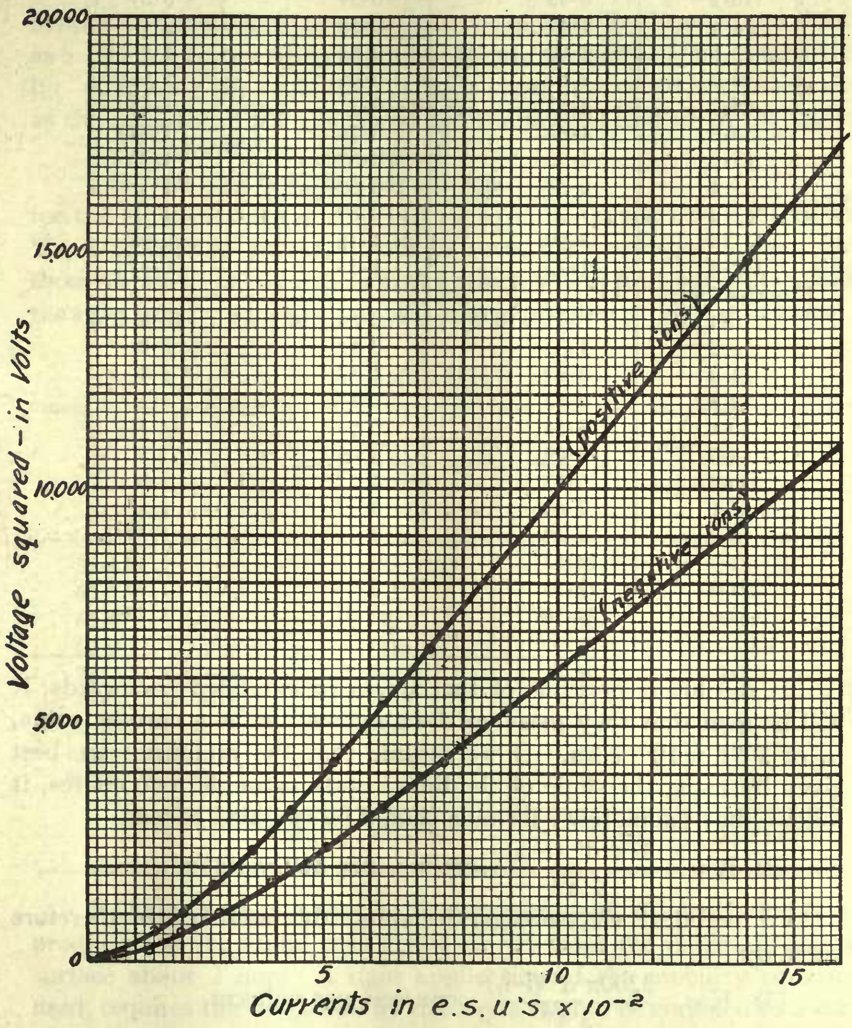


Figure 3

TABLE I

V—Applied Field in volts.
i—Current in e.s.u. per sq. cm.
k—Mobility $= 3 \cdot 35 \times 10^3 \times i/V^2$ cm/sec. per volt/cm.

Pressure = 81 atmospheres

V	i	i/V	i/V²
Positive ions			
8·1	$0 \cdot 47 \times 10^{-2}$	$0 \cdot 58 \times 10^{-3}$	$7 \cdot 1 \times 10^{-5}$
16·2	0·93	0·57	3·5
24·4	1·41	0·58	2·4
32·5	2·02	0·62	1·9
40·6	2·67	0·66	1·62
48·7	3·52	0·72	1·48
56·8	4·34	0·76	1·34
65·0	5·33	0·82	1·2[illegible]
73·1	6·34	0·86	1·1[illegible]
81·2	7·23	0·89	1·1[illegible]
121·8	13·99	1·15	0·94
162·4	21·72	1·33	0·82
Negative ions			
8·1	$0 \cdot 71 \times 10^{-2}$	$0 \cdot 88 \times 10^{-3}$	$10 \cdot 8 \times 10^{-5}$
16·2	1·33	0·82	5·0
24·4	2·02	0·83	3·4
32·5	2·83	0·87	2·7
40·6	3·84	0·94	2·3
48·7	5·09	1·04	2·1
56·8	6·32	1·12	2·0
65·0	7·60	1·17	1·8
73·1	8·50	1·16	1·59
81·2	10·52	1.29·	1·59
121·8	21·26	1·74	1·46
162·4	31·10	1·91	1·18

If the linear portions of the curves be extended backwards, it will be seen that they meet on the abscissæ line at a current value, i_0, of $1 \cdot 98 \times 10^{-2}$ e.s.u. If we assume that the mobilities are best given by using the slope of the linear portions of the two curves, it follows that the mobility formula should be modified to read

$$(2) \quad K = \frac{32\pi \, d^3 \, (i - i_0)}{9 \, V^2} \text{ cm/sec. per 300 volts/cm.}$$

In practical electromagnetic units, the mobility is therefore given by

$$(3) \quad K = \frac{3200\pi \, d^3 \, (i - i_0)}{3 \, V^2} \text{ cm./sec. per volt/cm.}$$

where i and i_0 are in e.s.u. and V in volts.

The values of $\frac{i-i_0}{V^2}$ have been calculated, and are given in Table II.

Using the mean value of $\frac{i-i_0}{V^2}$ for the positive and negative ions respectively, from Table II, it follows that

k_1 (positive) $=2\cdot 52\times 10^{-2}$ cm./sec. per volt/cm.

k_2 (negative) $=4\cdot 26\times 10^{-2}$ cm./sec. per volt/cm.

The values of the mobilities of positive and negative ions in helium at atmospheric pressure have been given by Franck and Pohl [1] as 5·09 cm./sec. per volt/cm. and 6·31 cm./sec. per volt/cm. respectively. Assuming the mobilities of both types of ions to vary inversely as the pressure of the gas, these determinations lead us to the values

$k_1=6\cdot 28\times 10^{-2}$ cm./sec. per volt/cm.

$k_2=7\cdot 80\times 10^{-2}$ cm./sec. per volt/cm.

for the mobilities of the respective ions in helium at 81 atmospheres. These calculated values, it will be seen, are somewhat higher than those obtained in our experiments, which would lead one to conclude that the inverse pressure law was not applicable at high pressures.

TABLE II

V	Positive ions		Negative ions	
	i	$\frac{i-i_0}{V^2}$	i	$\frac{i-i_0}{V^2}$
56·8	$4\cdot 34\times 10^{-2}$	$\cdot 731\times 10^{-5}$	$6\cdot 32\times 10^{-2}$	$1\cdot 34\times 10^{-5}$
60·9	4·81	·757	7·03	1·36
65·0	5·33	·792	7·60	1·33
69·0	5·86	·815	8·08	1·28
73·1	6·34	·816	8·50	1·22
77·1	6·41	·745	8·97	1·18
81·2	7·23	·749	10·52	1·30
121·8	13·99	·810	21·26	1·30
162·4	21·72	·748	31·10	1·10
	Mean	$\cdot 751\times 10^{-5}$	Mean	$1\cdot 27\times 10^{-5}$

It should be noted that, at the pressure used, the ionisation layer produced by the alpha rays extended out from the polonium-coated surface about 2 mm. A rigid application of the mobility equation used, requires the ionisation by the alpha rays to be confined to a very

[1] Franck and Pohl. Ber. d. Deut. Phys. Ges. pp. 69 and 194 (1907).

thin layer close to the surface of the plate CD. As indicated above, this condition did not strictly obtain in our experiments. It will be seen, however, that the effect of this departure from the requirements of the formula, would be to make the effective value of d, the distance between GH and CD, to be slightly less than 1·0 cm., which in turn would lead to values of k_1 and k_2 even less than those found. This result would make the difference between our values for the mobilities and those calculated from Franck and Pohl's numbers even more marked, and would go to emphasise still further the inapplicability of the inverse pressure law for the mobilities of ions in helium, especially at high pressures.

The measurements were not extended to lower pressures, because by so doing the thickness of the ionisation layer would be increased still further. This would render the mobility formula more inapplicable than ever. Pressures higher than 81 atmospheres were not available at the time the experiments were carried out.

The Physical Laboratory,
University of Toronto.
May 15, 1920.

The Pendulum, Simple Harmonic Motion, The Elastic Moduli and Impact—A Laboratory Experiment

By JOHN SATTERLY, F.R.S.C.

(Read May Meeting, 1920)

The author uses in the elementary Physics Laboratory at Toronto, an experiment which bears the name of "The Suspended Ball." The main part of the apparatus is a heavy spherical iron ball which hangs by a fine steel wire from the ceiling. The experiment is used as a review experiment, for it comprises in itself experiments on:

1. The triangle of forces;
2. Simple harmonic motion;
3. The simple pendulum;
4. Young's modulus of the metal of the suspension wire;
5. The modulus of rigidity of the metal of the suspension wire;
6. The transverse vibration of wires;
7. The longitudinal vibration of wires;

and, provided that two balls hang side by side, experiments on:

8. Impact and the Conservation of Momentum;
9. The co-efficient of restitution.

The iron ball E (Fig. 1), which weighs about 30 pounds, has been trimmed to the spherical shape, and two hooks, H and K, fixed to it. To one, H, is soldered the suspension wire, which is of such length that with the upper end of the wire soldered to a metal frame screwed to the ceiling the ball hangs with its bottom about an inch above the bench.

The other hook, K, is used as an attachment by which the ball can be drawn to one side by a horizontal force. The first part of the experiment consists in finding the relation between this horizontal force and the horizontal displacement. To get several values of the force, a chain, C, made up of 3 inch portions of a light chain (the chain used to pull down blinds is convenient for the purpose), the portions being joined together by ¾-inch rings, R_1, R_2, R_3, etc. This chain is linked up to a spring balance, D, reading to ounces. An old wooden retort or burette stand, P, cut down to about 8 inches high, is screwed to the bench in the line of movement of the ball. On hitching the spring balance into the hook K, and looping in turn successive rings over the post P, the ball can be pulled aside by different amounts and the forces read off on the spring balance. To measure the displacements an inch scale SS (reading to 1/10 in.) is screwed down to the bench and a block of wood, F, with an inset piece of brass bearing a sharp vertical line, I, follows up the ball. The position of the index is read to 1/10 of 1/10th of an inch.

In Fig. 1, E shows the ball hanging in its position of rest with the block F in contact with it and E^1, F^1, show their positions when the chain has been used to pull the ball back. Fig. 2 (plate) gives a photograph showing the ball in the displaced position.

The experiment from now onward is described in abbreviated "Instruction Sheet" form with the addition of a few numerical results.

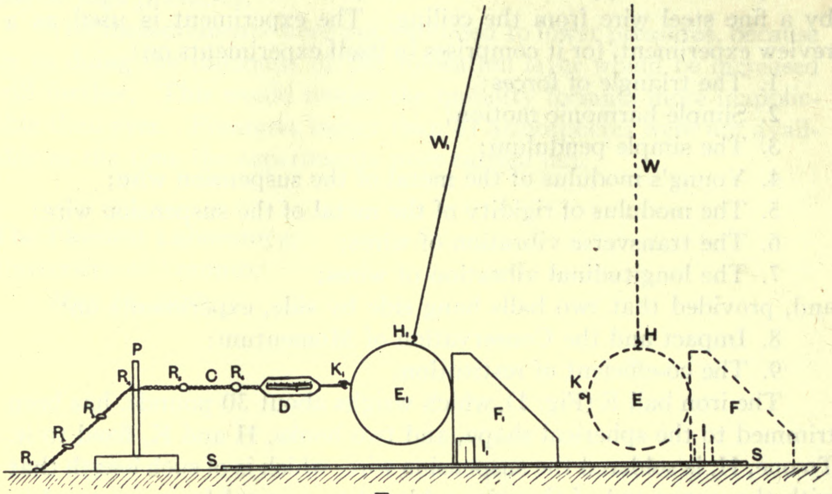


Fig 1.

EXPERIMENT I.—*Find the relation between the force required to produce a horizontal displacement and the magnitude of that displacement.*

Start from the position of zero displacement and loop one ring after another over the post. Read the dynamometer. The dynamometer reads to ounces. Double that reading gives very nearly the force in poundals. Therefore, record forces in poundals. Follow up the ball with the block F, and take the scale reading. Enter up results as indicated.

1	2	3	4	5
Force Poundals	Reading on the scale of the index mark I	Displacement of ball from zero position		The Ratio Force (poundals) ÷ displacement (feet)
		inches	feet	
O	A	O	O	
b	B	A–B	(A–B) 12	$\frac{b/A-B}{12}$
c	C	A–C	(A–C)/12	$c/\frac{A-B}{12}$
etc	etc	etc	etc	etc

Plot a curve between the numbers in the first and fourth columns and from the slope find the average value of the ratio force / displacement. Compare this value with the average of the number in the last column. Denote this constant by k.

Here is a sample set of figures:

1	2	3	4	5
0	37·26	..	..	..
25	33·62	3·64	·30	83
45	30·87	6·39	·53	85
67	27·90	9·36	·78	86
92	24·92	12·34	1·03	87
115	21·80	16·46	1·37	84
			Average	85

Therefore force (in dynes)=85 × displacement (in feet).

Further Theory.—When the displacement of a body from its position of rest is proportional to the displacing force, say k times this force, it follows that the force urging it back towards its normal position is also k times the displacement. Also when the body is vibrating in the line of this displacement the product "mass of body × its acceleration" is k times the displacement. But if the acceleration is proportional to the displacement the motion of the body is simple harmonic and the period is given by:

$$t = 2\pi\sqrt{\frac{\text{displacement}}{\text{acceleration}}}$$, which may be written

$$t = 2\pi\sqrt{\frac{\text{mass of body} \times \text{displacement}}{\text{mass of body} \times \text{acceleration}}}$$

$$= 2\pi\sqrt{\frac{\text{mass of body} \times \text{displacement}}{\text{displacing force}}}$$

$$= 2\pi\sqrt{\frac{\text{mass of body}}{\text{displacing force / displacement}}}$$

$$= 2\pi\sqrt{\frac{\text{mass of body}}{\text{k}}} = 2\pi\sqrt{\frac{\text{M}}{\text{k}}}$$

EXPERIMENT II.—Let the ball swing to and fro as a simple pendulum and find its time of swing. Make a mark on the bench to mark the central position and take the transits in one direction only. Enter up every fifth transit as indicated in the table.

Passage	Actual time by watch hrs. mins. secs.	Passage	Actual time by watch hrs. mins. secs.	Time occupied by 30 swings
0th	A	30	G	G–A
5th	B	35	H	H–B
10th	C	40	J	etc.
15th	D	45	K	"
20th	E	50	L	"
25th	F	55	M	"
			Average	..

Divide the average of the numbers in the last column by 30 to get the period t.

The ball dealt with above had a simple pendulum period of 3·76 seconds.

Combination of the results of Experiments 1 and 2.

From $t = 2\pi\sqrt{\frac{M}{k}}$ we get

$$M = \frac{kt^2}{4\pi^2} = \frac{85 \times 3\cdot76^2}{4 \times 9\cdot87} = 30\cdot5 \text{ pounds.}$$

which may be one per cent low from taking $g = 32$ instead of $32\cdot2$, and another per cent out from errors in the spring balance readings.

Find the length of the wire supporting the pendulum.

The wire is so long that the effective length of the simple pendulum is from the point of support to the centre of the bob. Calling this L, we get:

$$t = 2\pi\sqrt{\frac{L}{g}}$$

$$L = \frac{gt^2}{4\pi^2}$$

Numerically, in the case considered

$$L = \frac{32\cdot2 \times 3\cdot76^2}{4 \times 9\cdot87} = 11\cdot50 \text{ feet}$$

Measure the diameter of the sphere with the block of wood F, get the radius and the length of the hook and subtract from the above to get l, the length of the wire.

The diameter $= 6\cdot25$ inches $= \cdot52$ feet

The radius $= \cdot26$ feet

The length of the hook $= 1\cdot9$ inches $= \cdot16$ feet

Therefore, length of wire $= 11\cdot50 - (26 + \cdot16) = 11\cdot04$ ft.

If the length of the pendulum had been known the experiment could have been treated as an exercise on the Triangle of Forces, and the weight of the ball deduced.

Experiment V.—*The Modulus of the Rigidity of the Suspension Wire.*—Set the ball vibrating around the wire as axis and take its period of vibration. To facilitate this, a vertical white line is painted on the ball (see photograph). The vibrations should be timed in successive fives as described above.

The time of vibration is given by the formula

$$t_1 = 2\pi\sqrt{\frac{\text{Moment of Inertia of the Ball about vertical axis}}{\text{Couple of restitution exerted by the wire per unit angular displacement.}}}$$

If l = the length of the wire in feet

a = radius of cross section of wire, in feet

n = modulus of rigidity of material of wire

I = Moment of inertia of ball about the axis of vibration

$$t_1 = 2\pi\sqrt{\frac{I}{\frac{n\pi a^4}{2l}}}, \quad \text{or,} \quad n = \frac{8\pi Il}{t_1^2 a^4}$$

In the case of a suspended sphere $I = \dfrac{2\,Mr^2}{5}$

where M = mass of sphere   r = radius of sphere

$$\therefore n = \frac{16}{5}\,\frac{\pi Mr^2 l}{t_1^2 a^4}$$

Since a occurs to the fourth power it must be measured carefully. Select four places of the wire at equidistant intervals and measure the radius at those places in two directions at right angles. Correct for any zero error on the gauge.

In the experiment quoted

$t_1 = 50 \cdot 2$ seconds

$a = \cdot 000115$ feet

$$n = \frac{16 \times \pi \times 30 \cdot 5 \times 0 \cdot 26^2 \times 11 \cdot 04}{5 \times 50 \cdot 2^2 \times \cdot 000115^4} \text{ poundals per sq. ft.}$$

$= 5 \cdot 3 \times 10^{10}$ poundals per sq. foot

$= 1 \cdot 65 \times 10^9$ pounds per sq. ft.

The value of n can also be deduced from an experiment in which by means of two delicate spring balances (reading to 10 gms., say) and a piece of fine string, couples can be applied to twist the ball through successive angles of 2π, 4π, 6π, 8π, etc., deducing the average value of the ratio of the couple G to the angular displacement θ, and using the formula $n = \frac{G}{\theta} \frac{2l}{\pi a^4}$

Experiment IV.—*Young's Modulus of the Suspension Wire.*— If the ball is lifted up in the hands so that the wire is relieved of its weight and the hands suddenly removed, the ball drops and then vibrates up and down. The motion is simple harmonic and the period is given by

$$t_2 = 2\pi \sqrt{\frac{\text{Mass of ball}}{\text{Ratio of force to elongation of wire for forces parallel to the length of the wire.}}}$$

If Y = Young's Modulus of the metal composing the wire, and if a force F produces an elongation e

$$Y = \frac{F / \pi a^2}{e / l} = \frac{F}{e} \cdot \frac{l}{\pi a^2}$$

$$\frac{F}{e} = \frac{\pi Y a^2}{l}$$

$$t_2 = 2\pi \sqrt{\frac{M}{\frac{\pi Y a^2}{l}}} \text{ or } Y = \frac{4 \pi M l}{t_2^2 a^2}$$

t_2 is so short that a stop watch must be used and the time occupied by a large number of vibrations recorded as nearly as possible.

In the experiment quoted the ball made approximately six vibrations per second, so that

$$t_2 = 1/6 \text{ sec.}$$

$$\text{Therefore, } Y = \frac{4\pi\, 30\cdot 5 \times 11\cdot 04}{(1/6)^2 \times \cdot 000115^2} \text{ poundals per sq. foot.}$$

$$= 1\cdot 26 \times 10^{11} \text{ poundals per sq. foot}$$

$$= 4\cdot 0 \times 10^{9} \text{ pounds per sq. foot}$$

If the ball is gripped by the hands and urged up and down with the right frequency it is surprizing what a large resonant vibration can be produced. A change in the frequency of the effort quickly destroys the motion.

Calculation.—Having got n and Y deduce Poisson's ratio of the material of the wire. This ratio $= \frac{Y}{2n} - 1 = 1\cdot 21 - 1 = \cdot 2.$

EXPERIMENT VI.—*Determine the frequency of transverse vibration of the wire.*

Twang the wire by the finger in a direction at right angles to its length and determine the frequency of the note by a comparison method with a monochord or by a tonometer.

If the frequency is N

$$N = \frac{1}{2\,l}\sqrt{\frac{\text{tension}}{\text{mass per unit length.}}}$$

$$= \frac{1}{2\,l}\sqrt{\frac{M\,g}{\pi\, a^2\, \rho}}$$

where ρ the density of the material of the wire.

Assume a value of ρ and calculate N and compare the observed and calculated values. In experiment quoted, N, calculated, is 310.

EXPERIMENT VII.—*Determine the frequency of longitudinal vibration of the wire.*

Rub the wire lengthwise between finger and thumb or with a wet rag. The wire gives out a shrill note. Estimate the frequency of this note as nearly as you can (see above). If it is N_1

$$N_1 = \frac{v}{2\,l}$$

where v = the velocity of sound in the wire

$$= \sqrt{\frac{Y}{\rho}}$$

Assuming the value of Y calculated above calculate N_1 and compare it with the observed value. In the experiment quoted the calculated value of N_1 is 721.

The Laws of Impact.—If two bodies collide in direct collision, experiment will establish:

1. There is no change of momentum in the line of motion.
2. The ratio

$$\frac{\text{Relative velocity of separation of the two bodies}}{\text{Relative velocity of approach of the two bodies}}$$

is a constant. This constant is called the co-efficient of restitution.

An easy way of testing these laws is to hang two bodies side by side by two vertical wires of effective equal lengths. The balls should hang just in contact when at rest.

If one or both are drawn back and then released simultaneously they will collide in their lowest position, *i.e.*, their normal position when hanging at rest.

If M, M_1 = the respective masses of the two balls
u, u_1 = " " velocities " " " before impact
v, v_1 = " " " " " " after impact

all velocities being measured in the same direction, then the first law asserts

$$Mu + M_1u_1 = Mv + M_1v_1 \quad (1)$$

and the second law that

$$\frac{v_1 - v}{u - u_1} = \text{a constant} = e, \text{ say.}$$

If the balls are not withdrawn far from their normal positions the velocities on reaching the normal position, after leaving freely a position whose displacement is d, can be shewn to be very nearly equal to

$$d\sqrt{\frac{g}{L}} \text{ or } \frac{2\pi d}{t}$$

where t = the period of the ball vibrating as a simple pendulum, so that since velocities occur on both sides of equation (1) we may simply take velocities as proportional to the displacements. In the experiments the displacements are measured by blocks of wood as described above and averages are taken of several readings. No attempt need be made to read finer than 1/10-inch.

In a first experiment with balls weighing 30·5 and 9·9 pounds, the big ball was drawn back 22·5 inches, the little one remaining at rest. The big one was then released and after the collision the little one went forward 27·3 inches, and the big one 13·6 inches.

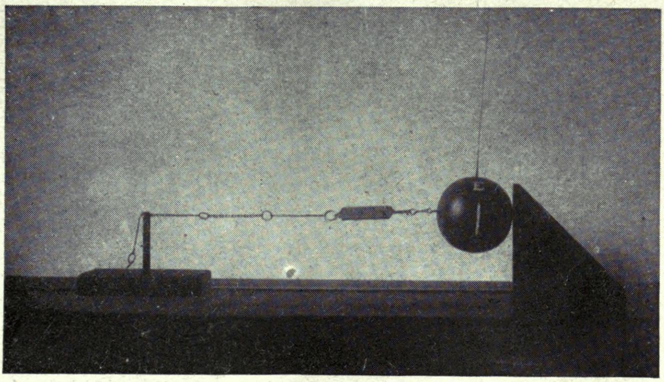


Figure 2

Then $Mu + M_1u_1 = 30{\cdot}5 \times 22{\cdot}5 + 9{\cdot}9 \times 0 = 687$

$Mv + M_1v_1 = 30{\cdot}5 \times 13{\cdot}6 + 9{\cdot}9 \times 27{\cdot}3 = 415 + 270 = 685$

therefore the momenta are equal.

$$\text{Also } e = \frac{27{\cdot}3 - 13{\cdot}6}{22{\cdot}5} = \frac{13{\cdot}7}{22{\cdot}5} = {\cdot}61$$

In a second experiment the little ball was drawn back 27·3 inches, and the big ball left hanging at rest. After the collision the big one went forward 11·0 inches and the little one rebounded 5·7 inches.

Then $Mu + M_1u_1 = 30{\cdot}5 \times 0 + 9{\cdot}9 \times 27{\cdot}3 = 270$

and $Mv + M_1v_1 = 30{\cdot}5 \times 11{\cdot}0 - 9{\cdot}9 \times 5{\cdot}7 = 336 - 57 = 279$

therefore the momenta are practically equal.

$$\text{Also } e = \frac{11{\cdot}0 + 5{\cdot}7}{27{\cdot}3} = \frac{16{\cdot}7}{27{\cdot}3} = {\cdot}61 \text{ as before}$$

In a third experiment both balls were drawn back and released at the same moment. They collided in their lowest positions and the results obtained confirmed the laws.

It is plain from the above description that the experiment is very instructive and needs only simple apparatus. These are two worthy commendations.

The Practical Study of a Catenary

BY JOHN SATTERLY, F.R.S.C.

(Read May Meeting, 1920)

The catenary furnishes to the student beginning the calculus one of the prettiest examples of applied mathematics. Yet it is rare that the student verifies the equation by practical work on a real hanging chain. The author has for some years encouraged his students to see what they could get out of such an experiment and the following results may be of interest to others.

MATHEMATICAL TREATMENT

The equations of the catenary are obtained as follows:

Let B A C (Fig. 1) be the hanging chain. Then considering one half only of the chain we get AB, Fig. 2.

Let w = weight of unit length of chain

s = the length of chain from AB to some point, P

T_0 = the tension at A, the lowest point

T_1 = the tension at P

θ = the slope of the chain at P

Then applying the triangle of force to the three forces, T_0, T_1 and ws (= the weight of the chain AP), we get

$$T_1 \cos \theta = T_0 \qquad (1)$$

$$T_1 \sin \theta = ws \qquad (2)$$

$$\frac{ws}{T_0} = \tan \theta$$

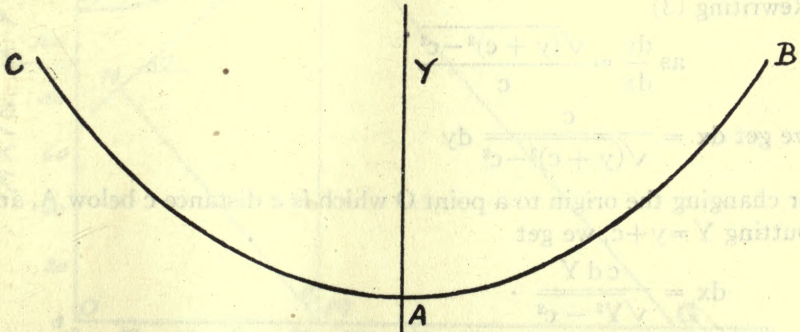


Fig 1

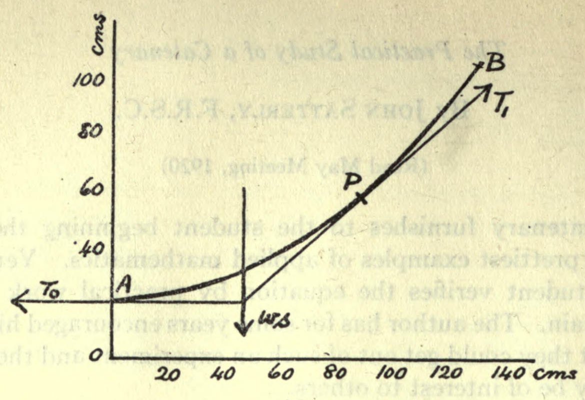


Fig. 2.

whence by putting $T_0 = wc$ where c is some length not otherwise defined we get

$$\tan\theta = \frac{ws}{wc} = \frac{s}{c}$$

Putting therefore $$\frac{dy}{dx} = \frac{s}{c} \qquad (3)$$

we get $$\frac{dy}{ds} = \frac{s}{\sqrt{c^2 + s^2}}$$

and taking, for a time, the origin at A, axis of x horizontal and axis of y vertical, we get by integration of this equation

$$y = \sqrt{c^2 + s^2} - c$$

$$\text{whence } s = \sqrt{(y + c)^2 - c^2}.$$

Rewriting (3)

$$\text{as } \frac{dy}{dx} = \frac{\sqrt{(y + c)^2 - c^2}}{c}$$

$$\text{we get } dx = \frac{c}{\sqrt{(y + c)^2 - c^2}}\, dy$$

or changing the origin to a point O which is a distance c below A, and putting $Y = y + c$, we get

$$dx = \frac{c\,dY}{\sqrt{Y^2 - c^2}}\,.$$

Making the substitution $Y = c \cosh \omega$, and integrating we get

$$Y = c \cosh \frac{x}{c}\,, \qquad (4)$$

also $s = c\frac{dy}{dx} = c\frac{dY}{dx} = c \sinh\frac{x}{c}$, (5)

also from (1) and (2)

$T_1 = \sqrt{T_0^2 + w^2s^2} = w\sqrt{c^2 + s^2} = w(y + c) = wY$ (6)

i.e. the tension at P is equal to the weight of chain which would reach from P down to the new axis of x.

Also from (1) and (2)

$\tan\theta = \frac{ws}{T}$

whence $s = c \tan\theta$ (7)

which is the intrinsic equation.

The Radius of Curvature at P may be shewn to be equal to $\frac{Y^2}{c}$ and is therefore equal to the normal PG (Fig. 3).

If a perpendicular is dropped from M, the foot of the ordinate of P upon the tangent PN intersecting it at N, then MN=c and PN=s.

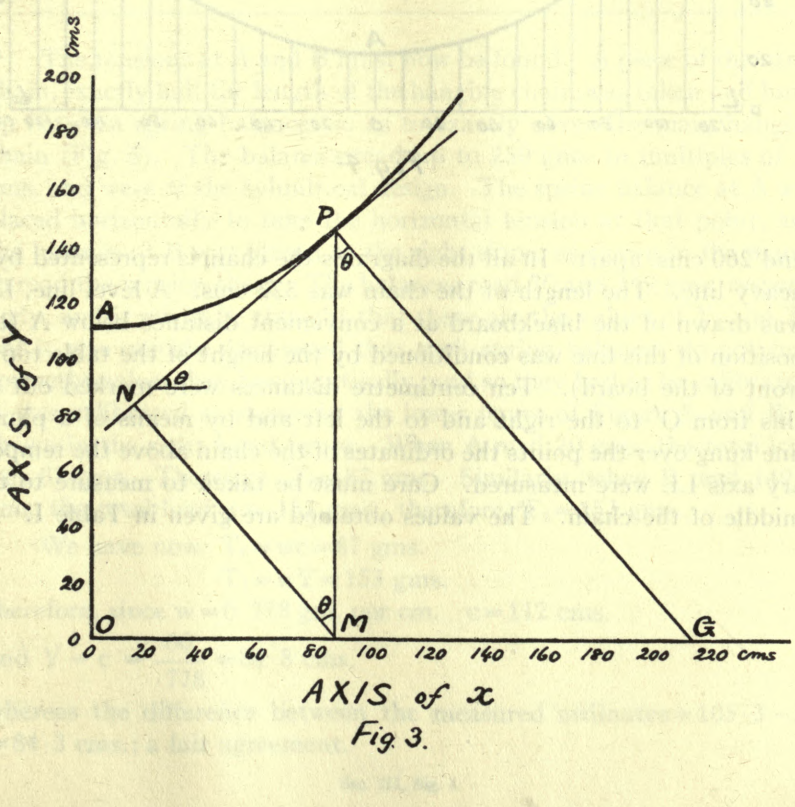


Fig. 3.

Therefore as P travels outwards from N the point N′ traces a curve (the tractrix) such that the length of the tangent to the catenary included between the catenary and the tractrix is equal to the length of chain from A to P. Also the tangent to the tractrix is of constant length.

Experimental Treatment

In the experiment to be described the chain known to the trade as Jack Chain No. 14 was employed. Its linear density is very uniform, averaging about ·778 gms. to the centimetre. It was hung from two nails, B and C (Fig. 4), driven into a blackboard, on the same level

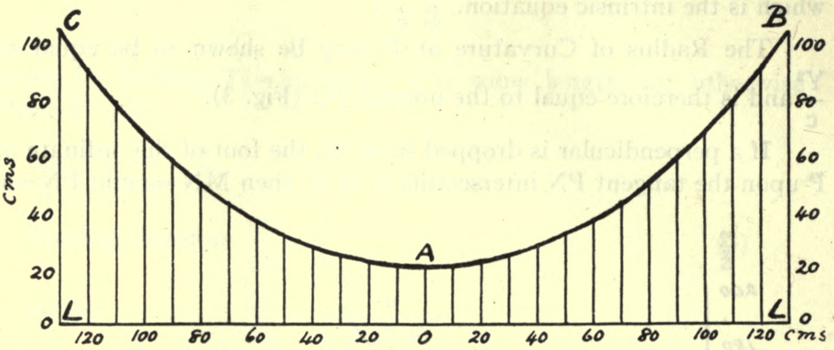


Fig. 4

and 260 cms. apart. In all the diagrams the chain is represented by a heavy line. The length of the chain was 322 cms. A level line, LL, was drawn of the blackboard at a convenient distance below A (the position of this line was conditioned by the height of the table top in front of the board). Ten centimetre distances were marked out on this from O′ to the right and to the left and by means of a plumb line hung over the points the ordinates of the chain above the temporary axis LL were measured. Care must be taken to measure to the middle of the chain. The values obtained are given in Table I.

TABLE I

To the Left		To the Right	
Ordinate	x	x	Ordinate
cms.	cms.	cms.	cms.
21·0	0	0	21·0
21·5	− 10	10	21·5
22·8	− 20	20	22·8
25·0	− 30	30	25·2
28·0	− 40	40	28·0
32·5	− 50	50	32·5
37·5	− 60	60	37·7
43·8	− 70	70	43·5
50·9	− 80	80	50·7
59·0	− 90	90	59·0
68·5	−100	100	68·5
79·4	−110	110	79·5
91·5	−120	120	91·7
105·3	−130	130	105·5

The tensions at A and B must now be found. A piece of the same chain, exactly half the length of the hanging chain, was taken and hung up between spring balances so as to exactly cover the main hanging chain (Fig. 5). The balances read up to 250 gms. in multiples of 10 gms. and were of the cylindrical design. The spring balance at A was placed horizontally to take the horizontal tension at that point, and the balance at B was placed at the right slope, as shewn in the figure, to read the tension there. The balances read 70 and 149 gms. respectively, and it might be thought that these are the values of T_0 and T_1, but it was quickly discovered that such spring balances do not read correctly unless they hang vertically, and so they had to be calibrated. A was calibrated as shewn in the lower figure of Figure 5, and B as shewn in the right hand figure. When A read 70 gms. the total load was 87 gms. Therefore, $T_0=87$ gms. Similarly, when B read 149½ gms. the total load was 153 gms., therefore, $T_1=153$ gms.

We have now $T_0=wc=87$ gms.

$T_1=wY=153$ gms.

therefore, since $w=0\cdot778$ gm. per cm. $c=112$ cms.

and $Y-c=\dfrac{66}{\cdot778}=84\cdot8$ cms.

whereas the difference between the measured ordinates $=105\cdot3-21$ $=84\cdot3$ cms.; a fair agreement.

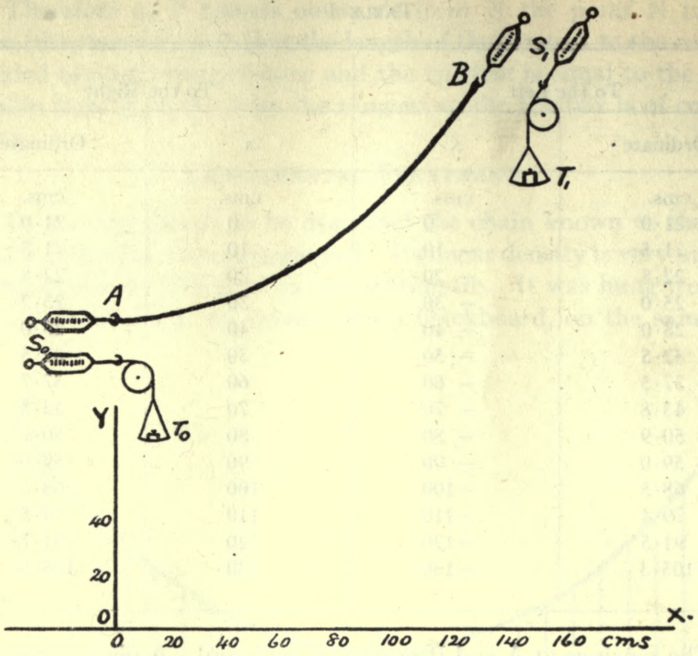


Fig. 5.

We know now that the axis of x is (112 − 21) = 81 cms. below the line LL, and it is now confirmed by finding whether the tension at any point in the chain is equal to the weight of chain that would reach from that point down to the axis of x.

To do this, the spring balances are removed and cotton threads attached to the half chain. Freely running pulleys, P_1, P_2, were supported near A and B respectively. The thread ran over these pulleys and supported free lengths of chain as shewn in Fig. 6. Care was taken to get the threads tangential to the chain at A and B. The vertical chains were adjusted in weight link by link until finally the portion AB of chain was exactly in front of the right hand half of the permanent chain hanging on the blackboard. D was made level with B, and as it was impossible to get F level with A an extra three inches or so of chain was hung from the top end F. It was then found that H and E were at the same level.

The total length of FH = 111 cms.; therefore, $T_0 = 111 \times \cdot 778 =$ 86 gms.

The length of DE = 192½ cms.; therefore $T_1 = 192\frac{1}{2} \times \cdot 778 =$ 150 gms.

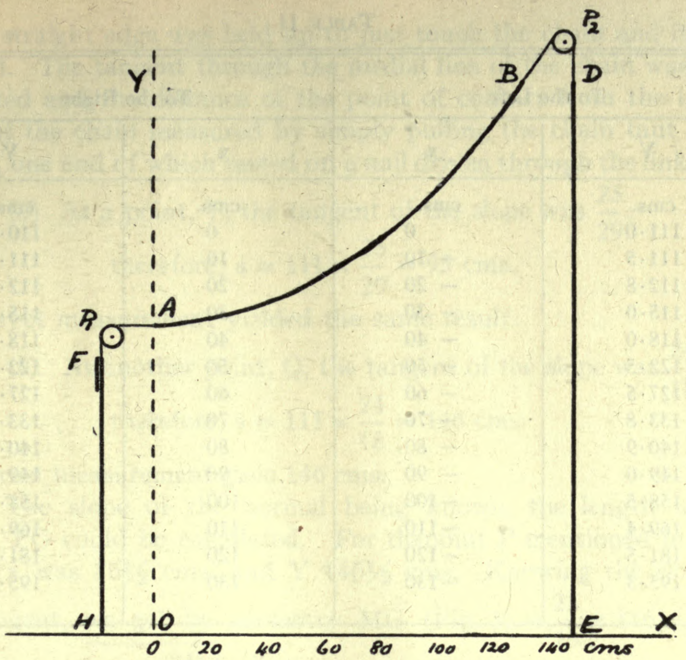


Fig. 6.

The difference between FH and DE = $81\frac{1}{2}$ cms., which agrees fairly well with the difference between 105·5 and 21·0, the measured ordinates from the line LL. The hanging chains afford perhaps an easier and more accurate method of measuring T_0 and T_1 than the use of balances or scale pans and weights.

Test of the Equations

Having got now the position of the axis of x, it is possible to convert all the previous measures of the ordinates into values of Y.

We thus get the following table:

TABLE II

To the Left		To the Right	
Y	x	x	Y
cms.	cms.	cms.	cms.
111·0	0	0	110·0
111·5	− 10	10	111·5
112·8	− 20	20	112·8
115·0	− 30	30	115·0
118·0	− 40	40	118·2
122·5	− 50	50	122·5
127·5	− 60	60	127·7
133·8	− 70	70	133·5
140·9	− 80	80	140·7
149·0	− 90	90	149·0
158·5	−100	100	158·5
169·4	−110	110	169·5
181·5	−120	120	181·7
195·3	−130	130	195·5

1. To test the equation $Y = c \cosh \frac{x}{c}$

(*a*) When $x = 60$ cms. $Y = 111 \cosh \frac{60}{111} = 111 \times 1{\cdot}150 =$ 127·6 cms.; this agrees well with 127·7 cms.

(*b*) When $x = 130$ cms. $Y = 111 \cosh \frac{130}{111} = 111 \times 1{\cdot}766 =$ 196 cms.; this agrees well with 195·5 cms.

This exercise trains students in the use of the hyperbolic functions.

2. To test the equation $s = c \sinh \frac{x}{c}$

(*a*) Take any point, P, say, where $x = 60$ cms.

$$s = 111 \sinh \frac{60}{111} = 111 \times {\cdot}568 = 63 \text{ cms.}$$

Direct measurement gave 63 cms.

(*b*) For the point $x = 130$ cms. we get

$$s = 111 \sinh \frac{130}{111} = 111 \times 1{\cdot}47 = 163 \text{ cms.}$$

Direct measurement gave 161 cms.

3. To test the equation $s = c \tan \theta$

A straight edge was held up to just touch the chain and its line marked. The tangent through the medial line of the chain was then estimated and the distance of the point of contact from the lowest point of the chain measured by simply pulling the chain taut along a scale, one end of which rested on a nail driven through the link at A.

(*a*) At a point, P, the tangent of the slope was $\frac{25}{29}$;

$$\text{therefore, } s = 111 \times \frac{25}{29} = 95 \text{ cms.}$$

Direct measurement yielded the same result.

(*b*) At another point, Q, the tangent of the slope was $\frac{24}{18}$;

$$\text{therefore, } s = 111 \times \frac{24}{18} = 148 \text{ cms.}$$

Direct measurement gave 146 cms.

4. The slope of the normal being known, the length of the normal PG could be calculated. For thepoint P mentioned in 3 (a) above, x was 86½ cms. and Y 146½ cms. Knowing the slope of the tangent, we get by geometry MG (Fig. 3) $= \frac{25}{29} \times 146\frac{1}{2}$, and $PG = 146\frac{1}{2}\sqrt{1 + \left(\frac{25}{29}\right)^2} = 194$ cms. The length of PG could have been measured directly, but this is the more convenient way of getting it. The formula $\frac{Y^2}{c}$ gives 193 cms.—a fair agreement.

5. From $s = c \sinh \frac{x}{c}$ and $y + c = c \cosh \frac{x}{c}$ we get

$$(y + c^2) - s^2 = c^2$$
$$\therefore y^2 + 2cy - s^2 = O$$
$$2cy = s^2 - y^2$$
$$c = \frac{1}{2} \cdot \frac{(s+y)(s-y)}{y}$$

This affords another way of giving c. Applying it to the point B, where $y = 105 \cdot 3 - 21 \cdot 0 = 84 \cdot 3$ cms., we get

$$c = \frac{1}{2} \cdot \frac{(161 + 84\cdot 3)\ (161 - 84\cdot 3)}{84\cdot 3} = 111 \text{ cms.}$$

This method does not require anything more than the hanging chain itself, the forces not being required, hence it is perhaps the simplest method of getting c.

We thus see how by experiment the formulæ of the catenary can be verified and the student brought to realise the mutual helpfulness of mathematics and physics.

Analysis of Earthquake Waves

By OTTO KLOTZ, LL.D., F.R.S.C.

(Read May Meeting, 1920)

This preliminary note is to give the results of the first attempt to apply the Henrici Harmonic Analyzer to the analysis of earthquake waves. When Professor Dayton C. Miller, of the Case School of Applied Science, Cleveland, gave his splendid address on the Science of Musical Sounds before our Section, illustrated by many diagrams, the writer was struck with the resemblance of some of the compound waves to earthquake waves and saw, or believed to see, its applicability to studies in seismology. The investigation determined upon was made possible through the kind co-operation of Professor Miller, with whose Henrici Harmonic Analyzer the numerical data was obtained.

The analyzer and the 32-element harmonic synthesizer to which reference will subsequently be made were described by Professor Miller in the *Journal of the Franklin Institute;* the former in September, 1916, and the latter in January, 1916.

The seismogram of September 6, 1915, giving a fine record of the earthquake in the Pacific off the coast of Central America was chosen for this first investigation. The epicentre of this quake was given by the Dominion Observatory as $\phi = 14° 14'$, $\lambda = 90° 30'$ W.; and the energy released $E = 10 \times 10^{23}$ ergs, computed from the Observatory seismogram. The exponent 23 is preserved, as it occurs in some other investigations, so that comparisons are confined to the co-efficients.

Whatever part of the seismogram is selected for analysis that part which is chosen for a period, that is, for the compound wave, after which repetition is supposed to take place, must be enlarged to exactly 400 mm. in order to fit the machine—the analyzer. It may be remarked that selecting a period, particularly for the P and S waves, is rather difficult, and its position on the seismogram not too obvious. Sections or periods were selected at the beginning of each of the waves P, S and L, representing the preliminary, first or longitudinal waves; the second or transverse waves; and the last, long or surface waves. Only for the beginning of the P waves, the cataclysism of the quake is the time absolutely certain. The mathematical process of analysis by Fourier series is too time-consuming, as the writer found out years ago, to apply the many analyses one wants, so that one interprets or reads the periods or supposed periods directly from the seismogram knowing at the same time that it is a questionable procedure.

The above sections or periods were each enlarged photographically to the required 400 mm. The harmonic analyzer is adapted for thirty components, that is, the analysis of a periodic wave will show which of the simple thirty sine waves are concerned and to what degree, as shown by the amplitudes, in producing the periodic wave.

The thirty components represent those waves whose periods are respectively the quotient of the period of the composite wave divided by the respective component; the 30th component will have a period half as long as the 15th, or a third of that of the 10th, and so on.

The analyzer takes five components at a time, so that, for the thirty, six tracings or followings with the stylus of the gram of 400 mm. are necessary.

The accuracy of the constants obtained and read off from the analyzer is readily shown by inserting them in the synthesizer—turning a handle—when the compound curve is traced on a sheet of paper,—in our case scarcely distinguishable from the original seismogram.

The seismograms are from a Bosch photographic seismograph having two components, the N–S one having air-damping, while the E–W one has magnetic damping by means of a strong horse-shoe wolfram-steel magnet, the horizontal pendulum rod being extended by a light aluminium plate moving between the jaws of the magnet, so that the magnetic damping renders the horizontal pendulum almost aperiodic.

The results of the analysis are given in the subjoined table:

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
	$30^{s}\cdot0$	15·0	10·0	7·5	6·0	5·0	4·3	3·8	3·3	3·0	2·7	2·5	2·3	2·1
P_{N-E} mm.	10·6	7·5	14·7	35·0	46·2	19·2	40·8	17·1	5·0	11·6	5·2	7·8	6·0	8·1
	15	16	17	18	19	20	21	22	23	24	25	26	27	28
	$2^{s}\cdot0$	1·9	1·8	1·7	1·6	1·5	1·4	1·4	1·3	1·3	1·2	1·2	1·1	1·1
	0·6	3·6	4·3	2·5	3·0	0·6	3·1	1·3	0·9	2·5	1·6	2·2	1·1	1·5
	29	30												
	$1^{s}\cdot0$	1·0												
	1·0	0·8												
P_{E-W}	$30^{s}\cdot0$	15·0	10·0	7·5	6·0	5·0	4·3	3·8	3·3	3·0	2·7	2·5	2·3	2·1
mm.	5·9	2·4	2·6	8·0	6·7	2·6	6·7	4·5	0·5	1·5	0·7	0·3	1·4	0·6
	$2^{s}\cdot0$	1·9	1·8	1·7	1·6	1·5	1·4	1·4	1·3	1·3	1·2	1·2	1·1	1·1
	0·5	0·2	0·4	0·2	0·5	0·3	0·5	0·2	0·1	0·1	0·0	0·1	0·1	0·1
	$1^{s}\cdot0$	1·0												
	0·0	0·1												
P_{N-E}	$67^{s}\cdot8$	33·9	22·6	16·9	13·6	11·3	9·7	8·5	7·5	6·8	6·2	5·6	5·2	4·8
	1·8	14·7	16·5	16·0	6·6	11·5	14·9	22·8	24·9	12·0	36·8	9·9	16·3	20·6
	4·5	4·2	4·0	3·8	3·6	3·4	3·2	3·1	2·9	2·8	2·7	2·6	2·5	2·4
	15·6	33·4	16·3	5·6	10·4	1·1	5·2	3·8	1·4	3·2	1·1	4·5	4·1	2·5
	2·3	2·3												
	3·8	1·8												

P_{E-W}	81ˢ·3	40·7	27·1	20·3	16·3	13·6	11·6	10·2	9·1	8·1	7·4	6·8	6·3	5·8
	0·8	3·2	5·1	4·9	4·0	1·6	2·2	2·7	3·8	4·9	6·2	0·8	5·1	5·4
	5·4	5·1	4·8	4·5	4·3	4·1	3·9	3·7	3·5	3·4	3·3	3·1	3·0	2·9
	2·4	4·0	1·1	3·0	3·8	6·7	1·6	2·2	1·1	0·5	2·7	1·3	0·0	1·1
	2·8	2·7												
	1·1	0·5												
S_{N-S}	132ˢ	66	44	33	26·4	22·0	18·9	16·5	14·7	13·2	12·0	11·0	10·2	9·4
	9·2	32·6	44·0	86·2	31·7	39·6	17·2	19·8	7·9	11·0	15·0	44·0	64·2	83·2
	8·8	8·3	7·8	7·3	6·9	6·6	6·3	6·0	5·7	5·5	5·3	5·1	4·9	4·7
	7·9	88·0	97·2	55·4	28·2	19·8	53·2	73·9	127·6	128·9	46·2	33·9	32·1	11·9
	4·6	4·4												
	21·6	23·3												
S_{E-W}	118·	59	39·3	29·5	23·6	19·7	16·9	14·8	13·1	11·8	10·7	9·8	9·1	8·4
	6·3	9·8	36·2	38·5	11·4	2·4	2·4	16·9	27·1	7·1	19·3	28·3	31·4	30·3
	7·9	7·4	6·9	6·6	6·2	5·9	5·6	5·4	5·1	4·9	4·7	4·5	4·4	4·2
	36·5	33·4	23·2	17·3	19·3	13·4	25·5	5·5	13·8	11·4	11·4	12·6	6·3	7·9
	4·1	3·9												
	6·7	9·4												
L_{N-S}	147ˢ·8	73·9	49·3	36·9	29·5	24·6	21·1	18·5	16·9	14·8	13·4	12·3	11·4	10·6
	13·3	9·9	9·4	10·4	16·7	2·0	15·3	32·5	25·6	22·7	35·0	98·4	13·3	5·4
	9·9	9·2	8·7	8·2	7·8	7·4	7·0	6·7	6·4	6·2	5·9	5·7	5·5	5·3
	19·2	28·6	21·7	36·5	4·4	23·7	19·7	39·4	34·01	10·8	28·6	22·2	17·7	3·9
	5·1	4·9												
	8·9	6·4												
L_{E-W}	144ˢ·6	72·3	48·2	36·1	28·9	24·1	20·6	18·1	16·1	14·5	13·1	12·1	11·1	10·3
	2·9	3·9	3·4	6·7	19·8	31·8	11·1	43·4	17·4	33·3	32·8	13·5	23·1	12·0
	9·6	9·0	8·5	8·0	7·6	7·2	6·9	6·6	6·3	6·0	5·8	5·6	5·4	5·2
	21·7	2·9	6·7	8·7	13·0	1·9	7·2	4·8	9·6	11·6	1·9	3·9	6·3	3·9
	5·0	4·8												
	1·4	2·9												

In the above the amplitudes in millimeters have all been reduced to a 30^s period representing 400 mm. of the analyzer. In the analysis the first P_{N-S}, P_{E-W} were of that period, hence no change for the amplitude, but for all the others the amplitudes were multiplied respectively by

$$\frac{67\cdot8}{30} \quad \frac{81\cdot3}{30} \quad \frac{132}{30} \quad \frac{118}{30} \quad \frac{147}{30} \quad \text{and} \quad \frac{144\cdot6}{30}$$

the numerators indicate the whole period for the compound wave under consideration. This reduction was necessary in order to make the amplitudes intercomparable. To repeat, whatever the period it must be photographed (enlarged), so as exactly to cover 400 mm. to fit the analyzer.

It may be observed that during the earthquake there were microseisms (micros), but they were practically unrecognizable on the E–W (magnetic damping) component, while on the N–S small micros appear whose average period was $5^s.25$, the variation being confined to one or two-tenths of a second.

Retabulating the mass of figures, and collecting the predominant amplitudes lying between 4 and 8 second periods for the P and S waves we have the following:

P_{N-S}	7^{s}·5	6·0	5·0	4·3	3·8									
30^{s}	35·0	46·2	19·2	40·8	17·1									
P_{E-W}	8^{s}·0	6·7	3·6	6·7	4·5									
30^{s}														
P_{N-S}	7^{s}·5	6·8	6·2	5·6	5·2	4·8	4·5	4·2						
67^{s}·8	24·9	12·0	36·8	9·9	16·3	30·6	15·6	33·4						
P_{E-W}	7^{s}·4	6·8	6·3	5·8	5·4	5·1	4·8	4·5	4·3	4·1				
81^{s}·3	6·2	0·8	5·1	5·4	2·4	4·0	1·1	3·0	3·8	6·7				
S_{N-S}	7^{s}·8	7·3	6·9	6·6	6·3	6·0	5·7	5·5	5·3	5·1	4·9	4·7	4·6	4·4
132^{s}	97·2	55·4	28·2	19·8	53·2	73·9	127·6	121·9	46·2	33·9	32·1	11·9	21·6	23·3
S_{E-W}	7^{s}·9	7·4	6·9	6·6	6·2	5·9	5·6	5·4	5·1	4·9	4·7	4·5	4·4	4·2
118^{s}	36·5	33·4	23·2	17·3	19·3	13·4	25·5	5·5	13·8	11·4	11·4	12·6	6·3	7·9
	4·1	3·9												
	6·7	9·4												

Similarly, if we select the governing amplitudes for the L or long waves also within the limits of 4 and 8 seconds, we obtain:

L_{N-S}	8·2	7·8	7·4	7·0	6·7	6·4	6·2	5·9	5·7	5·5	5·3	5·1	4·9
147^{s}·8	36·5	4·4	23·7	19·7	39·4	34·0	10·8	28·6	22·2	17·7	3·9	8·9	6·4
L_{E-W}	8·0	7·6	7·2	6·9	6·6	6·3	6·0	5·8	5·6	5·4	5·2	5·0	4·8
144^{s}·6	8·7	13·0	1·9	7·2	4·8	9·6	11·6	1·9	3·9	6·3	3·9	1·4	2·9

To give a further oversight of the analysis the following are given:

OUTSTANDING AMPLITUDES

P_{N-S}	30^{s}	10^{s}	7^{s}·5	6^{s}·0	4^{s}·3								
	10·6	14·7	35·0	46·2	40·8								
P_{E-W}	30^{s}	10^{s}	7^{s}·5	6^{s}·0	4^{s}·3								
	5·9	2·6	8·0	6·7	6·7								
P_{N-S}	33^{s}·9	22^{s}·6	9^{s}·7	8^{s}·5	7^{s}·5	6^{s}·2	5^{s}·2	4^{s}·8	4^{s}·2	4^{s}·0			
	14·7	16·5	14·9	22·8	24·9	36·8	16·3	20·6	33·4	16·3			
P_{E-W}	27^{s}·1	7^{s}·4	6^{s}·3	5^{s}·8	4^{s}·1								
	5·1	6·2	5·1	5·4	6·7								
S_{N-S}	44^{s}·	33^{s}	22^{s}	11^{s}	10^{s}·2	9^{s}·4	8^{s}·3	7^{s}·8	6^{s}·3	6^{s}·0	5^{s}·7	5^{s}·5	5^{s}·3
	44·0	86·2	39·6	44·0	64·2	83·2	88·0	97·2	53·2	73·9			46·2
S_{E-W}	39^{s}·3	29^{s}·5	13^{s}·1	9^{s}·8	9^{s}·1	8^{s}·4	7^{s}·9	7^{s}·4	5^{s}·6				
	36·2	38·5	27·1	28·3	31·4	30·3	36·5	33·4	25·5				
L_{N-S}	29^{s}·5	18^{s}·5	16^{s}·9	13^{s}·4	12^{s}·3	9^{s}·2	8^{s}·7	8^{s}·2	7^{s}·4	6^{s}·7	6^{s}·4	5^{s}·9	5^{s}·7
	16·7	32·5	25·6	35·0	78·4	28·6	21·7	36·5	23·7	39·4	34·0	28·6	22·2
L_{E-W}	24^{s}·1	18^{s}·1	14^{s}·5	13^{s}·1	11^{s}·1	9^{s}·6	7^{s}·6	6^{s}·0	5^{s}·4				
	31·8	43·4	33·3	32·8	23·1	21·7	13·0	11·6	6·3				

The amplitudes noted above are not only outstanding in their absolute value, but include, too, some that are outstanding compared with those adjoining on either side, as for instance in the last one of 6·3 for period 5^{s}4, the adjoining ones (not given above, but are on complete sheet) being each 3·9.

ABSOLUTE MAXIMA.

P_{N-S}	6^{s}·0	(4^{s}·3)
	46^{s}·2	(40·8)
P_{E-W}	7^{s}·5	(4^{s}·3)
	8·0	(6·7)

ABSOLUTE MAXIMA.

$P_{N\text{-}S}$	$6^{s}\cdot2$ $36\cdot8$	($4^{s}\cdot2$ $33\cdot4$)
$P_{E\text{-}W}$	($7^{s}\cdot4$ $6^{s}\cdot2$)	$4^{s}\cdot1$ $6\cdot7$
$S_{N\text{-}S}$	($7^{s}\cdot8$ $97\cdot2$)	$5^{s}\cdot7$ $127\cdot6$
$S_{E\text{-}W}$	($7^{s}\cdot9$ $36\cdot5$)	$29^{s}\cdot5$ $38\cdot5$
$L_{N\text{-}S}$	$12^{s}\cdot3$ $78\cdot4$	
$L_{E\text{-}W}$	$18^{s}\cdot1$ $43\cdot4$	

Now that the first harmonic analysis of earthquake waves has been made, one may properly ask what does it teach us or what have we learned? A completely satisfactory answer can not at present be given. Some expected results have been obtained, but also some unexpected ones.

Considering the different kind of waves in their order, we note that for the P waves, which the analysis limits in the lower limit to a period of 1 second, shorter periods if recorded are not analysed. Yet we know that often the P waves are of the latter order. When we approach longer periods, periods from about 5 to 6·5 seconds, we enter into the region of microseisms and of the period of the Bosch pendulums; the effect especially of the latter it is difficult to evaluate or eliminate. One trouble about the period of the pendulum is that it is not absolutely constant and one is not disposed to stop the functioning of the seismograph frequently to make a redetermination of that period. The range of course would be less than a second. The N–S component, as already noted, has air damping, while the E–W has magnetic damping, making the pendulum practically aperiodic and hence not subject, or at least subject to a far less degree, to the motion of the pendulum than the N–S is likely to be.

It will be observed that for the P waves the periods of approximately 4, 6 and 7·5 seconds stand out prominently on both components, and may be taken as the predominant waves of the earth particles. The long period waves amongst the P waves, especially the one of the order of 30 seconds, I draw attention to without being able to correlate them with any previous data available.

For the S waves we have hitherto recognized as a common wave length a period of 8 seconds or thereabout, and this the analysis shows too. The large amplitude for $5^{s}7$ period on the N–S component—air damped—looks suspiciously like pendulum effect and resonance. The freely moving pendulum when disturbed will make but few oscillations before coming to rest, so that if disturbed again during the interval of the period (compound) under consideration would most likely be in a different phase from that which it would have had, had the simple sine wave motion continued its consequent effect on the compound wave.

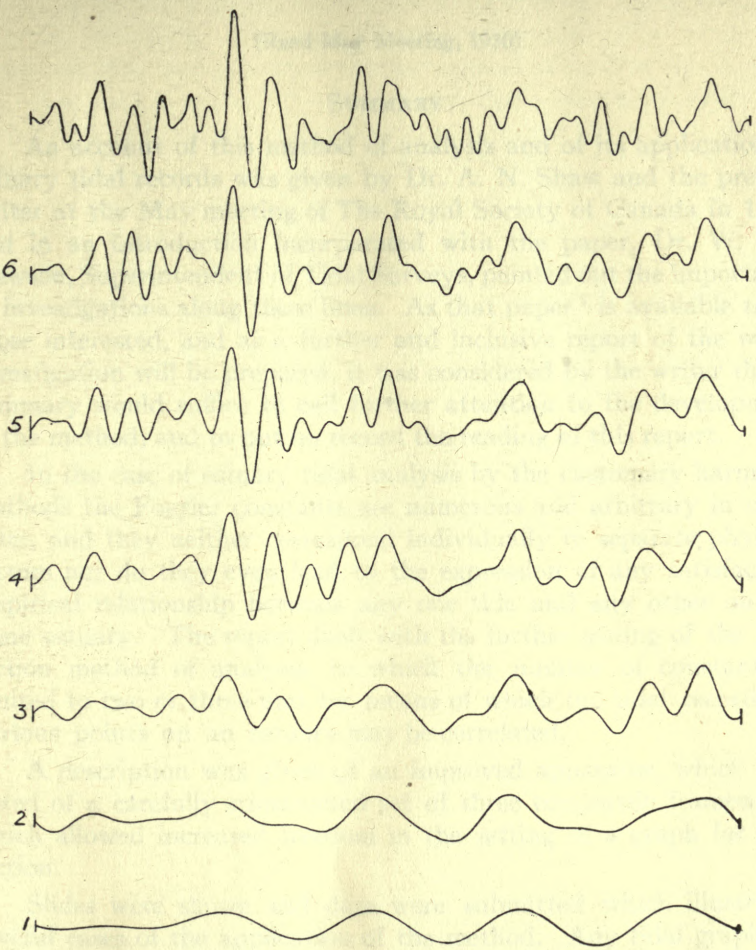
For the L waves the outstanding periods are 12 and 18 seconds, periods that have often been directly measured. But it will be observed that other waves ranging from about 5 to 30 seconds are markedly conspicuous, more so than those we recognize in the later L waves when they are free from the P and S waves, and show themselves in fairly uniform sinuous waves. Now, it is a characteristic of L waves, when one can see them directly on the seismogram, to begin with a long period, often of 40 seconds, then rapidly to fall to about 20 seconds, later to drop by gradations to about 12 seconds, at which period they remain frequently to the end of the quake or as long as one can directly measure them. The writer some years ago offered as an explanation of this decrease in wave length for the L waves, the greater surface mass involved at the beginning of the quake, and with the continuance of the quake effect in travelling over the earth for half an hour, an hour, or even several hours, the depth of the earth's crust involved became less and hence the period less also.

Now, the graduation of period which we directly measure on the seismogram does not, from the inherent conditions of the analysis, always manifest itself. The theory upon which the analysis is based presupposes a combination and superposition of regular, continuous sine curves or waves forming a compound curve of definite periodicity. As already stated, it is difficult to select the section for the P, S, or L waves which appears to form a complete cycle. As a matter of fact, such cycles do in reality not exist, for the waves affecting the earth particle are supplemented continuously by new wave trains, reflected by various paths.

The analysis, therefore, is limited to that extent, and periods of waves which are not sub-multiples of the assumed period of the compound curve are excluded in the above analysis, even though they exist. For a satisfactory study of seismograms by means of the analyzer and synthesizer these instruments should be available for instant use—on the one hand that consideration may be given to the assumption of different compound curves as the periodic one, in order that the really predominant waves, their period and amplitude may emerge; and on the other hand to study and compare the analyses of different seismograms, that may possibly lead to the discovery of selective waves, dependent upon the nature of the material and conditions along their paths, modified by depth. The Observatory is in hopes of securing an analyzer and synthesizer.

This preliminary investigation is an earnest of a line of investigation it is contemplated following up, and it is hoped future communications to The Royal Society will throw more light on the constitution of the interior of the earth as manifested by seismic waves.

The accompanying illustration is explained by its sub-title.



Earthquake September 6–7, 1915. S wave, E-W component. Ottawa.

1. Synthesis of components 1 to 5.
2. Synthesis of components 1 to 10.
3. Synthesis of components 1 to 15.
4. Synthesis of components 1 to 20.
5. Synthesis of components 1 to 25.
6. Synthesis of harmonic components 1 to 30 inclusive.
7. Enlargement of original record from seismogram.

The Analysis of Estuary Tidal Records by a Projection Method

By MISS VIOLET HENRY, M.SC.

Presented by DR. A. S. EVE, F.R.S., F.R.S.C.

(Read May Meeting, 1920)

SUMMARY

An account of this method of analysis and of its application to estuary tidal records was given by Dr. A. N. Shaw and the present writer at the May meeting of The Royal Society of Canada in 1919, and in an introduction incorporated with the paper, Dr. W. Bell Dawson, Superintendent of Tidal Surveys, pointed out the importance of investigations along these lines. As that paper [1] is available to all those interested, and as a further and inclusive report of the whole investigation will be prepared, it was considered by the writer that a summary would suffice to call further attention to the development of the method, and to put on record the reading of this report.

In the case of estuary tidal analysis by the customary harmonic methods the Fourier constants are numerous and arbitrary in character, and they neither correspond individually to separate physical factors nor do they even lead to the expression of any satisfactory empirical relationship between any one tide and any other on the same estuary. The report dealt with the further testing of the projection method of analysis, in which the number of constants is limited to two or three and by means of which the tidal records at various points on an estuary may be correlated.

A description was given of an improved apparatus, which consisted of a carefully constructed set of three concentric frameworks which allowed increased freedom in the setting of a graph for projection.

Slides were shown and data were submitted which illustrated several cases of the application of the method. Any tidal graph for any one of the tidal stations on the St. Lawrence estuary could be projected into any other which was further up the river. Similar projections were possible also, in the case of each of the estuaries examined, for example that of Port Essington into that of Port Simpson, in British Columbia; and that of Carter's Beacon into that of Root Creek, in Hudson's Bay.

---

[1] Shaw, A. N., and Henry, V., Trans. Roy. Soc. Can., Vol. 13, p. 139, (1919).

Some illustrations were shown which gave a direct comparison between the harmonic and the projection methods. Prof. Dayton Miller very kindly arranged to have the harmonic analyses for the purpose made in his analysing laboratory at Cleveland. It was seen for estuary tides having steep graphs, that as many as ten Fourier constants which varied from tide to tide might be required to express the curve even approximately—whereas the projection method correlated it with other tides up and down the estuary with the aid of only three constants in each case.

An account was given of a new method of prediction which may be based on this projection analysis. If the projection relations between the tides at certain stations, A, B, C, and D, all on the same estuary, are known for any one day, and if the tide at A is known for another day, then by projection at angles determined by the known relations it should be possible to determine the tides for B, C, and D on the second occasion. If the variation at A for the season is known, then the tides for the season at the other stations should be deducible. A description was given of the experiments performed to verify this method.

The writer is greatly indebted to Dr. Bell Dawson and to Dr. A. N. Shaw for their keen interest, for the assistance rendered by furnishing the tidal data and for numerous suggestions.

McGill University.

The "Alkali" Content of Soils as Related to Crop Growth

(A REPORT OF PROGRESS)

BY FRANK T. SHUTT, M.A., D.SC., and ALICE H. BURWASH, B.A.

(Read May Meeting, 1920)

Seven years ago the Division of Chemistry of the Experimental Farm System was called upon by the Reclamation Service (then known as the Irrigation Branch) of the Department of the Interior, to assist in the reclassification of certain Canadian Pacific Railway Company's lands within the dry belt of Southern Alberta. In this work one of the objects was to ascertain and delimit the areas more or less impregnated with "alkali," thus permitting, from the standpoint of saline content, the classification of the areas involved into irrigable and non-irrigable lands. The examination of soils from suspected areas has included the determination of the alkali, both as to nature and amount to a depth of five feet.

In the interpretation and application of the data obtained it was found necessary at the outset to employ the "limits of toxicity" as proposed and temporarily adopted by American investigators in reporting on the value of alkali lands. It was evident, however, before the work had made much progress that the use of these limits would not permit the correct classification of the lands under examination, chiefly owing to the fact that much of the alkali found differed markedly in important features from that occurring in the Western United States and which had furnished the data for the establishment of the American standards. Consequent upon this discovery an investigation was instituted to obtain data which might rightly be used in formulating limits or standards more strictly applicable to lands in Western Canada. Two reports of progress in this work have already been made by the Division of Chemistry[1]; the present paper contains an account of work accomplished in 1919–20 and constitutes the third contribution in this important enquiry.

The field work has consisted in the selection of a number of areas bearing crops, either native or cultivated, and within which soil samples could be secured: (1) from land producing a good crop

---

[1] The Alkali Content of Soils as related to Crop Growth by Frank T. Shutt, M.A., D.Sc., and E. A. Smith, M.A. Trans. of Royal Society of Canada, 1918, pp. 83–97.

Ibid. Trans. of Royal Society of Canada, 1919, pp. 233–242.

(native or cultivated), and evidently free from all save negligible amounts of alkali; (2) from land upon which there was a poor or meagre growth, indicating that the alkali present approached the limits of tolerance for the crop in question and (3) from land upon which there was no growth, due to excess of alkali. From each of these selected areas a series of three groups of soil samples has been taken within a comparatively short distance of one another; these would necessarily represent soil essentially free from alkali, soil in which the alkali content was such as to markedly affect growth, and soil so seriously impregnated as to inhibit all growth. Each group consists of four samples: A—0′0–0′·5, B—0′·5–1′·5, C—1′·5–3′·0 and D—3′·0–5′·0.

The previous papers submitted in this investigation record the results of the examination of nine series of soil groups, the crops involved being: Western Rye Grass, Native Prairie Grass, Oats, Wheat and Onions. The present report deals with soils sown to Wheat, Oats, Timothy, Vetch and Rye. While certain of the areas previously examined were from "dry" land, the four now reported on were all under irrigation.

Wheat

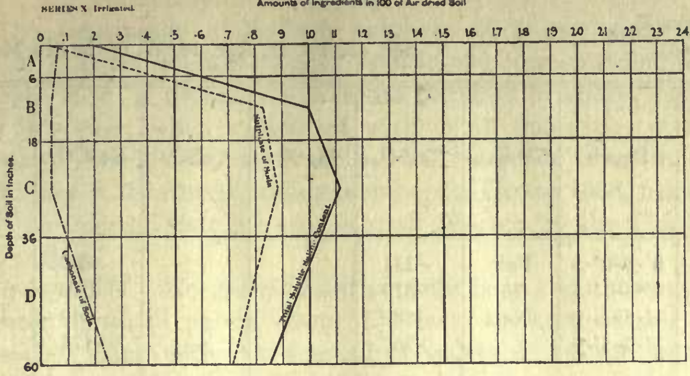
Series X, Section 35, Township 18, Range 14, West of the 4th Meridian.

The samples of this series were collected in a wheatfield, four miles north-east of Brooks, Alta., on Farm 2, Duke of Sutherland Colony. This farm had been under irrigation for a number of years and seemed well adapted to such a means of cultivation, possessing a good slope and a surface soil of dark clay loam with a subsoil consisting of sand and clay silt. The yield on the best parts of the field was probably about 32 bushels per acre. The field is about 300 yards west of the main canal and the alkali present, in all probability, has been carried down to this level by seepage.

WHEAT

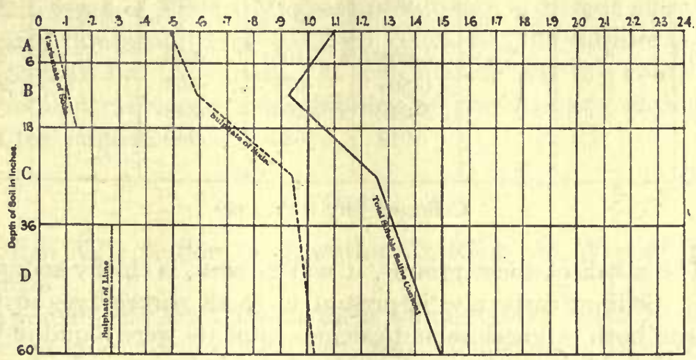
Fair to Good Growth.

Amounts of Ingredients in 100 of Air dried Soil



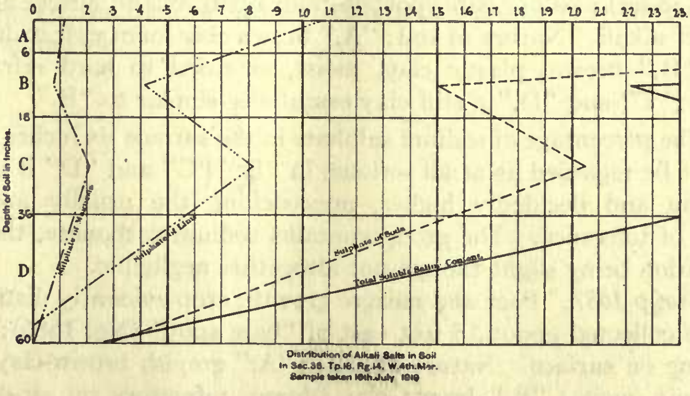
WHEAT.

Poor Growth.



WHEAT.

No Growth.



Distribution of Alkali Salts in Soil
In Sec.35. Tp.18. Rg.14. W.4th.Mer.
Sample taken 16th.July 1910

WHEAT

Series X
(Irrigated). Sec. 35, Tp. 18, Rge. 14. W. of the 4th Mer.

Group	Depth	Growth	Na_2SO_4	$MgSO_4$	$CaSO_4$	Na_2CO_3	Total soluble saline content
1688	0′·0–0′·5	Fair	·231			·060	·380
	0′·5–1′·5	to	·823			·040	·998
	1′·5–3,·0	Good	·880			·040	1·106
	3′·0–5′·0		·767			·174	·942
1687	"	Poor	·505			·078	1·054
			·591			·111	·926
			·941				1·254
			·996		·270		1·404
1686	"	No	4·008	·105	·903		5·320
			1·506	·077	·408		2·216
			2·047	·204	·818		3·228
			·919	·080	·240		1·328

Collected July 16th, 1919

The alkali of these groups, it will be seen, is chiefly sodium sulphate. Sodium carbonate is present in small percentages in Group 1688 and both magnesium and calcium sulphate were found in Group 1686. Chlorides are absent throughout the series.

Group 1688. Fair to good growth of healthy appearance. Height of crop at date of collection, about 32 inches. Location of group about 33 feet east of "bare spot" (Group 1686), but no surface appearance of alkali. Nature of soil: "A," brown clay loam rich in humus, dry; "B," brown, plastic clay, moist, air-dried to hard refractory lumps; "C" and "D," a stiff clay essentially similar to "B."

The percentage of sodium sulphate in the surface six inches ("A") cannot be regarded as at all serious; in "B," "C" and "D" it is very uniform and decidedly higher, approaching the usually accepted limits of tolerance. The group contains sodium carbonate, the concentration being slight though not altogether negligible.

Group 1687. Poor and meagre growth; crop evidently distressed. Group collected about 15 feet east of "bare spot" (No. 1686); alkali showing on surface. Nature of soil: "A," greyish brown clay loam with silt, moist; "B," brown clay, damp, refractory on air-drying;

"C," plastic clay, wet; "D," plastic clay, containing some peat-like masses, wet, refractory on air-drying.

The percentage of sodium sulphate (0·5 per cent) in "A" (0'·0–0'·5) is considerably higher than in the corresponding member of Group 1688; it probably represents the limit of safety, especially, as in this case, when associated with small quantities of sodium carbonate. The alkali content of "B," "C" and "D" is not materially higher than in the corresponding members of Group 1688, from which it may be inferred that the crop is most affected by the alkali in the first 6 inches.

Group 1686. No growth; soil entirely bare and showing alkali. Diameter of alkali patch, about 150 feet. Nature of soil: "A," brown clay loam, with fair amount of vegetable matter, wet; "B," brownish-grey clay, wet; "C" and "D," grey silty clay, wet.

The percentage of sodium sulphate is well beyond the limit of tolerance, being 4 per cent in the first six inches, decreasing to ·9 per cent at a depth of 5 feet. Magnesium sulphate is present more or less uniformly throughout (·07 to ·2 per cent), but the calcium sulphate is concentrated at the surface. It is significant that this group is free from sodium carbonate, the inhibition of growth being entirely due to sodium sulphate.

Oats

Series XI. Section 19, Township 23, Range 22, West of the 4th Meridian.

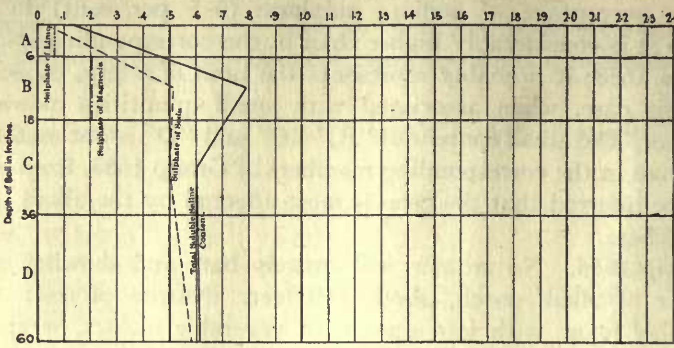
The oat field from which these samples were taken is situated about ten miles north of Gleichen, Alta. It had been irrigated for a number of years, during which time the bare spots due to alkali, it was stated, had increased in size. The crop, speaking generally, at the time of inspection, July 24th, was only fair. The soil on this farm is typical of the Gleichen district, rich dark loam with a subsoil mixture of sand and silt.

OATS.

Fair to Good Growth

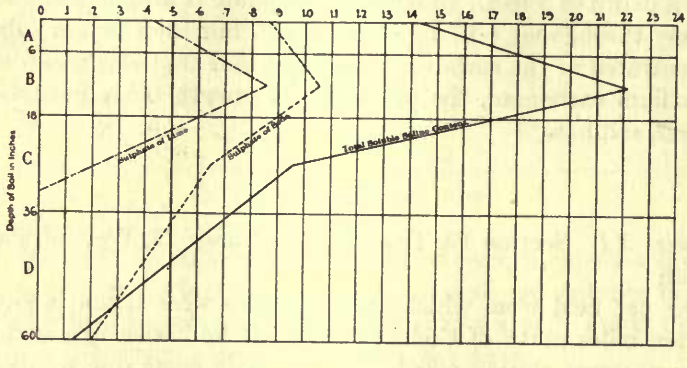
Amounts of Ingredients in 100 of Air dried Soil

SERIES XI Irrigated.



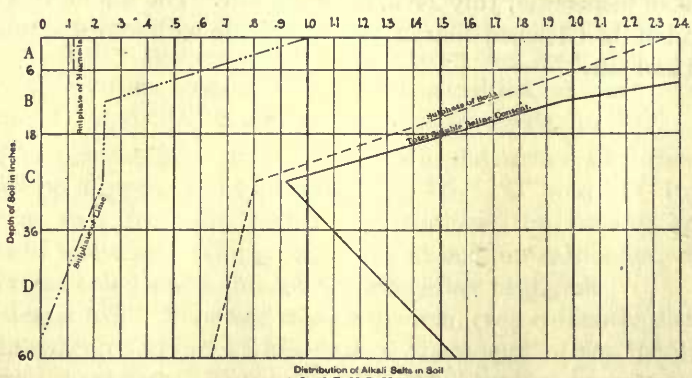
OATS.

Poor Growth



OATS.

No Growth.



Distribution of Alkali Salts in Soil
In Sec.19. Tp.23. Rg.22. W.4th.Mer.
Sample taken 24th.July 1919

OATS

Series XI
(Irrigated) Sec. 19, Tp. 23, Rge. 22, W. of the 4th Mer.

Group	Depth	Growth	Na_2SO_4	$MgSO_4$	$CaSO_4$	Na_2CO_3	Total soluble saline content
1693	0′·0–0′·5	Fair	·144		·061		·292
	0′·5–1′·5	to	·513	·203			·784
	1′·5–3′·0	Good	·495				·600
	3′·0–5′·0		·550				·608
1692	"	Poor	·912	·165	·527		1·618
			1·054	·103	·855		2·202
			·643	·018	·214		·950
			·362				·432
1691	"	No	2·190	·120	·811		3·069
			1·670		·239		1·956
			·804		·232		·918
			·700		·068		1·324

Collected July 24, 1919

Again the alkali is essentially sodium sulphate, varying in amount from ·1 per cent on the region characterized by good growth to ·9 per cent on the distressed area and 2 per cent on the bare spots. There is some magnesium sulphate present, but no doubt in quite innocuous quantities, and the soil throughout the series is quite free of sodium carbonate and chlorides.

Group 1693. Fair to good growth. No alkali showing. Nature of soil: "A," greyish brown, moderately light loam, well supplied with humus, dry; "B," reddish-brown clay with considerable sand, damp; "C," greyish-brown sandy clay, fairly plastic, damp, air-dries to hard brittle masses; "D," similar to "C."

In the surface 6 inches the percentage of sodium sulphate is only ·14 per cent, a practically negligible amount; in "B," "C" and "D" it is quite uniform and about ·5 per cent.

Group 1692. Poor growth. Vegetation evidently distressed, but no surface indication of alkali. Nature of soil: "A," brown, moderately heavy loam, fair supply of humus, moist, air-dries into refractory lumps which show slight efflorescence; "B," mixture of clay and sand, moist, plastic, air-dries to hard lumps; "C," clay and silt, damp; "D," clay with large proportion of sand, wet.

The sodium sulphate in "A" and "B" is approximately 1·0 per cent. This is associated with small percentages of magnesium sulphate. The crop was apparently struggling with little success, the alkali, evidently, closely approaching the limit of toxicity.

Group 1691. No growth, soil wet, alkali showing, and entirely destitute of vegetation. Nature of soil: "A," dark brown, sandy loam, wet, with efflorescence, air-dries to small friable lumps almost grey, due to incrustation; "B," dark brown sandy clay, wet, plastic, with marked efflorescence on drying; "C," reddish-brown sandy clay, slightly damp, plastic, slight efflorescence on drying; "D," greenish-grey clay, wet, dries into light yellow, hard lumps which exhibit efflorescence.

It will be remarked that magnesium salts are practically absent and further that the soil is free from chlorides and carbonates; growth in this instance must be inhibited entirely by sodium sulphate, which in the surface 6 inches reaches a concentration of 2 per cent.

Timothy

Series XII. Section 7, Township 22, Range 22, West of the 4th Meridian.

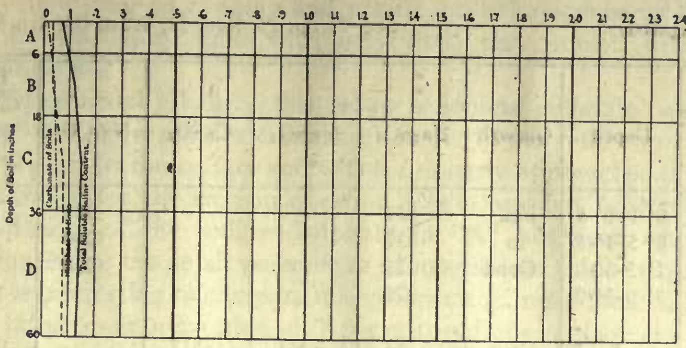
This group was taken from an irrigated field 1½ miles east of Gleichen, Alta. The area had been under irrigation for 6 years and had received three waterings in the season of 1919 before the date of inspection, July 24th. The third application of water had been made one week previous to the collection of the samples. The surface soil is a rich, dark loam and the subsoil a mixture of silt and fine sand. In the best parts of the field the crop was good, the timothy being quite thick and of a good length.

TIMOTHY.

Fair to Good Growth.

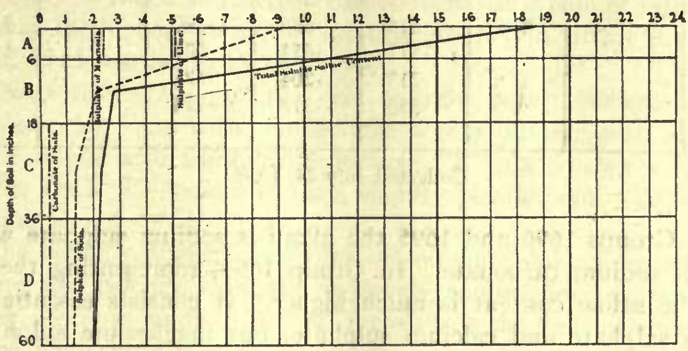
Amounts of Ingredients in 100 of Air dried Soil

SERIES XII Irrigated.



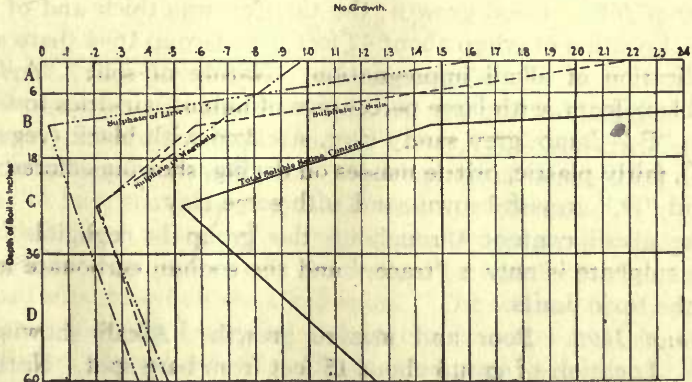
TIMOTHY.

Poor Growth.



TIMOTHY.

No Growth.



Distribution of Alkali Salts in Soil
In Sec.7. Tp.22. Rg.22. W.4th.Mer.
Sample taken 24th.July 1919

TIMOTHY

Series XII
(Irrigated) Sec. 7, Tp. 22, Rge. 22, W. of the 4th Mer.

Group	Depth	Growth	Na_2SO_4	$MgSO_4$	$CaSO_4$	Na_2CO_3	Total soluble saline content
1696	0′·0–0′·5	Fair	·037			·020	·080
	0′·5–1′·5	to	·037			·040	·118
	1′·5–3′·0	Good	·075			·048	·144
	3′·0–5′·0		·078				·136
1695	"	Poor	·753	·241	·517		1·492
			·215				·278
			·137			·038	·232
			·128			·038	·214
1694	"	No	1·814	·895	1·200		4·780
			·577	·651	·027		1·458
			·215	·204	·121		·522
			·353	·378	·274		·988

Collected July 24, 1919

In Groups 1696 and 1695 the alkali is sodium sulphate with a trace of sodium carbonate. In Group 1694, representing the bare spot, the saline content is much higher. It consists essentially of sodium sulphate and calcium sulphate, but magnesium sulphate is also present in considerable amounts. In Groups 1695 and 1694 the analysis shows higher concentrations of alkali near the surface.

Group 1696. Good growth; the timothy was thick and of good length. Location of group about 42 feet from Group 1694 (bare spot). No indication of alkali impregnation. Nature of soil: "A," rich sandy black loam, with large percentage of humus, air-dries to friable masses; "B," damp, grey sandy clay, streaked with black (vegetable matter), fairly plastic, brittle masses on drying, showing efflorescence; "C" and "D," greyish-brown sand with some clay.

The alkali content throughout the group is negligible. The sodium sulphate is only a "trace," and the sodium carbonate is well below the toxic limits.

Group 1695. Poor and meagre growth. Alkali showing on surface. Location of group about 15 feet from bare spot. Nature of soil: "A," rich black, moderately heavy loam, marked efflorescence on drying; "B," brownish-grey clay, wet, plastic, with a little sand and dark streaks of organic matter, no visible efflorescence on drying; "C," yellow-grey clay, damp and plastic, no efflorescence on drying; "D," brownish-grey sand with very little clay, moist, dries into friable masses.

The essential alkali of this group is sodium sulphate, which in "A" (0′·0–0′·5) reaches a concentration of ·75 per cent—an amount when present in the surface soil which evidently approaches the limit of endurance for the crop in question. It is possible, however, that the influence of the sodium sulphate in "A" has been somewhat accentuated by the small percentage of magnesium sulphate present.

It is interesting to compare this group with Group 1688, Series X. In the latter an impregnation of ·8 per cent sodium sulphate at a depth of ·5 to 1·5 feet—the surface soil "A" containing only ·23 per cent—apparently does not affect the crop. In the group under consideration a concentration of ·75 per cent sodium sulphate in the first ·5 feet soil is evidently as much as the crop can endure. It is also of interest to note that in the soil below "A" of this group (No. 1695) the alkali falls off to almost negligible amounts.

Group 1694. No growth; soil entirely bare. Nature of soil: "A" black clay loam with considerable organic matter, wet, air-dries to hard masses with marked effloresence; "B" plastic clay with sand and silt, wet; "C" sand and clay, slightly plastic, wet; "D" almost pure sand.

The saline content, consisting of sodium sulphate, magnesium sulphate and calcium sulphate, is largely concentrated towards the surface. Sodium sulphate in "A" far exceeds the limit of endurance and the high percentage of magnesium sulphate present would undoubtedly increase its toxicity.

Vetch and Rye

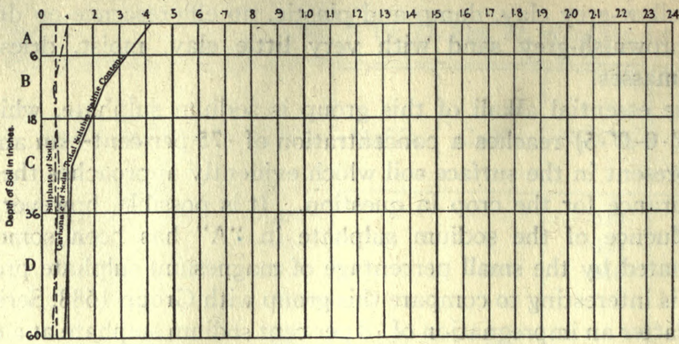
Series XIII. Lot 27, 476, Summerland, B.C.

The samples of this series were collected in a field about 4 miles southwest of Summerland, Okanagan Valley, B.C. The area had been under irrigation for several years. At the time of inspection a certain number of bare spots showing alkali were in evidence. On a part of the field the crop was very meagre, but over a considerable proportion of the area it was quite good. An orchard occupied this area, but the trees had succumbed on the alkali spots. The soil on the surface is a dark brown loam, well supplied with vegetable matter and is underlaid by a mixture of sand and silt. Hardpan occurs at a depth of 22 to 28 inches. This lot (27–476) furnished groups examined in this investigation in 1917 (crop: onions) and in 1918 (crop: oats).

VETCH & RYE.

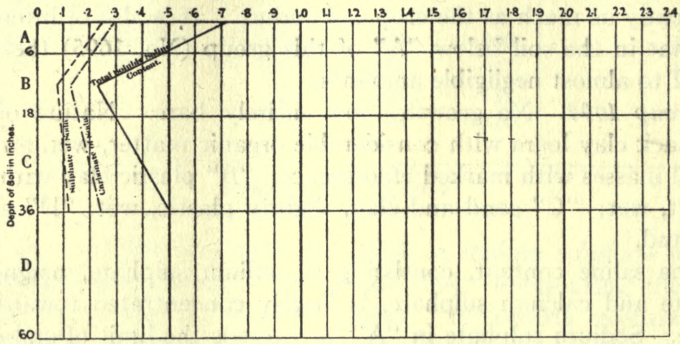
Fair to Good Growth

SERIES XIII Irrigated. Amounts of Ingredients in 100 of Air dried Soil



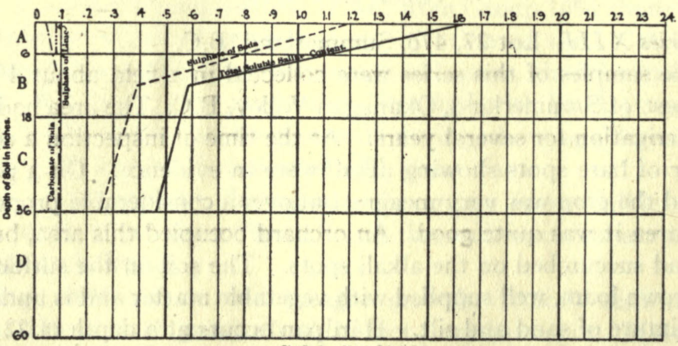
VETCH & RYE.

Poor Growth.



VETCH & RYE.

No Growth.



Distribution of Alkali Salts in Soil
Lot 27, 476, Summerland B.C.
Sample taken 8th Aug 1928

VETCH AND RYE

Series XIII (Irrigated). Lot 27, 476, Summerland, B.C.

Group	Depth	Growth	Na_2SO_4	$MgSO_4$	$CaSO_4$	Na_2CO_3	Total soluble saline content
1701	0′·0–0′·5	Fair	·055			·087	·370
	0′·5–1′·5	to	·058			·048	·238
	1′·5–3′·0	Good	·052			·063	·136
	3′·0–5′·0		·053			·048	·116
1700	0′·0–0′·5	Poor	·208			·253	·600
	0′·5–1′·5		·073			·127	·230
	1′·5–2′·5		·110			·200	·402
1699	0′·0–0′·5	No	·997		·080	·056	1·376
	0′·5–1′·5		·388			·097	·582
	2′·0–5′·0		·302			·094	·510

Collected August 8, 1919

Sodium carbonate is present in all three groups of the series, but in No. 1701 (Good Growth) it is not in sufficient quantities to be injurious to the crop. Sodium sulphate is the chief alkali of No. 1699 (No Growth), but occurs in minor or insignificant amounts only in No. 1700 and 1701.

Group 1701. Good growth. This group was taken 110 feet west of the bare spot (No. 1699). Nature of soil: The surface soil "A" is a rich dark brown sandy loam, well supplied with vegetable matter; "B" is a brown sandy loam with some clay; "C" and "D," grey brown sandy clay. All samples of the group were fairly dry when collected.

The sodium sulphate content throughout the group is negligible. The percentage of sodium carbonate is higher in the surface soil ("A") than in the subsoil (as is usually the case with this class of alkali), but evidently the amount (·087 per cent) is not sufficient to materially affect the crop—vetch and rye.

Group 1700. Poor growth; although the crop was sparse and meagre there were no surface indications of alkali. The point of collection was 30 feet west of the bare spots (Group No. 1699). Nature of soil: "A," fine greyish brown sandy loam with pebbles, well supplied with humus, slightly moist; "B," very similar to "A"; "C," greyish white sandy clay, nearly dry, rather refractory on drying; "D," no sample collected, as hardpan occurred at depth of 28 inches.

Considering that the sodium sulphate in this group would have no material effect on the crop, it may be concluded tentatively that ·25 per cent sodium carbonate marks an extreme limit for vetch and rye.

Group 1699. No growth. Surface appearance of alkali. Nature of soil: "A," dark brown fine sandy loam with pebbles, moist, showing slight efflorescence on drying; "B" and "C," sand, with very little clay or silt, rather dry; "D" not collected owing to hard pan at 22 inches.

Failure of crop growth in this case appears to be due chiefly to the effect of sodium sulphate, which in "A" reaches approximately 1 per cent. The sodium carbonate present in "A," ·056 per cent, although not negligible, can only be acting as a contributory factor.

Detailed discussion of these and previously reported data for the purpose of establishing limits of tolerance will be postponed until further evidence has been obtained. Satisfactory progress has been made, but the difficulty and importance of the problem involved demand more investigatory work before final conclusions can be safely drawn.

The soil samples of the several series now reported on were collected and the field notes thereon written by Mr. E. A. Smith, M.A., the joint author of the two papers on this subject previously presented to the Society.

Physical Problems Which Arise in Studying the Influence of Atmospheric Conditions Upon Health

By A. NORMAN SHAW, D.Sc.

Presented by DR. A. S. EVE, D.Sc., F.R.S., F.R.S.C.

(ABSTRACT)

The object of this paper is to attract more workers to a very important field. The need for further investigation is great, and emphasis is laid upon the necessity of eliminating the frequent errors in certain experiments which are concerned with the gain or loss of heat. Examples and advice are given, particularly with reference to the proper discrimination between conflicting factors, to the treatment of humidity questions, and to the determination of the characteristics of hygroscopic surfaces.

The following list of nine problems requiring attention are suggested as leading to research which could be undertaken in any laboratory, and from which "results" would be almost certain. Comments and some details in regard to the general object and the possible procedure are given in each case.

1. The variation of aqueous vapour pressure from characteristic hygroscropic substances with changing external temperature.

2. The variation of the internal temperature with the difference in aqueous vapour pressure between that of the surface and the surrounding air, for small volumes of hygroscopic materials.

3. The influence of the irregularity of a hygroscopic surface upon its vapour pressure.

4. Simple methods of measuring total heat emission.

5. The influence of turbulence and incident radiation upon instruments for measuring the rate of heat loss from bodies.

6. The improvement of the physical apparatus designed for the calorimeter experiments on metabolism.

7. The applications of the atmometer.

8. The influence of atmospheric conditions upon the electrical state of a surface.

9. The development of electrical hygrometers for precision work.

NOTE—This paper is printed in extenso in the Transactions of the Royal Canadian Institute, Toronto.

Typical Problems Which Arise in [illegible]

By A. [illegible]

Presented by [illegible]

The object of this paper is [illegible] important field [illegible] emphasis is laid upon the [illegible] in certain equipments which [illegible] heat. Examples and advice [illegible] the proper determination [illegible] of humidity questions, and [illegible] of hygroscopic substances.

The following list of [illegible] suggestions as leading to [illegible] laboratories, and from which [illegible] Conference and those dealing [illegible] possible scientific and [illegible]

1. The variation of [illegible] hygroscopic substances with [illegible]

2. The variation of [illegible] in aqueous vapour pressure [illegible] surrounding air, for small volumes [illegible]

3. The influence of the [illegible] the vapour pressure.

4. Special methods of measuring [illegible]

5. The influence of [illegible] instruments for measuring the [illegible]

6. The improvement of the [illegible] designed for the calorimetric measurements on [illegible]

7. The applications of the [illegible]

8. The influence of atmospheric conditions upon the electrical state of a surface.

9. The development of electrical hygrometers for precision work.

NOTE.—This paper is printed in [illegible] the Transactions of the Royal Canadian Institute, Toronto.

The Capacity of the Capillary Electrometer

By A. L. CLARK, Ph.D., F.R.S.C.

(Read May Meeting, 1920)

In spite of the fact that the capillary electrometer has been the subject of study ever since the pioneer work of Lippmann[1], the question of the cause of the large capacity and its possible variation with the potential difference cannot be said to have been answered satisfactorily. The controversy over the explanation of electro-capillary phenomena and the existence of an electric double layer at the boundary between a metal and an electrolyte or a gas is still open to contribution and the importance of the question makes advisable the publication of the following investigation.

If the large capacity of the electrometer is due to a double layer such as conceived by Helmholtz,[2] it might be expected that the properties of this double layer would depend on the difference of potential of the two sides and the capacity[3] might be a function of this potential difference. Contrary to the explicit statement of Burch[4] that the capacity is independent of the difference of potential, preliminary observations showed that the capacity is a function of the potential difference. Also, contrary to his statement of the case, the capacity is very different when the direction of the applied potential is reversed. As ordinarily used, the mercury of the electrometer is the cathode. Otherwise the mercury becomes fouled after a short time and sticking results. Later study of the variations of capacity have confirmed the results obtained earlier, and the following paper is an account of the work carried out in the summer of 1917.

APPARATUS

The form of electrometer used is essentially the same as that used by Burch with a few modifications for convenience in handling and for changing capillaries. The tubing was of the soft, soda-glass variety selected to be free from irrgeularities. It was washed with hot aqua-regia, water, hot potassium hydroxide and distilled water and finally

[1] Lippmann, Pogg. Ann. 149, 546, 1873; Wied. Ann. II, 320, 1880. Compt. rend. 76, 1407, 1873; 95, 686, 1892. Ann. de Chem. et Phys. (5), 494, 1877; Jour. de Phys. (2) 2, 116, 1883.

[2] Helmholtz. Wied. Ann. 7, 337, 1879; 16, 30, 1882.

[3] The word capacity is used here in the sense of apparent capacity.

[4] Burch, Electrician (London). July 17, 27, 31, Aug. 7, 1897.

with re-distilled water. The tubes were dried by a current of air, drawn through a drying train to ensure freedom from dust. Too great care in washing cannot be exercised if smooth action is desired.

The mercury was washed in dilute nitric acid and distilled. After the first distillation, the still was carefully cleaned and the mercury re-distilled into the electrometer tubes as needed. The electrolyte for the major part of the work was 25 per cent sulphuric acid. The platinum wires for connecting to the mercury in the electrometer were carefully cleaned before inserting and all points in the connecting tubing were either welded or they were sealed with wax in the case of glass-rubber connections. If carefully prepared, there is no sign of any leakage of air from the apparatus, practically no leakage of charge, no trace of local emf. when on closed circuit, or creeping on open circuit.

For charging the electrometer, a simple potentiometer consisting of a stretched nichrome wire provided with sharp-edged moveable contacts, was used. This potentiometer wire was connected in series with a rheostat, a milammeter and a storage cell. The wire itself was carefully tested and found to be uniform and the contacts were without appreciable resistance. The latter point is very important for low potentials, as any irregularity in contact leads to incorrect values of the capacity.

The excursions of the electrometer were measured with a micrometer microscope mounted on a micrometer slide.

Capacity Measurements

Since the capacity of any electrometer depends on the position of the meniscus in the tube, all observations of the capacity for purposes of comparison must be made at the same point in the tube. The capacity can be measured by the method of mixtures using the electrometer itself instead of a galvanometer, but a better method is to charge a standard condenser to a known potential and allow it to share its charge with the uncharged electrometer. The condenser is charged to the desired P.D. which is known from the potentiometer to which it is connected. Next, the condenser is insulated from the source of supply and connected to the electrometer. The excursion of the meniscus is noted and then a second connection to the potentiometer gives the P.D. after the mixture. When the condenser is charged to a new P.D. the position of the meniscus is adjusted by changing the pressure so that the meniscus always comes to rest at the same point in the tube throughout the series.

The method of charging the electrometer and allowing it to share its charge with a standard condenser is not satisfactory owing to the change in capacity of the electrometer due to the changed position of the meniscus.

If the original potential of the standard condenser of capacity C_1 is V_1 and after mixture is V, we have for the total charge

$$Q_1 = C_1V_1 = (C_1 + C)\,V = C_1V + Q$$

where C is the capacity of the electrometer in the final position. Q is the charge in the electrometer after mixture. From these equations

$$C = C_1 \frac{V_1 - V}{V}$$

$$\text{or} \qquad Q = C_1\,(V_1 - V).$$

Using the first we may get the value of C, but for comparison of results, we may plot Q against V, *i.e.*, the charge in the electrometer against the potential. Then, if the capacity is constant the graph will be straight, if variable it will be curved.

If the capacity is not constant it should be defined as $\frac{dQ}{dV}$, or as the slope of the Q-V curve. The ordinary definition of capacity at any given potential difference gives the average value over the interval of potential from zero to the final value.

Figure 1 shows the general character of the results of capacity measurement. In most cases for direct charging, with mercury as the cathode, the capacity decreases as the potential difference increases and becomes nearly constant. For reverse charging the capacity always increases and for the larger potentials becomes very large. The slope of the curve is continuous through the origin. In a few cases, the curve for direct charging was concave upward and the capacity increased a little and became constant. In either case the capacity seems to approach a steady value. In all cases where the curve for direct charge is concave upward, the capacity is very high. This form of curve is easily interpreted.

We may regard the electrometer as a system composed of two condensers in series, one at the surface of the mercury in the capillary tube, the other at the surface in the larger vessel. If we call the capacity of the first C_1 and that of the second C_2, the combined capacity is given by

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} \quad \text{or}$$

$$C = \frac{C_1C_2}{C_1 + C_2}$$

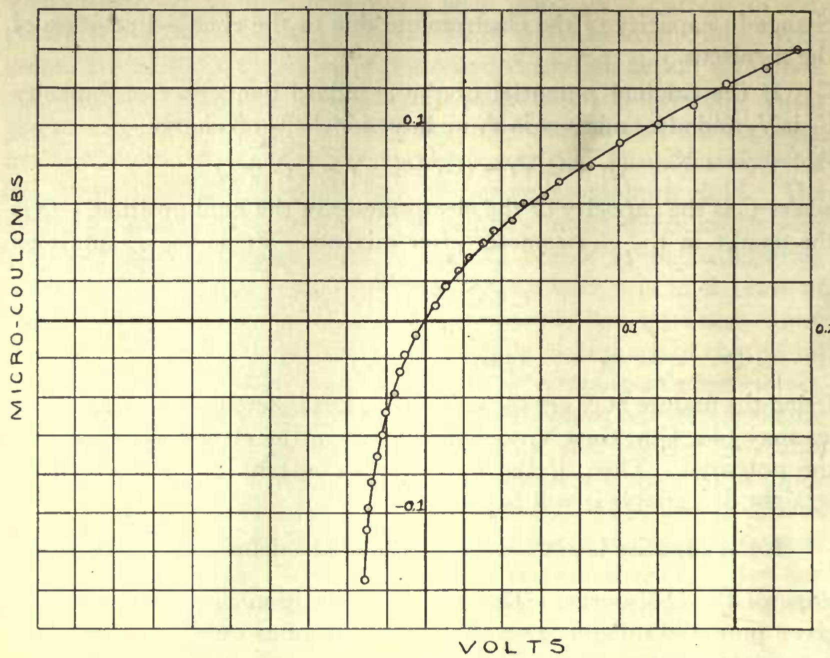


FIG. 1.

If C_2 is very large compared with C_1, this becomes $C=C_1$ and the apparent capacity is that of the smaller condenser. If C_1 is not sufficiently small, then C depends on C_2.

If we add a small charge, dq, to the electrometer, the capacity changes by the amount

$$d\,C=\frac{C_1^2dC_2+C_2^2dC_1}{(C_1+C_2)^2}$$

So the change in observed capacity depends on $C_1^2dC_2+C_2^2dC_1$.

In many of the observed cases dC_1 is negative, while dC_2 is always positive. If we assume that this is always true, then C may increase, decrease or remain stationary if $C_1^2dC_2-C_2^2dC_1$ is greater than, less than, or equal to 0 respectively, or if $\frac{dC_2}{dC_1}$ is greater than, less than, or equal to $\frac{C_2^2}{C_1^2}$.

Examination of Figure 1 (which is for the case where C_2 is very large compared with C_1 and hence $C=C_1$) we see that the changes in capacity for negative charging are very large compared with those with positive charging. The same must be true for C_2. Hence $\frac{dC_2}{dC_1}$ will be very large, as the slope of the tangent in the negative part of the curve changes very rapidly. So in case $\frac{C_2^2}{C_1^2}$ is not very large, we may have $\frac{dC_2}{dC_1} > \frac{C_2^2}{C_1^2}$ and then $dC > 0$ and the curve slopes upward in the positive portion.

In case $\frac{C_2}{C_1}$ is very large the curve will slope as in Figure 1.

Since in making these determinations of capacity, it is necessary to have the meniscus stop at the same point after the discharge into the standard condenser, the pressure requires adjustment to bring the meniscus to the proper final point. While it seemed unlikely that this small change of pressure would have any effect on the capacity, an electrometer was arranged to be placed inside a bell jar from which the air could be removed. This necessitated an arrangement for a wide change of pressure, which was accomplished without much difficulty. There is certainly no change in capacity due to change of pressure of an amount less than one atmosphere.

A striking example of the increase of capacity with negative charging of the electrometer was seen in the case of electrical oscillations of a system in which the electrometer was included. All attempts to build an electrometer with resistance low enough to obtain oscillations [1] with it in series with a self-inductance proved futile. But, by arranging a standard condenser in parallel with the electrometer and these in series with the self-inductance, oscillations are possible. Approximate theory shows that these are oscillations impressed on a logarithmic charge or discharge curve.

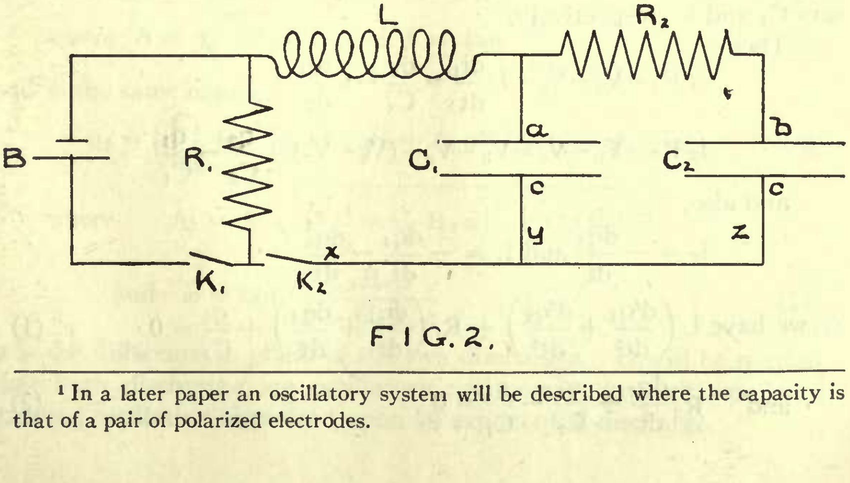


FIG. 2.

[1] In a later paper an oscillatory system will be described where the capacity is that of a pair of polarized electrodes.

We may treat the electrometer as though it were a simple condenser in series with a high resistance, neglecting both changes in this resistance and the capacity of the condenser. The arrangement of the discharge circuit is shown in Figure 2. The battery whose emf is E supplies the current I through the resistance R_1 and a key K_1, which is one of the keys of a drop chronograph. The two condensers of capacities C_1 and C_2 are connected as shown and are charged so that the potential difference is I R. R_2 is the high resistance of the electrometer whose capacity is C_2. L is a self-inductance inserted so that the discharge may be oscillatory. The second key K_2 of the drop chronograph may be inserted at x, y or z. When both keys are closed the system is charged and in both condensers the plates are at a common difference of potential I R. If K_1 is opened the discharge begins and continues until K_2 is opened. If K_2 is at x, the oscillation ceases and the two condensers settle down to the same difference of potential. If K_2 is at y, the first condenser C_1 is left with the charge it had at the instant of opening the key K_2. If K_2 be connected at z, the condenser C_2 is left with the charge it had at the instant of opening the key. In any case we may measure the charge by connecting both with a ballistic galvanometer and calculate the potential from the known capacities. Or we may connect to an electrometer and measure the potential. For the case where K_2 is at x or z, we may use the capillary electrometer to measure the potential. The first arrangement only was used.

Suppose plates *a* and *b* are charged positively so that when K_1 is opened the charge flows from *a* and *b* through the system. Let the current in circuit 1 be i_1, in circuit 2 be i_2, the charge on plate *a* of C_1 be q_1, on plate *b* of C_2 be q_2, potential of *a* be V_a and of *c* be V_c. Let R_1 include resistance of L. We may call the capacities of the condensers C_1 and C_2 respectively.

Then:

$$i_1 R_1 = V_a - V_c - L\frac{di_1}{dt} = \frac{q_1}{C_1} - L\frac{di_1}{dt}$$

$$i_2 R_2 = V_b - V_a = V_b - V_c - (V_a - V_c) = \frac{q_2}{C_2} - \frac{q_1}{C_1}$$

and also,

$$i_2 = -\frac{dq_2}{dt} \text{ and } i_1 = -\frac{dq_1}{dt} - \frac{dq_2}{dt}$$

So we have $$L\left(\frac{d^2q_1}{dt^2} + \frac{d^2q_2}{dt^2}\right) + R_1\left(\frac{dq_1}{dt} + \frac{dq_2}{dt}\right) + \frac{q_1}{C_1} = 0 \quad (1)$$

and $$R_2\frac{dq_2}{dt} + \frac{q_2}{C_2} - \frac{q_1}{C_1} = 0 \quad (2)$$

$$\text{or} \quad q_1 = \frac{C_1 q_2}{C_2} + C_1 R_2 \frac{dq_2}{dt}$$

We may differentiate this equation and substitute in (1), obtaining

$$\frac{d^3q_2}{dt^2} + \frac{C_1R_1R_2 + L + \frac{LC_1}{C_2}}{L\,C_1\,R_2}\frac{d^2q_2}{dt^2} + \frac{R_1 + R_2 + R_1\frac{C_1}{C_2}}{L\,C_1\,R_2}\frac{dq_2}{dt} + \frac{q_2}{LC_1C_2R_2} = 0 \qquad (3)$$

We may apply the general method for linear differential equations with constant co-efficients by placing $q_2 = \epsilon^{\lambda t}$, substitution of which in (3) gives

$$\lambda^3 + \frac{C_1R_1R_2 + L + L\frac{C_1}{C_2}}{L\,C_1\,R_2}\lambda^2 + \frac{R_1 + R_2 + R_1\frac{C_1}{C_2}}{L\,C_1\,R_2}\lambda + \frac{1}{L\,C_1\,C_2\,R_2} = 0 \qquad (4)$$

yielding three values of λ, so that

$$q_2 = a_1\epsilon^{\lambda_1 t} + a_2\,\epsilon^{\lambda_2 t} + a_3\epsilon^{\lambda_3 t} \qquad (5)$$

It will be shown later that only one root of the λ equation is real. The other two must be conjugate imaginaries. We may call $\lambda_1 = \lambda$, the real root, and the other two may be written $\alpha + i\beta$ and $\alpha - i\beta$. So we have finally

$$q_2 = a\epsilon^{\lambda t} + \epsilon^{\alpha t}\,(A\cos\beta t + B\sin\beta t) \qquad (6)$$

Differentiation and substitution in (2) give

$$q_1 = a\left(\frac{C_1}{C_2} + C_1R_2\,\lambda\right)\epsilon^{\lambda t}$$

$$+\,\epsilon^{\alpha t}\left[\left\{\frac{C_1}{C_2}A + C_1R_2(A\alpha + B\beta)\right\}\cos\beta t + \left\{\frac{C_1}{C_2}B + C_1R_2(B\alpha - A\beta)\right\}\sin\beta t\right] \qquad (7)$$

We may, of course, write (6) as

$$q_2 = a\epsilon^{\lambda t} + A\epsilon^{\alpha t}\cos(\beta t - \phi) \qquad (8)$$

$$\text{where } A = \sqrt{A^2 + B^2} \text{ and } \phi = \tan^{-1}\frac{B}{A} \qquad (9)$$

and in the same manner

$$q_1 = \left(\frac{C_1}{C_2} + C_1R_2\,\lambda\right) a\,e^{\lambda t} + A_1\,e^{\alpha t}\cos(\beta t - \phi + \omega) \qquad (10)$$

$$\text{where} \quad A_1 = A\sqrt{\left(\frac{C_1}{C_2} + C_1\,R_2\,\alpha\right)^2 + C_1^2\,R_2^2\,\beta^2}$$

$$\text{and} \quad \omega = \tan^{-1}\frac{C_2\,R_2\,\beta}{1 - C_2\,R_2\,\alpha} \qquad (11)$$

ω is the difference in phase of the two discharges. It will be noticed that both discharges are oscillatory and consist in each case of a damped oscillation impressed upon an exponential discharge.

In the experimental determination of the discharge curve the following values were used:

$C_1 = 10^{-6}$ farad.
$C_2 = \cdot 27\ (10)^{-6}$ farad (capillary No. 12).
$L = \cdot 81$ henries.
$R_1 = 100$ ohm.
$R_2 = 171000$ ohm (capillary No. 12, approximate value).

C_2 was measured by the method already outlined and is the value for zero difference in potential. The resistance was determined from the discharge curve as explained later.

The λ equation becomes

$$\lambda^3 + 150,3\lambda^2 + 1,238,700\,\lambda + 26,741,000 = 0 \qquad (12)$$

Trial shews one root to be $-21\cdot 64$, and the resulting equation yields the roots $-64\cdot 33 \pm 1110\,i$ (13)

so that $\alpha = -64\cdot 33 \qquad \beta = 1110.$

and the period $\dfrac{2\pi}{\beta} = \cdot 00566.$

The period obtained by experiment is $\cdot 00567$ sec.

We may now determine the constants of integration,

for when $t = 0\quad q_2 = Q_2,\ \dfrac{dq_2}{dt} = 0,\ \ q_1 = Q_1$ and $\dfrac{dq_1}{dt} = 0$

of which one is redundant.

Take $a + A = Q_2$

$a\lambda + \alpha A + \beta B = 0.$ and

$a\lambda^2 + \alpha^2 A + 2\alpha\beta B - \beta^2 A = 0$

Solving and substituting values, we have

$$\left.\begin{aligned} a &= 1\cdot 00188\ Q_2 \\ A &= -\theta\cdot 00188\ Q_2 \\ B &= 0\cdot 0194\ Q_2 \end{aligned}\right\} \qquad (14)$$

and $\phi = \tan^{-1} 10\cdot 32 = -84^0\cdot 28^1$

$\omega = \tan^{-1} 23\cdot 93 = 87^0\ 48^1$

$\phi^1 = \tan^{-1} \cdot 05816 = 3_1{}^0 19$

We may obtain q_2 experimentally by inserting K_2 at z, q_1 by inserting at y and q_1+q_2 by inserting at x (Fig. 2)

Since $Q_2 = \dfrac{C_2}{C_1} Q_1 = \cdot 27 Q_1$

$$q_1+q_2 = Q_1\left\{ \cdot 2715\,\epsilon^{-21\cdot 64t} + \epsilon^{-64\cdot 33t}\left(\begin{matrix} \cdot 9938 \cos 1110t + \cdot 0633 \\ \sin 1110t \end{matrix} \right) \right. \qquad (15)$$

If we use the capillary electrometer to indicate the potential without determining q_1 or q_2, we may insert key K_2 at either z or x, when we obtain the potential of the electrometer at the instant of opening K_2, or we may obtain the final potential of the system when it settles down after K_2 is opened.

Using $E_1 = \frac{q_1}{C_1}$ and $E_2 = \frac{q_2}{C_2}$

we have the potential of the condenser system at any instant

$$E = \frac{q_1+q_2}{C_1+C_2} = \frac{C_1 E_1}{C_1+C_2} \left\{ \cdot 2715, \text{ etc.} \right. \quad (16)$$

This equation plotted follows the general character of the experimental curve, but the amplitude is considerably greater. This is to be accounted for, probably in the emf of the concentration cell caused by the transport of ions in the acid solution due to the passage of electricity through it.

For making or breaking the circuit in this and other determinations of charge and discharge curves a Webster chronograph[1] was used. The potentiometer connections were led to a non-inductive resistance through one key of the chronograph. The self-inductance (·81 henries), and the electrometer and condenser in parallel, were connected to the terminals of the non-inductive resistances through the second key of the chronograph. The falling weight opens the two

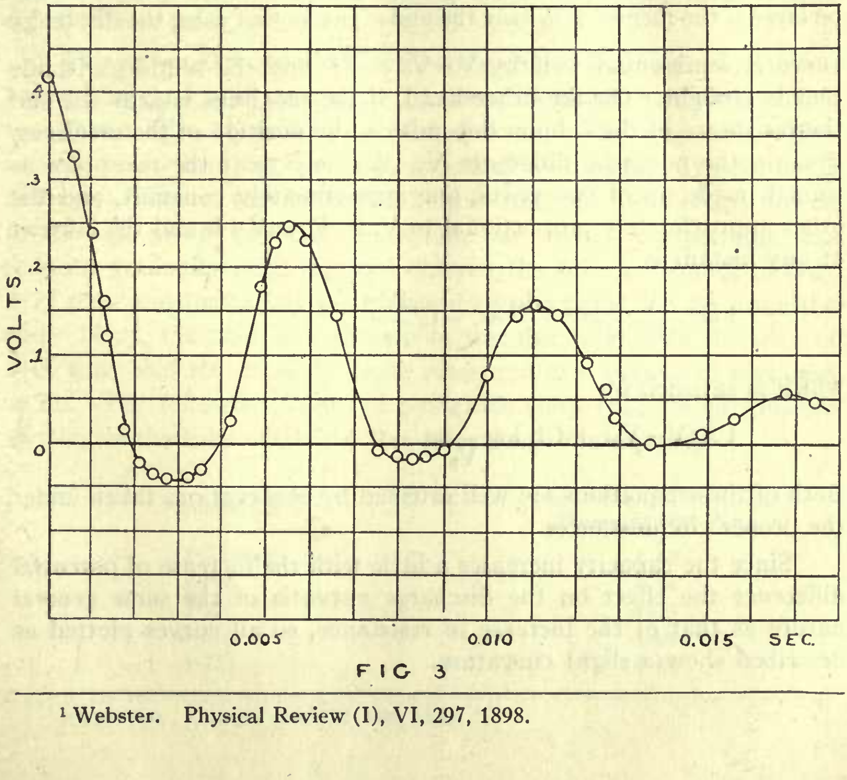


FIG 3

[1] Webster. Physical Review (I), VI, 297, 1898.

keys with a short interval of time between and the electrometer shows the final potential of the condenser. This time interval may be changed at will over a wide range and a series of readings taken for different times of charge or discharge.

Figure 3 shows the result using for $R=100$ ohms. The standard condenser had a capacity of 1 microfarad and the electrometer about ·27 microfarads with normal charging.

It will be noticed that the minima are much nearer the mean positions on which would be a logarithmic curve than the maxima, and the curvature is much less also. This is the result of the condenser having different capacities in the different directions.

Non-Oscillatory Discharge Curves

It was easy to obtain charge and discharge curves with the above mentioned chronograph, but the effects of varying resistance and capacity are best seen by plotting the results semi-logarithmically. If the resistance of the electrometer is mainly that of the mercury and acid column in the small tube, the changes will be relatively small when the meniscus is not too near the open end of the tube, but may be large if the meniscus is near the end. In the first case, the discharge curve is represented well by $V=V_0\,\epsilon^{-\frac{t}{RC}}$ and the semi-logarithmic plot is straight. On the other hand, if the meniscus is near the end the resistance of the column depends on the position of the meniscus, thus on the potential difference V. We may treat the resistance as though made up of two parts, one approximately constant, and the other approximately proportional to V, so $R=aV+b$ and the current at any instant is

$$i=\frac{V}{aV+b}=-\frac{dq}{dt}=-C\frac{dV}{dt}$$

which is satisfied by

$$Ca\,(V-V_0)+Cb\log\frac{V}{V_0}=-t.$$

Both of these equations are well satisfied by observations taken under the proper circumstances.

Since the capacity increases a little with the increase of potential difference the effect on the discharge curve is of the same general nature as that of the increase in resistance, so all curves plotted as described show a slight curvature.

EXTENT OF THE DOUBLE LAYER

The capacity increases as the meniscus is operated nearer the end of the tube, which is contrary to what might be expected. This fact alone suggests that the double layer is not confined to the meniscus.

Lippmann [1] calculated the thickness of the double layer from observations on the surface tension and the corresponding potential difference which give the surface density σ. The thickness of the double layer is then found from $\sigma = \frac{1}{4\pi d}$.

The calculated value is $d = 1 \cdot 4 \ (10)^{-7}$mm. — of *molecular* dimensions. If we calculate the thickness of the double layer from the capacity and the dimensions of the meniscus, we obtain a very much smaller value, *i.e.*, of the order 10^{-12}mm. Then, either the double layer has no such existence, as assumed by Lippmann, or the acid-mercury surface is much greater than the area of the nearly hemispherical meniscus. For example, the capacity of capillary No. 6 was measured in the usual manner and found to be approximately ·25 mf. The diameter of the tube was about ·035 mm. The area of the meniscus is then approximately $2(10)^{-5}$ sq. cm. Then, either the double layer is only $6.8(10)^{-12}$cm. thick or its area is 0·039 sq. cm.

This raises the question of the creeping of the acid solution between the glass and mercury. To test this point, a fresh capillary was drawn (No. 11) and operated as follows: The large tube, which tapered below into the capillary, was filled with mercury in the usual manner. Then it was immersed in the acid and the mercury forced to run out under pressure to exclude air. Then the pressure was reduced gradually until the acid entered the tube a distance of only 2·75 mm. and the capacity was measured at a point 2·5 cm. from the end. Next, the acid was allowed to wet the tube for a distance of 3·00 mm. and the capacity again measured at a point 2·5 mm. and so on. The following values of potentials show that the progressive wetting of the tube with acid does not change the capacity.

Amount wet	Capacity in terms of Potentiometer wire
2·75 mm.	4·68
3·00 "	4·64
3·25	4·75
3·50	4·89
3·75	4·68

[1] Lippmann. Compt. rend. 95, 686, 1882.

Then either the acid solution is forced back by the return of the meniscus after wetting, which is not at all likely, or it creeps up of itself between the acid and mercury.

In a paper on the Angle of Contact[1] it was shown that when the angle of contact made with glass by a mercury surface covered with dilute sulphuric acid is zero, the acid creeps between the mercury and glass. Further experiments show that this creep always occurs with H_2SO_4 at least when the concentration is higher than one-half of one per cent. A large number of tubes was prepared by washing with aqua regia, water, potassium hydrate and distilled water. Distilled mercury was placed in the tubes and covered with dilute sulphuric acid. Many different sizes of tubes were used in order to study a possible effect depending on the diameter of the tube. While the smaller tubes seem to have a larger creep than the larger ones, the occurrence of rapid creep among the large and of small creep among the small tubes render such a conclusion doubtful.

The curves for the creep plotted as total distance against the time are approximately exponential. The acid creeps rapidly during the first few hours and then more and more slowly until it becomes almost stationary. Its rate depends so much on the cleanliness of the glass surface that the line between the wetted and unwetted portion, which is very sharp and distinct at first, becomes less and less distinct until it is difficult to follow. Some have been followed for several weeks. Measurements of the electrostatic capacity of these layers show that with constant potential difference the capacity is probably proportional to the area.

Further, the rate of creep depends on the pressure, so that as the acid descends in the tube it reaches regions of greater and greater pressure, so that the motion is slower and slower. If we take a tube small enough to make it possible to invert it without the mercury escaping, the creep is very rapid, in some cases so rapid that it is difficult to follow.

It is easy then to account for the high value of the capacity of the electrometer as used in the above experiments. The acid rises rapidly for some distance in the tube and the wetted area in the conical tube is many thousand times the area of the meniscus.

Experiments show that if the mercury in the tube is the cathode, the rate of creep is diminished by a potential difference applied to the electrometer and increased if the mercury is the anode. But these effects are small and do not explain the changes in capacities observed.

[1] Clark. Trans. Roy. Soc. Can., XII, 51, 1918.

Measurements of capacity in tubes large enough to permit the measurement of wetted area yield a calculated thickness of the double layer substantially the same as that given by Lippmann.

If we admit the existence of a double layer, the change in capacity with the applied difference of potential seems to indicate a change in the thickness in the double layer brought about by the charges on the plates of the layer.

In conclusion, I have to thank Mr. A. L. Greenlees for his painstaking care in carrying out nearly all of the experimental work in the foregoing paper.

Physics Laboratory, Queen's University
Kingston, Canada.

Algebraic Proof of the Existence Theorem for the Branches of an Algebraic Function of One Variable.

BY PROFESSOR J. C. FIELDS, F.R.S.

(Read May Meeting, 1920).

The proof of the Existence Theorem presented in this paper is one which the writer has given to his students for many years past in a course of lectures on the algebraic functions. The method is almost obvious and its simplicity will perhaps commend itself to those who have occasion to give an introductory course on the theory of the algebraic functions.

Consider an equation

1. $$f(z, u) = u^n + f_{n-1} u^{n-1} + \ldots + f_o = o$$

in which the coefficients $f_{n-1}, \ldots, f_o$ are series in powers of z with integral exponents. We shall suppose that no negative exponents present themselves. We shall assume that n is greater than 1 and we shall also assume that $f(z, u)$ contains no multiple factor.

On applying to $f(z,u)$ and $f'_u(z,u)$, regarded as polynomials in u, the process for finding the greatest common divisor we determine two functions $Q(z,u)$ and $R(z,u)$, polynomials in u of degrees $n-2$ and $n-1$ respectively with coefficients which are power-series in z, such that

2. $$Q(z,u)\, f(z,u) + R(z,u)\, f'_u(z,u) = z^m\ ((z))$$

where m is 0 or a positive integer and where in the power-series $((z))$ the constant term is different from 0. Furthermore it is readily seen that we may assume not only that $Q(z,u)$ and $R(z,u)$ are integral with regard to the element z but also that neither of them is divisible by z. For cancellation of the powers of u on the lefthand side of (2) cannot take place if one only of the two expressions here in question is divisible by z. The exponent m is then a perfectly definite number. If on substituting for u in $f(z,u)$ a power-series $P(z)$ we obtain a power-series in z in which the lowest exponent is greater than m it is evident from the identity (2) that the result of substituting $P(z)$ for u in $f'_u(z,u)$ will be a power-series in z in which the lowest exponent is equal to or less than m.

Let us now first assume that the coefficient f_o in $f(z,u)$ is divisible by z but that not all of the n coefficients $f_{n-1}, \ldots, f_o$ are so divisible. Suppose f_k to be the last of these coefficients which is not divisible by z. We shall attempt to divide $f(z,u)$ by a polynomial $u^k + q_{k-1}u^{k-1} + \ldots + q_o$ in which the coefficients $q_{k-1}, \ldots, q_o$ are power-series in z as yet undetermined save that they are all assumed to be divisible by z. We shall have

3. $f(z, u) = (u^k + q_{k-1} u^{k-1} + \ldots + q_o)(u^{n-k} + Q_{n-k-1} u^{n-k-1} + \ldots + Q_o)$
$+ S_{k-1} u^{k-1} + \ldots + S_o$

where $Q_{n-k-1}, \ldots, Q_o, S_{k-1}, \ldots, S_o$ are power-series in z. Identifying coefficients of $u^{n-1}, u^{n-2}, \ldots, u^k$ on the two sides of (3) we obtain

4. $$f_t = \sum_{s=0}^{n-t} q_{k-s} Q_{t-k+s} ; \; t = n-1, n-2, \ldots, k,$$

where it is to be understood that q_{k-s} is to be replaced by 0 when the suffix $k-s$ happens to be negative. Since we have $q_k = 1$ the relations (4) can evidently also be written in the form

5. $$Q_{t-k} = f_t - \sum_{s=1}^{n-t} q_{k-s} Q_{t-k+s} ; \; t = n-1, n-2, \ldots, k.$$

Identification of the coefficients of $u^{k-1}, u^{k-2}, \ldots, u^o$ on the two sides of (3) gives us

6. $$S_t = f_t - \sum_{s=0}^{t} q_{t-s} Q_s; \; t = 0, 1, \ldots, k-1.$$

We can now readily determine the coefficients in the series $q_o, \ldots, q_{k-1}$ and $Q_o, \ldots, Q_{n-k-1}$ in accord with the relations (5) in such manner that the series S_t furnished by (6) are divisible by as high a power of z as we will.

We have assumed that the constant terms in the series $q_o, q_1, \ldots, q_{k-1}$ are all 0. The identities (5) then evidently determine the constant terms in the series $Q_o, Q_1, \ldots, Q_{n-k-1}$ to be equal to the constant terms in the series $f_k, f_{k+1}, \ldots, f_{n-1}$ respectively. Of importance is the fact that the constant term in Q_o, being the same as the constant term in f_k, is different from 0. Bearing this in mind and equating to 0 in succession the coefficients of z in the expressions for $S_o, S_1, \ldots, S_{k-1}$ given by the identities (6) we successively determine the coefficients of z in $q_o, q_1, \ldots, q_{k-1}$ in terms of the constant terms in $Q_o, Q_1, \ldots, Q_{k-1}$. The identities (5) thereafter determine the coefficients of z in the series $Q_o, Q_1, \ldots, Q_{n-k-1}$ in terms of the constant terms in these series and of the coefficients of z in the series $q_o, q_1, \ldots, q_{k-1}$. Now equating to 0 in succession the coefficients of z^2 in the expressions for $S_o, S_1, \ldots, S_{k-1}$ given by the identities (6) we successively determine the coefficients of z^2 in $q_o, q_1, \ldots, q_{k-1}$ in terms of the coefficients already determined in these series and in the series $Q_o, Q_1, \ldots, Q_{n-k-1}$. The identities (5) thereafter determine the coefficients of z^2 in the series $Q_o, Q_1, \ldots, Q_{n-k-1}$ in terms of the coefficients already determined in these series and in the series $q_o, q_1, \ldots, q_{k-1}$.

By repetition of the process employed above suppose that we have determined the constant terms and the coefficients of $z, z^2, \ldots, z^{\lambda-1}$ in the series $q_o, q_1, \ldots, q_{k-1}, Q_o, Q_1, \ldots, Q_{n-k-1}$ in accord with the identities (5) and so that the series $S_o, S_1, \ldots, S_{k-1}$ in (6) are all divisible by z^λ. Equate to 0 in succession the coefficients of z^λ in the expressions for $S_o, S_1, \ldots, S_{k-1}$ given in (6) and we successively determine the coefficients of z^λ in the series $q_o, q_1, \ldots, q_{k-1}$ in terms of the coefficients of lower powers of z in these series and in the series $Q_o, Q_1, \ldots, Q_{n-k-1}$. The identities (5) thereafter determine the coefficients of z^λ in the series $Q_o, Q_1, \ldots, Q_{n-k-1}$ in terms of the coefficients already determined in these series and in the series $q_o, q_1, \ldots, q_{k-1}$. By induction therefore we conclude that however great λ may be we can determine the constant terms and the coefficients of $z, z^2, \ldots, z^{\lambda-1}$ in the series $q_o, q_1, \ldots, q_{k-1}, Q_o, Q_1, \ldots, Q_{n-k-1}$ in such order that each one is expressed rationally in terms of those already determined, their determination being made in accord with the identities (5) and in such manner that the expressions $S_o, S_1, \ldots, S_{k-1}$ in (6) are all divisible by z^λ. That the constant terms and the coefficients have been so determined we shall indicate by writing

$$7.\quad f(z, u) \equiv (u^k + q_{k-1}u^{k-1} + \ldots + q_o)(u^{n-k} + Q_{n-k-1}u^{n-k-1} + \ldots + Q_o) \pmod{z^\lambda}.$$

If we do not exclude fractional exponents from the coefficients $f_{n-1}, \ldots, f_o$ in (1) but suppose these coefficients to be series arranged according to integral powers of the element $\zeta = z^{1/\nu}$ we can replace z by ζ in the preceding argument. On assuming that f_k is the last of the coefficients which is not divisible by ζ we arrive at a factorisation of the form

$$8.\quad f(z, u) \equiv (u^k + q_{k-1}u^{k-1} + \ldots + q_o)(u^{n-k} + Q_{n-k-1}u^{n-k-1} + \ldots + Q_o) \pmod{z^{\lambda/\nu}}$$

where $q_o, \ldots, q_{k-1}, Q_o, \ldots, Q_{n-k-1}$ are series in powers of $\zeta = z^{1/\nu}$ in which the constant terms and the coefficients of $z^{1/\nu}, \ldots, z^{(\lambda-1)/\nu}$ are determined, the constant terms in $q_o, \ldots, q_{k-1}$ being assumed to be 0.

In what precedes some but not all of the roots of the equation $f(o, u) = 0$ are equal to 0. The general case where the roots of this equation are not all equal can be immediately reduced to the case just handled. For on writing $u = v + \rho$, where ρ is one of the roots of the equation $f(o, u) = 0$, we obtain an equation $F(o, v) = 0$ some but not all of whose roots have the value 0. By what we have seen above then we can effect a modular factorisation of $F(z, v)$ after the manner of that given in (8) for $f(z, u)$ in the special case which we there had in view. Retransforming $F(z,v)$ to $f(z,u)$ on writing $v=u-\rho$ the modular factorisation of $F(z,v)$ conserves itself and the modular factorisation of $f(z,u)$ in (8) may then evidently be taken to hold good in all cases where the roots of $f(o,u)=0$ are not all equal, the constant terms in $q_o, q_1, \ldots, q_{k-1}$ however being no longer assumed to have the value 0.

Let us now consider the case in which the roots of the equation $f(o,u)=0$ are all equal. On writing $u=v-\frac{1}{n}f_{n-1}$ we transform $f(z,u)=0$ into an equation

9. $$g(z,v)=v^n+g_{n-2}v^{n-2}+\ldots+g_o=0$$

where the coefficient of v^{n-1} is 0. The roots of the equation $g(o,v)=0$ will evidently all be equal. Also the common value of these roots is 0 since their sum is 0. In the equation (9) then the coefficients $g_{n-2}, \ldots, g_o$ must all have the value 0 for $z=0$ and must therefore each be divisible by some positive power of z.

Putting $v=z^a y$ in (9) and dividing through by z^{na} we arrive at an equation

10. $$G(z,y)=y^n+g_{n-2}z^{-2a}y^{n-2}+\ldots+g_o z^{-na}=0.$$

Indicating the lowest exponents in the series $g_{n-2}, \ldots, g_o$ by $a_{n-2}, \ldots, a_o$ respectively let us choose a so that none of the numbers

11. $$a_{n-r}-r\,a\,;\ r=2,3,\ldots,n$$

is negative and so that one of them at least is 0. The coefficients of the powers of y in $G(z,y)$ then involve no negative exponents. Also the roots of the equation $G(o,y)=0$ do not all have the value 0 and are evidently therefore not all equal to each other, since their sum is 0. By what precedes then there will be a factorisation of $G(z,y)$ analogous to that of $f(z,u)$ in (8). Writing $y=z^{-a}v=z^{-a}(u+\frac{1}{n}f_{n-1})$ and retransforming the factored $G(z,y)$ to terms of u we shall evidently have, in the case here in question also, a factorisation of $f(z,u)$ of the type given in (8). In all cases then we may suppose the modular factorisation of $f(z,u)$ given in (8) to hold good the constant terms in $q_o, q_1, \ldots, q_{k-1}$ however, as already indicated, being no longer assumed to have the value 0.

To the factors in (8) we can apply the factoring process employed in what precedes. By repeated applications of this process we can replace the right hand side of (8) by a product of n factors linear in u

and, what suffices for our purpose, we can evidently effect a modular factorisation of $f(z, u)$ in the form

12. $$f(z,u) \equiv (u-h)\ (u^{n-1}+h_{n-2}u^{n-2}+\ldots+h_0)\ (\text{mod } z^{\lambda/\mu})$$

where $h, h_{n-2}, \ldots, h_0$ are polynomials of degree $\lambda - 1$ in the element $z^{1/\mu}$. Here λ may be taken as great as we will. Assume for the moment that we have $\mu = 1$ and take $\lambda = 2m+1$. The function $f(z, h)$, regarded as a series in powers of z, is then divisible by z^{2m+1} and the function $f'_u(z, h)$, as a consequence of the identity (2), is divisible by the power z^m at most. Substituting $u = t+h$ in (1) we obtain an equation

13. $$t^n + e_{n-1}t^{n-1} + \ldots + e_1 t + e_0 = 0$$

in which the coefficients $e_{n-1}, \ldots, e_0$ are series in powers of z involving no negative exponents. In particular we have $e_1 = f'_u(z, h)$, $e_0 = f(z, h)$. The series e_1 is precisely divisible by a power z^{m_1} where $m_1 \overline{\gtrless} m$ while e_0 is divisible by the power z^{2m+1}.

By well known means it may now be shewn that the equation (13) is satisfied by a convergent series of the form

14. $$t = a_1 z^{m+1} + a_2 z^{m+2} + \ldots\ldots$$

To this series adding the polynomial h we obtain a series $u = P_1$ which satisfies the equation $f(z, u) = 0$. We have for the moment assumed $\mu = 1$. If this is not the case we substitute $\zeta = z^{1/\mu}$ and the preceding argument then proves the existence of a series $u = P_1$ in powers of ζ which satisfies the equation. We can then split off a linear factor $u - P_1$ from $f(z, u)$ and successive applications of the process splits $f(z, u)$ into a product

15. $$f(z, u) = (u - P_1) \ldots (u - P_n)$$

where, as we know, the series $P_1, \ldots, P_n$ group themselves in cycles.

Transactions of The Royal Society of Canada
SECTION IV

SERIES III | MAY, 1920 | VOL. XIV

A Devonian Glacier

By G. F. MATTHEW, D. SC., F.R.S.C.

(Read May Meeting, 1920)

That a glacier of Devonian Age is not quite so impossible as it might once have been thought, is clear from the facts, now acknowledged of a glacial floor to the Cambrian rocks of Northern Scandinavia and the discovery that glacial conditions existed both North and South of the equator in Triassic times. Such discoveries and others have given a severe shock to the theory of Laplace, so long held, as to the origin of the planetary masses, and turned more attention to the Planetesimal theory of Prof. Chamberlain and others, who would derive such masses from the aggregation of cold particles of matter floating in the cosmic spaces in past ages.

Without entering into speculations as to the origin of the planetary systems the writer proposes to present herein the evidences of certain phenomena observed in connexion with the present appearance of the terrain which lies at the base of the Carboniferous rocks as they are seen in the eastern part of the Maritime Provinces of Canada, and especially in the vicinity of the city of Saint John, New Brunswick.

It is true that he has not observed a glacial floor beneath this terrain, nor has he found this to abound with glaciated stones and boulders, as do the more recent deposits of the modern Glacial Period, nevertheless there are some characteristics of this terrain which are essentially *glacial*.

THE GEOLOGICAL COMPLEX ON WHICH THE SUPPOSED GLACIER RESTED

In the first place I propose to say a few words in reference to the *geological complex* which formed the foundation on which the glacier was built up, and left its characteristic deposit.

The exposed part of the complex had in its longest diameter a course approximately from N.E. to S.W., in the former direction emerging from beneath the Coal Measures (Carboniferous) and in the latter disappearing beneath the waters of the Bay of Fundy, an indentation of the Atlantic coast of North America; it is with the portion of this complex in the immediate vicinity of Saint John that we are most directly concerned.

The core of this complex consists of pre-Cambrian rocks having as a central mass, some old intrusive granitic rocks which have cut and altered others that are associated with them, such as gneisses and mica-schists; with these are found masses of limestones, argillites and intrusive diorites. Outside of this core, one finds on each side Cambrian slates and sandstones holding characteristic fossils; there is a considerable breadth of these Cambrian strata on each side of the complex, on the Southern side there are three synclinal folds, and on the North perhaps an equal number in the valley of the Kennebecasis river, where, however, they are much broken up, and concealed by the lake-like expansions of that stream.

Resting upon these Cambrian rocks on each side of the complex are strata of Silurian age, recognizable on the North side by marine fossils of that time; but on the South holding so far as is known, only remains of land plants, insectians and phyllopod crustaceans. Sir J. W. Dawson considered these plants to be Devonian, while David White and Mrs. Stopes thought them to be Carboniferous.

There remains a still later series of beds on the southern slope of this complex, but these beds have no counterpart on the Northern slope in this vicinity (though they outcrop further West).

The whole of this complex must have been subjected to severe pressure from the seaward (Southeastern) side, as all its argillaceous beds are characterized by a similar slaty cleavage, have a N.E.–S.W. course, and a hade to the S.E. usually at a high angle; whereas the overlying shales are devoid of cleavage, and the beds dip Northward at a lower angle than do the strata of the complex, It is in these overlying strata, however, that the indications of ice-action have been found.

It does not appear that the most pronounced indications of ice action are to be found amongst the comparatively fine red shales and sandstones which constitute the basal beds of this series as seen at the "narrows" near the outlet of the St. John river and elsewhere along the northern slope of the complex, but rather amongst the conglomerates and other coarse beds which attain a thickness of many scores of feet at the Boar's Head further up the river, and are easily distinguishable from those of the older terrains by their high content of fragments of limestones similar to the limestones found at the centre of the complex.

These limestone fragments are found in the conglomerates on both limbs of the complex, from which it would appear that they were thrown off on both sides of a central elevated protaxis.

The Principal Mass of "Till"

While there are many points where these peculiar conglomerates may be observed in the valley of the Kennebecasis, there is one place near the Eastern end of Long Island where they have a great thickness and exhibit a mass of one hundred to one hundred and fifty feet in thickness without any preceptible stratification. Here the deposit has the aspect of *glacial till*, and may be an old morainal mass. A part of it is visible in the "Minister's Face" on that island. This face has a sheer height of one hundred and twenty feet at its front. The material is a confused aggregate of gneissic blocks mingled with fragments of granites, limestones and quartzites held together in a paste of red clay and sand showing no traces of stratification. Occasional boulders with rounded ends may be seen in the cliff-slope; but almost all the fragments are angular, and only a very few are to be found which show a striated surface. Except for the rarity of these latter, and the absence of evidence of distant transportation, the conditions resemble those of modern glacial drift. On the Southern side of the complex, however, evidences of transportation are not wanting, for conglomerates of this terrain are to be found at Red Head on the eastern side of St. John harbor, which contain limestone blocks that have been derived from the old complex and carried southward three miles or more across Cambrian and Silurian rocks to their present position. The beds of the complex had already been folded, and marked by slaty cleavage, and they dip in a direction the opposite of that to which the conglomerates have been tipped.

Probable Aspects of the Southern Slope of the Older Palæozoic Complex

These are fairly traceable except as regards the Devonian part of this complex, which is more fully developed to the westward. A regular succession of strata may be traced in the complex, from the intrusive crystalline rocks at the core through pre-Cambrian gneisses, marble and less crystalline limestones, and upward through graphitic slates and other clastics, to the base of the Palæozoic. This shows feldspathic ash and brecciated rocks, below the red slate and sandstone, which in slightly altered conditions form the foundation of the overlying Palæozoic succession. Passing the greenish grey slate and grey quartzite, which are the first fossiliferous Cambrian rocks here, one finds a succession of grey slaty flags and sandstones of the second division of the St. John Group (Cambrian) and then (above) the grey and black slates of the third division (which also contains the base of the Ordovician, Arenig, etc.). In the city of St. John three synclinal folds in the Cambrian, etc. can be seen; these are reduced to one on the western side of St. John harbor, the other two folds being cut out by faults, or concealed by overlying deposits of a later age. These later deposits, mostly greenish-grey argillites, are unconformable to the Cambrian terrain and have a lower angle of dip. Near their summit, where the dip is S.E., they are covered (unconformably) by the red conglomerate and shales of the old glacial series which forms the subject of this paper. These shales and conglomerates dip at a low angle to the nortwestward, a dip which is quite at variance with that of the older rocks beneath them, in which the dip is at a high angle to the S.E.

The limestone fragments in the overlying conglomerates are evidently derived from the pre-Cambrian limestones of the complex to the northward and have been transported a distance of three or four miles from their original beds.

At the point where the upper part of the grey slate series ends on the Black river road eastward of Saint John, the succession in the underlying complex is interrupted by a deposit of volcanic breccia, marking the base of an overlying slaty series, here lying directly upon the older part of the complex, but presenting a lower angle of dip than the preceding slates, yet exhibiting similar slaty cleavage; further west this portion of the complex (known as the Mispec Group) is separated from the rest, and is evidently of later origin, but still is of greater antiquity than the Devono-Carboniferous, which forms the basis of the present article.

Probable Conditions on the Northern Slope of the Complex

On this slope of the complex greater displacements have occurred, both parallel to the course of the slaty cleavage and at right angles to it; these have caused irregular depressions which have made it difficult to trace the displacements that have occurred along fault lines, and the relations of the fragments in the old glacial "till" to the beds of the complex from which they have been derived. However, we again find the old pre-Cambrian limestones our surest guide in tracing the fragments to their source. Pieces of a peculiar marmorized variety of the limestone, which is well marked, exist in ledges of that formation near the western end of Long Island in Kennebecasis River, and are seen in the glacial till of the "Minister's Face" above referred to, among the more numerous pieces of gneiss, with which they are associated. The place where this marble would pass near the "Minister's Face" is now underneath the waters of Rothesay Bay on the above named river. Here the movement of the "till" would have been to the northward.

Both N.E. and S.W. of the mass of "till" on Long Island the red rocks (supposed to be coeval with the mass of the "till") show evidence of stratification, the coarser material being separated from the mud beds; but the red color of the waste material is not changed. These conditions are best seen at the southwest end of the Kennebecasis valley, in the Narrows near the outlet of the St. John River, where the base of the red sandstone formation is well exposed. But one must rise considerably above the base of the beds exposed here, before reaching the coarse conglomerate of the Boar's Head, which here marks forcibly the extreme glacial conditions indicated by the "till" of the "Minister's Face." It would thus appear that the approach of glacial conditions was gradual. This gradual approach and recession of frigid conditions is indicated also by the relation of the higher part of the terrain to the lower; this is well shown on the north side of Kennebecasis island at the junction of the river of that name with the main St. John river, where may be seen the passage from the red rocks of the lower member to the grey sandstones and shales of the upper member of the series. The upper contains a Pocono ("Culm")[1] flora, while the lower holds near Eastport, Maine, the Upper Devonian flora described by the late Sir J. W. Dawson, and further elaborated by Mr. David White of the U. S. Geological Survey; it is instructive to see at Kennebecasis island, the red rocks invaded by the grey with its plant-remains; this retires again to give place to the red rocks, which again recede and the grey rocks take permanent possession. This grey member is much more conspicuous in the upper part of the Kennebecasis Valley where it forms an important part of the terrain. The color of this member of the series may be due to the growth of vegetation, discharging the red color from the sediments of a glaciated area.

Summary

Under the hypothesis that of the conglomerates of the "Minister's Face" on Long island in Kennebecasis bay, are of the same nature as the "till" of the Glacial Period, *viz.* of morainic origin, the writer marshals facts observed in the neighbourhood of the city of Saint John, N.B., in support of this theory. He also attempts to show the

[1] The term "Culm" Flora is objectionable because it was applied to a flora thought to be Devonian, but which the late Mr. E. N. Arber showed to be analogous to that of the Lower English Coal Measures.

geological age of this glacial deposit on the ground that it was accumulated at the close of the Devonian period. He describes a pre-existant "Complex" of pre-Cambrian and early Palæozoic rocks, as being the foundation on which this old glacial deposit was based, and evidently looks upon it as parallel in its origin to the deposits at the base of the Cambrian in Scandinavia, and to the Triassic of the eastern hemisphere, which have been thought to be of similar glacial origin.

Granitic Segregations in the Serpentine Series of Quebec

By JOHN A. DRESSER, M.A., F.R.S.C., F.G.S.A.

(Read May Meeting, 1920)

GENERAL

The area commonly called the "Serpentine Belt" of southern Quebec is occupied by a series of ultra-basic rocks which run northeasterly in a narrow, intermittent band along the Southeastern flank of the Sutton, or main, Appalachian axis, from the southern boundary of the province to the Gaspé peninsula. These rocks are intrusive through sediments of Cambrian and Ordovician, if not also some of still later age. The series is remarkable economically as being the chief source of the world's supply of asbestos, also for the production of chromite; and, otherwise, for the wide range and uniformity of differentiation exhibited by the rocks of which it is composed.

PRINCIPAL ROCKS

The principal rocks are peridotite, pyroxenite, and diabase. In the mining areas, which as yet are confined to the counties of Megantic, Wolfe and Richmond, their relations are fairly well known, and their origin by differentiation from one magma, though probably intruded at different periods in different parts of the "belt," is well established. They occur as sills, stocks and bodies of intermediate shape, adjusted to the attitude of the enclosing strata. In all forms, the principal differentiates are arranged in the order stated above (that of decreasing basicity and density), in sills, from the base upward; in stocks from the centre outward.[1]

MINOR AND SECONDARY ROCKS

There are also lesser amounts of other rocks. Between pyroxenite and diabase there is frequently a zone of rock that would be more precisely classed as gabbro. Diabase not infrequently passes into porphyrite as its outer margin; peridotite, in places of better differentiation, becomes dunite; and other varietal distinctions might be made. Amongst secondary rocks, pyroxenite altered to talcose

[1] This annular arrangement of differentiates in stocks, by which a core of peridotite is surrounded by zones of pyroxenite and diabase in outward succession, has also been described by Duparc and Pamphile in the ultra-basic rocks of the Urals—*Comptes Rendus de la Société des Ing. Civ.*—Paris. cir. 1910

schists and serpentine, derived from peridotite, are abundant. The latter gives its name to the series from its economic importance as the country rock of the asbestos deposits.

Granitic Rocks

Besides the principal rock varieties and their allied and secondary phases, there are numerous smaller dykes and irregular acid masses which are generally of granitic character. In size they vary from bosses occupying several acres to mere nodules or stringers an inch or less in diameter. They are distributed without any apparent order, but are, as far as known, confined to the peridotite-serpentine areas.

Character: Lithologically the dominant material is a hornblende granite which shows certain peculiar mineral relations, which serve to distinguish it from the only other type of grantie known in the region, which is the biotite-muscovite granite of Stanstead. In some of the larger bosses, biotite is also present and the rocks become coarsely porphyritic. In other phases the rock is aplite, or pegmatite. Certain occurrences of lime silicate minerals, vesuvianite, garnet, and diopside, also probably belong to this group.

Relations: In many cases these peculiar rocks occur in the form of small dykes, and they have been generally classed entirely as such in published descriptions. The dykes are small, rarely exceeding 20 feet in width, irregular in size and direction, and are seldom traceable beyond a few hundred feet in length. They have not been observed to cross one another.

Irregular masses are numerous and variable in size as noted above. In many instances it is difficult to say definitely in which category an occurrence of granite should be placed, since there are wide gradations in form as well as in size.

As there is little differentiation evident in the smaller bodies, whether dykes or irregular masses, it has been generally inferred that all were injected while the country rock was still heated, and that they are end products of intro-telluric differentiation of the general magma, which were introduced at a somewhat later stage than the other members of the series. From time to time, however, bodies of granite have been observed, which appear to be completely isolated from one another and which suggest an origin by magmatic differentiation in place. Recent developments in mining also have afforded further information which goes to confirm this view. So on the whole it seems advisable to review the relations of these rocks.

Until recently, mining was carried on almost entirely by open-cut methcds, or quarrying. Consequently only one surface of the rock was ordinarily exposed at a time. Granite dykes appeared and disappeared in the progress of mining, and when lost were supposed to be faulted into unmined ground. This doubtless occurs, and perhaps frequently, but the dykes are rarely, if ever, traceable by any means available beyond a few hundred feet in length, and usually for much shorter distances. But the adoption of underground methods of mining, with the development of large areas at different levels in advance of actual mining, affords a better view. It is thus made possible to observe on all sides—above, below and all around—many masses of granite and to be assured that they are not connected with one another nor with any parent mass.[1]

True dyke forms, which actually and frequently occur, seem satisfactorily accounted for as the filling of contraction cracks in the earlier cooled peridotite, by the more acid and still liquid granitic residue. These dykes, it may be repeated, are local in extent, are irregular in distribution, have not been observed to cross one another, and are confined to the peridotite-serpentine area.

Contact Features: The contact between the granites and the enclosing serpentine is generally sharp, rarely if ever gradational. This is somewhat in contrast to the relations existing between other rocks of the series, and has been frequently cited as evidence of the intrusive character of the granite. The smaller dykes and masses are apt to be aplitic in character and to show little variation throughout. But in the larger of the isolated bodies, the tendency seems to be to develop pegmatite along the border of the granite near the contact.

Individual Bodies: The largest single body of granite in the mining area is an elliptical boss, three-quarters of a mile long and about a quarter of a mile in its greatest width. The actual contact is drift-covered except for intervals of a few hundred feet. The central and greater part of this area is composed of coarsely porphyritic biotite-hornblende granite. Towards the margin, in exposed areas at least, biotite disappears and the rock becomes the ordinary hornblende granite of the series.. Bordering this phase, and separating it from the serpentine there is a distinct zone of pegmatite, perhaps 2 or 3 feet in width. From this pegmatite border small dykes or veins, also of pegmatite, are occasionally found running into the granite for distances of 40 or 50 feet. They seem to become more acid the farther they penetrate the granite, and end in or near stringers of quartz. No invasion of the serpentine by pegmatite was observed in this locality,

[1] The writer is indebted to the managers of the Bell and the Jacobs mines, the Hon. G. R. Smith and Mr. N. R. Fisher, for facilities in visiting their underground workings at various times.

but dykes of this material are not infrequent in the serpentine of the district. The relation of the pegmatite veins to the granite, as just cited, is, as has been pointed out by Graham in other occurrences (*op. cit.*) analagous to that of the granite dykes of the larger peridotite-serpentine bodies and may be regarded as acid residues of the original magma filling contraction cracks in the cooling granite.

To cite another occurrence, a mass of granite 17 feet in diameter is exposed in one of the underground workings in such a position as to assure its isolation. It is a hornblende granite of the prevailing type. Hornblende is more abundant in the centre than near the sides of the mass. The actual edge is composed chiefly of coarse grained feldspar, and may be designated as a pegmatite. In places along the contact of pegmatite and serpentine, the feldspar of the former is partially replaced by diopside, which appears to indicate that some measure of chemical action took place between the acid residue and the basic wall rock. In general then, the contacts are sharp, and in the larger bodies there is a tendency toward the development of pegmatite along the margin of the granitic masses, and lime silicates in contact with the wall rock.

Lime Silicates: Certain lime-silicate bodies previously referred to have been recently studied by Graham, Harvie and Poitevin.[1] These are often in the form of dykes. They consist in part or even entirely of lime garnet, vesuvianite or diopside. Graham thus summarizes the field evidences with regard to their relation to the granite. "Aplitic dykes of normal character, containing little or no garnet are frequent, but occasionally they are found to be highly garnetiferous, while in other cases aplite is traversed by narrow veinlets of fine granular garnet. It is difficult to avoid the impression that all gradations exist between normal aplite and the dykes composed entirely of garnet, and that an aplite might be found to gradually change into a garnet (or vesuvianite or diopside) dyke in one and the same continuous fissure, although such an ideal case has hitherto not been observed."

It is probable that these unusual rock types are developed mainly in the local dykes. Irregular, but not necessarily isolated masses of them have been observed. Further study is required to definitely settle this point.

---

[1] Economic Geology, Vol. XII, No. 2, 1917, R. P. D. Graham.

Summary Report, Geol. Survey Can., R. Harvie.

Museum Bulletin, No. 27 Geol. Survey Can., 1918, E. Poitevin and R. P. D. Graham.

ORIGIN OF SERPENTINE AND ASBESTOS (*Chrysotile*)

The derivation of serpentine and asbestos from peridotite may be regarded as one process, differing only in the degree of alteration produced. It has been recently and thoroughly discussed by Graham,[1] who shows, in the case of the Black Lake-Thetford area, that the hydration has been effected by hydro-thermal silicious waters. The source of such waters has been a subject of some discrepancy of opinion amongst writers on the subject in the past, a difference which may now disappear.

It has long been recognized that granite is usually found in, or near, the richer asbestos ground of Thetford, Black Lake and Danville. Accordingly it has been claimed, on one hand, that the asbestos is due to the introduction into the peridotite of acid water by intrusions of granite. On the other hand the richness of the asbestos ground, if dependent on the presence of granite, does not appear to be proportionate to the amount of granite present, and the total amount of granite is relatively very small. Consequently, others have looked for the main cause in magmatic waters accompanying the intrusion of the peridotite itself. Granting the differentiation in situ of granite and peridotite from the same magma, these differences no longer have reason to exist. Granite thus becomes an indication, rather than a cause, of the presence of acid waters in the magmatic residue needed to produce serpentine and asbestos.

Place in the Series: As the least dense and, theoretically, the latest member of the series to solidify, granite might be expected to occupy a place in the upper portion of the series amongst the other acid differentiates. But it does not occur in this position. Instead, it is essentially an accompanying feature of the peridotite, which forms the lowest part of the series, and, moreover, is distributed in it without any order that has yet been discerned. The position of the granite is, therefore, a somewhat anomalous one, if it is regarded as a direct differentiate from the original magma. Considered as a derivative from an ultra-basic phase of the magma, which cooled as peridotite, however, the granite occurs in the position and within the limits to be expected of it.

This implies some degree of differentiation within the magma after intrusion but while it was still in a fluid state, an assumption that seems to find support in the prevailing and very constant arrangement of the principal rocks of the series in stratiform order in sills, and in annular order in stocks. Also there is variation within

[1] Economic Geology, Vol. XII, No. 2, 1917.

each of the principal differentiates themselves and even in the granite, showing that segregation in situ took place within the various derivatives. It seems warrantable, therefore, to conclude that the granite may have been thus segregated from magma of the peridotite phase in situ in a late stage of its solidification, perhaps a stage termed by Harker [1] the "squeezing of the sponge" of basic crystals, which resulted in the expulsion of minor acid residues and the forming of differentiates of extreme types.

Comparison with Other Areas: Descriptions of comparable areas that are applicable to this subject are not numerous in geological literature. An instance of differentiation of like wide range is afforded by the work of Dakyns and Teall in Argyleshire, Scotland.[2] Here the series of differentiates is stated to include peridotite, olivine-diallage (wehrlite), diorite, tonalite, and granite, the latter ranging to phases of high acidity. In this series the acid rocks greatly predominate and the ultra-basic rocks are of minor importance, except as indicating the wide range of differentiation. In the Quebec series the rocks occur in the reverse order of importance.

In the Gowganda district of Ontario, investigated by Collins,[3] there is, perhaps, a better parallel. In this region the wide-spread sills of Nipissing diabase contain small dykes of aplite, and masses of an acid rock closely allied to aplite. Compared with the serpentine series of Quebec, the Gowganda intrusives, besides being more acid in composition, cooled more quickly and the differentiation is less complete. In a summary Collins says: "Where cooling was slow enough, the magma forming these large bodies (the sills) obeyed imperfectly a tendency to differentiate into two parts; a principal one of ordinary diabase, and a subordinate one of aplitic nature. The aplite occurs as dykes and irregular segregations within the diabase."

Elsewhere (p. 81) Collins also remarks applicably to the present question, "Segregation was more or less complete according to the rate of magmatic congelation . . . . irregular spots and patches of "red rock" (a phase of aplite) from 1cm. to 100m. in diameter, and aplite dykes, developed during the more protracted cooling of the sills. Perhaps there was a tendency on the part of the lighter aplite to rise to the upper surface of the diabase, for a considerable quantity of aplitic bodies have been found in the upper portions of the sills, but the results of this tendency are not strongly in evidence.

Differentiation of diabase and aplite from one original magma was accompanied by differentiation within each of these derivatives."

---

[1] A. Harker, XII, International Geological Congress, 1913.

[2] Cited in Geikie's Text Book of Geology, 4th ed., 1903, p. 710.

[3] Geological Survey fo Canada, Memoir 33, 1913, W. H. Collins.

SUMMARY

In a review of the granitic rocks of the serpentine series two forms of occurrence are distinguished, *viz.:* dykes and irregular masses. These are only selected as types since there are all gradations in shape between them.

The dykes and dyke-like forms are small and irregular; they do not intersect one another and are limited to the peridotite-serpentine area. They are believed to be local fillings of contraction cracks, or other spaces, in the cooling peridotite by part of the more acid and still liquid magmatic residues.

The irregular masses are now known to be isolated from one another in numerous cases that could be observed and may be so isolated in many more, perhaps in a great majority of the occurrences. Along the margin of larger masses there is a tendency to develop pegmatitic phases rather than fused or transitional contacts, between them and the adjacent rocks. Reactions such as might be expected to take place between thermal acid waters and ultra basic rocks is evidenced in places by the development of lime silicates. On the whole there is strong ground for the belief that these granites, aplites, etc., are residual segregations from the magma of the peridotite and that they have been formed by differentiation in situ.

SUMMARY

In a review of the granitic rocks of the serpentine series two forms of occurrence are distinguished, viz. dykes and irregular masses. These are only selected as types since there are all gradations in shape between them.

The dykes and dyke-like forms are small and irregular; they do not intersect one another and are limited to the peridotite-serpentine area. They are believed to be local fillings of contraction cracks, or gather spaces, in the cooling peridotite by part of the more acid and still liquid magmatic residues.

The irregular masses are [illegible] known [illegible] from one another in numerous cases that could be observed and may be so isolated in many more, perhaps in [illegible] of the occurrences. Along the margin of larger masses there is a tendency to develop pegmatitic phase rather than [illegible] transitional contacts between them and the adjacent rocks. [illegible] such as ought to take place between [illegible] and ultra-basic rocks is evidenced in places by the [illegible] of lime [illegible] whole there is strong ground for [illegible] that these [illegible] etc., are residual segregations [illegible] of the [illegible] that they have been formed by [illegible] magma.

The Relationships of the Palæozoic to the Pre-Cambrian along the Southern Border of the Laurentian Highlands in Southeastern Ontario and the adjacent Portions of Quebec

By M. E. WILSON, B.A., Ph.D.

Presented by J. A. DRESSER, M.A., F.R.S.C., F.G.S.A

(Read May Meeting, 1920)

INTRODUCTION 2 & 3

The principal structural and stratigraphical features that characterize the Palæozoic formations occurring along the southern border of the Laurentian highlands in southeastern Ontario and the adjacent portions of Quebec were long ago described in considerable detail by Logan in the Geology of Canada, 1863, as well as later by Ells and Ami in several reports of the Geological Survey and in numerous papers contributed to the Transactions of this Society and other publications. Recently, however, some new interpretations of these data have been proposed by Kindle and Burling in a Museum Bulletin entitled "Structural Relations of the Pre-Cambrian and Palæozoic Rocks north of the Ottawa and St. Lawrence Valleys."[1] In this publication it is concluded:

1. That the Palæozoic sediments occurring in the lower Ottawa and St. Lawrence valleys occupy their present depressed position with respect to the Laurentian highlands that adjoin them on the north mainly because they have been downfaulted into this position; and

2. That the southern border of the Laurentian highlands to the north of the lower Ottawa and St. Lawrence rivers is delimited by a through-going fault which expresses itself physiographically as a fault-line scarp.

The purpose of the present paper is to present additional data bearing on this subject, and to point out that these data seem to indicate that some modifications in the conclusions of Kindle and Burling, previously cited, are necessary.

---

[1] No. 18, Geol. Surv. Can., 1915.

[2] Published by permission of the Director of the Geological Survey.

[3] The writer wishes to express his indebtedness to Messrs. E. D. Ingall, W. A. Johnston, and other members of the staff of the Geological Survey for suggestions and criticisms contributed to a discussion of the subject of this paper at meetings of the Logan Club of the Geological Survey in 1917.

General Data

For the purpose of general description the border zone adjoining the Laurentian highlands in the lower Ottawa and St. Lawrence valleys may be conveniently divided into 4 subdivisions: (1) the region extending along the southern border of the Laurentian highlands between Montreal and Quebec; (2) the lowland area including the eastern part of southeastern Ontario and the adjacent territory in Quebec and New York State; (3) the irregular depression forming the lower Ottawa valley to the west of Ottawa, and, (4) the region lying between the Laurentian highlands and Lake Ontario to the west of Kingston.

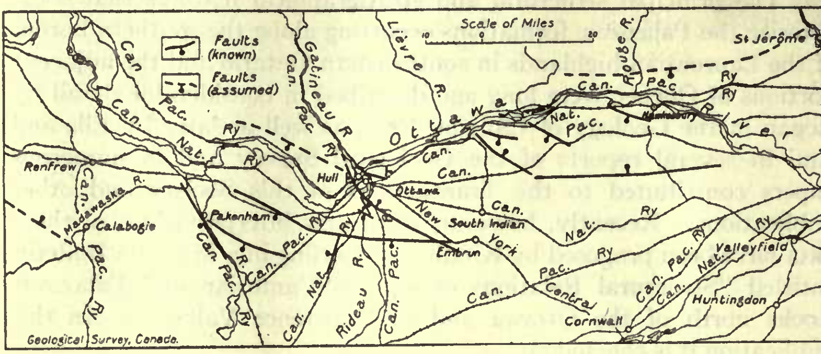


Diagram showing the principal faults along which the Palæozoic and older formations occurring in the lower Ottawa valley have been displaced.

In the first of these localities, the district lying north of the St. Lawrence between Montreal and Quebec, the Palæozoic formations as shown on the published maps of the Geological Survey[1] outcrop in succession from north to south as continuous belts trending parallel to the southern margin of the Laurentian plateau. In the district lying north of Montreal and eastward as far as Three Rivers the complete succession from the Potsdam sandstone to the Queenston shale is represented but from the Three Rivers district eastward to Quebec the lowermost formations are missing and the Trenton limestone rests directly on the Pre-Cambrian. The regional dip of the Palæozoic strata in this border belt, according to the observations of Logan[2] and Ells[3] is generally between one and three degrees towards the south and

[1] Map of Canada, in atlas accompanying Geology of Canada, 1863. Three Rivers Sheet, accompanying Part J, Vol. XI, Geol. Surv. Can., 1898.

[2] Geology of Canada, 1863, pp. 150 and 152–53.

[3] Geology of the Three Rivers Map-Sheet, Ann. Rep. Geol. Surv. Can., Vol. XIV, 1901. 1898, Part J., pp. 14–15

hence away from the Laurentian highlands, and it is evidently on this account that the various formations outcrop successively from north to south in belts trending parallel to the margins of the adjoining Pre-Cambrian uplands. The total thickness of strata represented in this Palæozoic belt is probably not less than 3,000 feet.[1]

The second subdivision in the Palæozoic border zone includes the district in southeastern Ontario and the adjacent portions of Quebec and New York state that lie between the Laurentian highlands on the north and the Adirondack mountains on the south. Throughout most of this territory the predominating formation exposed at the surface is the Trenton which as shown on the map of Canada prepared by Logan and on the Grenville and Cornwall sheets prepared by Ells, outcrops broadly in the region lying between the lower Ottawa and St. Lawrence rivers. Around this central area of Trenton the older Palæozoic formations, the Black River, the Chazy, the Beekmantown, and the Potsdam outcrop in successive belts so that except where the relationships have been obscured by faulting the structure is that of a broad syncline.[2] In the region adjoining the lower Ottawa river adjacent to Ottawa and eastward, however, a faulted zone occurs in association with which areas of shale and limestone belonging to the Utica, the Lorraine and the Richmond formations have been down-faulted into juxtaposition with older formations the maximum displacement so far recorded being that adjacent to the Hull and Gloucester fault along which at one point the Richmond shale adjoins the Beekmantown dolomite. The displacement in this locality is therefore equal to the thickness of the strata intervening between the Beekmantown and the Richmond, or approximately 1,600 feet.[3] The maximum thickness of the Palæozoic represented in this faulted belt is estimated to be 1,900 feet; the maximum thickness of strata present throughout the region outside the faulted zone where the Trenton limestone is the uppermost formation on the other hand is approximately 1,200 feet.

The district included in the Ottawa valley to the west of Ottawa which forms the third subdivision of the Palæozoic border belt,

[1] Ami, H. M. and Adams, F. D., Ann. Rep. Geol. Surv. Can., Vol. XIV, 1901, Pt. O, pp. 25–29.

[2] Ells, R. W., the Physical Features and Geology of the Palæozoic Basin, Between the Lower Ottawa and St. Lawrence Rivers, Proc. and Trans. Royal Soc. Can., 2nd series, Vol. VI, 1900, pp. 99–120.

[3] Ami, H. M., On the Geology of the Principal Cities in Eastern Canada, Proc. and Trans., Royal Soc. Can., 2nd series, Vol. VI, 1900, p. 129. Foerste, A.F., Upper Ordivician formations in Ontario and Quebec, Mem. 83 Geol. Surv., Dept of Mines Can., 1919. From information regarding drilling records in the Ottawa district supplied the writer by E. D. Ingall.

is merely the western continuation of the subdivision previously described, but is distinguished by certain features which are either absent or cannot be observed in the region to the eastward. It consists of a broad depression, the irregularities in the surface of which are occupied in places by outliers of Palæozoic strata ranging in age from the Potsdam to the Utica. The older Palæozoic formations represented in the Ottawa valley—the Potsdam, the Beekmantown, and the Chazy—however, progressively disappear in these outliers in an east-west direction so that in the western part of the depression as well as in the Timiskaming depression farther to the north the Black River formation rests directly on the surface of the Pre-Cambrian. Similar overlap relationships can also be observed, here and there, within the depression, thus in the vicinity of Clear lake in Sebastopol township, Renfrew County, Ontario, the Utica formation rests on the surface of the Pre-Cambrian at an elevation of approximately 800 feet above sea level, whereas in the valley of the Bonnechere a few miles to the northeastward the Beekmantown occurs in the same relationship at an elevation of less than 400 feet above sea level. It would seem probable, therefore, that between these two points there was an original difference in elevation of the Pre-Cambrian surface, upon which the Palæozoic sediments were laid down, equivalent to the thickness of sediments intervening between the Beekmantown and the Utica or approximately 600 feet, an amount greater than the present difference in elevation of the two localities.

The fourth subdivision—the region adjoining the southern border of the Laurentian plateau to the west of the Kingston district—differs from the region to the eastward in that only the Black River and Trenton formations are represented. These however, are distributed in the usual successive parallel belts from north to south and as in most other border localities dip to the southward away from the Laurentian upland. Likewise where the Palæozoic adjoins the Pre-Cambrian in this locality the Ordovician limestone occurs as scattered outcrops over the surface of the Pre-Cambrian throughout a wide zone so that the border line between the Pre-Cambrian highlands and the Palæozoic lowland is most indefinite.

Local Details of the Plateau Border

The Eardley Escarpment: The southern border of the Laurentian plateau in the region northwest of Ottawa is sharply delimited by an escarpment several hundred feet in height which extends for a distance

[1] Ells, R. W., Report on the Geology of a Portion of Eastern Ontario, Ann. Rep. Geol. Surv. Can., Vol. XIV, Pt. J, 1901, p. 7.

of 30 miles in a northwesterly direction parallel to the north shore of Lake Deschene, from Kings mountain, northwest of the city of Hull, to a point in Onslow township approximately three miles north of the village of Quyon. Since this escarpment has its greatest development in Eardley township and is known locally as Eardley mountain it can be most appropriately designated the Eardley escarpment. At its eastern end the escarpment is cut off abruptly by the Gatineau river valley but at its western end it gradually diminishes in height in the direction of its termination. From the Eardley escarpment westward the Pre-Cambrian border everywhere presents the poorly defined gently sloping relationships which characterize the southern border of the Laurentian highlands in most other localities.

From the Gatineau Valley to Montebello: In the region to the east of the Eardley escarpment and as far as the village of Montebello a distance of 40 miles the highland border like that to the west of the Eardley escarpment is poorly defined, remnants of Palæozoic sediments lying here and there over the Pre-Cambrian surface throughout a zone several miles in width. These relationships are typically exemplified in the region included in the Buckingham map recently published by the Geological Survey. In the southern part of this area scattered outcrops of Potsdam sandstone overlain in places by Beekmantown dolomite occur for a distance of 7 miles north of the Ottawa river and 6 miles north of the point where the Pre-Cambrian predominates as the bedrock formation. In a few of these outcrops the strata appear to conform to the surface of the underlying Pre-Cambrian but more generally they dip to the southward at low angles and thus conform approximately to the regional slope of the Pre-Cambrian floor upon which they were deposited. The maximum thickness of Potsdam sandstone exposed in these outcrops is generally not more than 30 feet, whereas the thickness in the vicinity of Ottawa a few miles farther to the south is said to be 200 feet.[1] This increase in thickness of the Potsdam from north to south suggests that in Pre-Palæozoic time as at present the Pre-Cambrian surface in this region had a gradient to the southward.

The Grenville escarpment. The southern border of the Laurentian highlands from the Montebello district eastward to St. Jerome, a distance of approximately 35 miles, is marked by a second striking escarpment which rises abruptly to a maximum elevation of 700 feet

[1] Ami, H. M., Proc. and Trans., Royal Soc. Can., new series, Vol. VI, 1900, p. 129.

The thickness of Potsdam encountered in a well drilled in Dundonald Park, Ottawa, according to Mr. E. D. Ingall was 265 feet.

above the lowland which adjoins it on the south. Since this feature attains its greatest prominence in Grenville township to the north of the town of Grenville it may be appropriately named for purpose of reference the Grenville escarpment. Between Montebello and the village of Fasset at the west end of this escarpment a group of prominent hills lies along the margin of the plateau but the linear scarp feature that characterizes the plateau border from Fasset eastward is not well developed. At its eastern end, on the other hand, the escarpment although only from 100 to 200 feet high maintains its linearity to its termination a few miles west of St. Jerome.

St. Jerome to Quebec: From the town of St. Jerome eastward to Quebec a distance of approximately 130 miles the highland border exhibits the same indefinite relationships observed in most other localities. It is true that the surface of the Pre-Cambrian highlands is much more irregular than that of the Palæozoic lowlands and that these irregularities, when viewed from points in the Palæozoic lowlands at a distance from the highlands, appear as a continuous line of elevation, but this is an optical illusion for the greater part of the hills that appear to be in alignment in reality lie may miles within the Laurentian plateau and have no relationship to the plateau margin.

Discussion

Factors Determining the Present Relationship of the Palæozoic to the Pre-Cambrian

It is evident from the general data previously cited that the Palæozoic formations occurring in the lower Ottawa and St. Lawrence valleys stand at an elevation ranging from several hundred to several thousand feet below the elevation of the Pre-Cambrian highlands that adjoin them on the north. Three hypotheses that might explain these relationships of the Palæozoic to the Pre-Cambrian suggest themselves: (1) That the depression in which the Palæozoic sediments occur, is pre-Palæozoic in age, or (2) that the Palæozoic sediments have been downwarped or downfolded, or (3) downfaulted into their present position.

If the Palæozoic sediments occurring in the lower St. Lawrence valley were deposited in a depression, as the first of these hypotheses assumes, then successively younger formations would overlap one another in the direction of the Laurentian highlands; and as regards the older Palæozoic formations the Potsdam, Beekmantown, and Chazy, these relationships hold, for, as previously pointed out, these formations are present in the lower Ottawa and St. Lawrence valleys in the region extending from the Three Rivers district on the east to

Alumette Island, and the Kingston district on the west and are absent outside this region not only on the east and west but in the outliers of Palæozoic occurring far within the Laurentian highlands on Lake Timiskaming[1] and on Lake St. John.[2]

It may be concluded, therefore, that the early Palæozoic formations occurring in the lower St. Lawrence basin were deposited in a widely extended depression which had a depth equal to the thickness of these formations or from 600 to over 1,000 feet throughout nearly its entire extent.

It has been previously noted that throughout the greater part of the region adjoining the southern border of the Laurentian highlands the Palæozoic formations dip to the southward away from the Pre-Cambrian upland and in consequence outcrop in successive parallel belts trending approximately parallel to the margin of the plateau, and, since these formations were presumably laid down originally in horizontal position, they have evidently been downwarped relatively to the pre-Cambrian highlands since they were deposited. Thus in the region adjoining the southern border of the Laurentian highlands, between Montreal and Quebec and in central Ontario, the Palæozoic formations have been depressed from several hundred to several thousand feet with respect to the adjoining highlands, and similarly in the region which lies between the Laurentian highlands and the Adirondack mountains, of New York State, despite the fact that the relationships in this locality have been somewhat obscured by faulting, the distribution of the Palæozoic formations indicates clearly that these have been folded into a broad syncline. As a consequence of this folding the top of the Trenton formation in southeastern Ontario stands approximately at the same elevation as the base of the Potsdam outcropping along the northern border of the Adirondack mountains in New York State, so that the Palæozoic strata in Ontario with respect to those occurring a few miles to the southward in New York State have been depressed over 1,200 feet.[3]

So far as known, nearly all the important faults that intersect the Palæozoic strata outcropping in the northern part of the lower Ottawa and St. Lawrence valleys are confined to a belt of territory lying along the Ottawa river between a point a few miles west of Ottawa and Montreal. These faults, as shown in the figure on page 16, generally trend in an east-west or northwest direction and have

---

[1] Williams, M. Y., Mus. Bull., No. 17, Geol. Surv., Dept. of Mines, Can., 1915.

[2] Dresser, J. A., Mem. 92, Geol. Surv., Dept. of Mines, Can., 1916, pp. 29–35. Hume G.S. Sum. Rep., Geol. Surv., Dept. of Mines, Can. 1916, pp. 188–192.

[3] See map accompanying N.Y. State Mus. Bull. No. 191, by H. P. Cushing.

a maximum length in the case of the longest faults of 30 to 40 miles. The displacement along the faults, although it attains a maximum of approximately 1,600 feet in the case of the Hull and Gloucester fault, is generally considerably less than this amount and usually decreases by several hundred feet in a few miles in directions away from the point of maximum displacement both along the line of fault and at right angles to the line of fault. It is obvious therefore, that, although faulting has been an important factor in lowering the elevation of the Palæozoic strata throughout the belt of territory adjoining the Laurentian highlands between the Ottawa district and Montreal, these displacements are local in extent and, quantitatively at least, are relatively the least important of all the factors by which the present relationships of the Palæozoic to the Pre-Cambrian in southeastern Ontario and the adjacent portions of Quebec may be explained.

Origin of the Eardley and Grenville Escarpments

That the Eardley and Grenville escarpments probably owe their origin to Post-Ordovician faulting evidently suggested itself long ago to the officials of the Geological Survey engaged in field work in the Ottawa valley, for, on a map of Ottawa county prepared by Vennor and published in the Report of Progress of the Geological Survey for 1876–77, the Eardley escarpment is indicated on the margin of the map as a fault. The general data upon which this hypothesis is based are the following[1]:

The occurrence of the escarpments along the northern edge of an area in which the Palæozoic strata are intersected by numerous faults having the same average length and parallel trends.

The occurrence of the escarpments in places on the contact of the Palæozoic and the Pre-Cambrian.

The manner in which the escarpments cut abruptly across the structure of the Pre-Cambrian rocks which adjoin them on the north.

The absence of any change in the lithological character of the Palæozoic sediments adjacent to the escarpment such as would probably be present if the escarpment were Pre-Palæozoic in age.

When engaged in field work in the Grenville district in 1916 the writer examined the base of the Grenville escarpment in favorable localities in the hope of finding outcrops of Palæozoic in which some evidence favorable to or opposed to the faulting hypothesis might be found, but at that time the only exposure observed in close proximity

[1] See Kindle, E. M., and Burling, L. D., Mus. Bull. No. 17, Geol. Surv., Dept. of Mines, Can., p. 23, 1915.

to the scarp was a mass of Beekmantown dolomite that outcrops in lot eleven, Range III, Grenville township. This mass outcrops in the bank of a creek and dips to the south away from the Laurentian highlands at an angle of approximately 35 degrees. Recently, however, Mr. Arthur Lanigan, of Calumet, has drawn the writer's attention to two outcrops of Potsdam sandstone that peep through the talus on the slope of the escarpment in lot 20, Range II, Grenville township. At this point the sandstone is exposed on the hill slope about 100 feet above its base and directly in front of a steep scarp of Pre-Cambrian granite gneiss. The sandstone is the fine-grained normal variety, contains no pebbles of granite gneiss, is much broken, and at one point is intersected by a small east-west fault—the surface of which is polished and striated vertically. The actual contact of the sandstone and the granite gneiss is not exposed, however. On making a further search for outcrops in this locality it was found that Beekmantown dolomite was present in the banks of a small creek gully situated a few hundred feet to the west of the sandstone outcrops. Here also the dolomite is much broken and terminates abruptly against a scarp of granite gneiss. On the whole, therefore, although the actual fault contact was not observed there is much evidence to indicate that a fault is actually present in this locality.

As regards the origin of the Eardley escarpment no outcrops of Palæozoic strata, so far as known to the writer, have been observed in close proximity to its base, and the hypothesis that a fault is present in this locality is based entirely on the general evidence already cited.

Objections to the hypothesis that the Eardley and Grenville escarpments are related in their origin to a through-going fault or are parts of a fault-line scarp.

The data indicating that the Eardley and Grenville escarpments are not related in their origin to a through-going fault have been previously stated and hence may be merely summarized in this connection. Among the most important of these data are the following:

The Eardley and Grenville escarpments are comparable in length and parallel in trend to local faults that intersect the Palæozoic formations along the Ottawa river a few miles farther to the south. They are therefore probably related in their origin to similar local faults and in that case would be entirely separate from one another.

If the southern border of the Laurentian highlands to the north of the lower Ottawa and St. Lawrence rivers were delimited by a continuous fault this fault would presumably express itself physiographically as a continuous fault-line scarp, whereas, except in two districts, the highland border in this region is comparatively gently sloping the regional gradient of the Pre-Cambrian surface being generally not more than 20 to 50 feet per mile.

In those portions of the highland border that are gently sloping, outliers of Palæozoic strata belonging to the same formation occur scattered over the surface of the Pre-Cambrian. It is obvious therefore that in such localities at least a fault of considerable displacement could not be present.

Conclusions

The region lying along the southern border of the Laurentian plateau to the north of the lower Ottawa and St. Lawrence valleys is of special interest to the geologist because, perhaps more than any other locality, it affords an opportunity to study the relationships of the early Palæozoic formations to the Pre-Cambrian of the Canadian shield and from these relationships to infer the extent of the Palæozoic submergence over the eastern part of this ancient land mass. The purpose of the present paper has been to briefly summarize the available data bearing on the relationships of the Palæozoic to the Pre-Cambrian in this region, and from these data to draw whatever conclusions they seemed to warrant. These conclusions briefly stated are twofold (1) that the present relationships of the Palæozoic to the Pre-Cambrian along the southern border of the Laurentian highlands in southeastern Ontario and the adjacent portions of Quebec have been brought about by a combination of three factors; (*a*) the deposition of the early Palæozoic formations, Potsdam, Beekmantown and Chazy in a broad depression extending over a large part of the region now included in the lower Ottawa and St. Lawrence valleys; (*b*) the downwarping or downfolding of the Palæozoic formations along the whole southern border of the Laurentian plateau; and (*c*) the downfaulting of the Palæozoic strata in scattered localities but chiefly in a zone extending along the lower Ottawa river from the Ottawa district eastward to Montreal.

(2) That the southern border of the Laurentian highlands to the north of the lower Ottawa and St. Lawrence valleys, is marked in two localities by abrupt escarpments which probably owe their origin to differential erosion along local fault planes but is not delimited by a through-going fault nor by a fault-line scarp.

The Norite Rocks of the Lake Athabaska Region

By F. J. ALCOCK, B.A., PH.D.

Presented by D. B. DOWLING, B.SC., F.R.S.C.

(Read May Meeting, 1920)

Intrusive into the Pre-Cambrian gneissic complex north of Lake Athabaska are numerous dyke rocks consisting of granites, pegmatites and aplites, lamprophyres, amphibolites, gabbros, norites and diabases. From a petrographical point of view the norite rocks are the most interesting and a brief summary concerning them is given below.

GREAT RELATIONS

The norite rocks outcrop towards the eastern end of lake Athabaska and on both sides of the Stone river which enters the lake from the east. In the country north of the lake it is most frequently found in the form of sill-like intrusions along the foliation planes of the old gneissic complex; but in places it is also found in dykes, cutting across the regional foliation. The extent of the larger intrusions has not been determined.

GENERAL CHARACTER

The rock presents considerable variation in aspect and composition. Freshly broken surfaces are commonly dull and the feldspar and pyroxene constituents show no traces of cleavage planes. A few small bright specks of pyrite may generally be observed. Weathering imparts a pinkish-gray coloration to exposed surfaces and at the same time develops evidences of a slight foliation.

Even in the coarser grained varieties individual crystals cannot be distinguished in hand specimens, the rock in this type having the appearance of a mixture of dark and light coloured materials. In the denser, more uniform varieties the rock has a greyish-black colour.

In thin section the main type is found to consist of plagioclase, hypersthene and iron ore. The plagioclase is labradorite, and much of it is unstriated. Many of the crystals show a combination of pericline and albite twinning. Many sections show evidences of granulation. Some of the feldspar crystals have been broken into small fragments; hypersthene occurs as large irregular crystals surrounded by broken fragments. Small quantities of magnetite and pyrite and minute shreds of brown biotite occur as accessory minerals.

Varieties

Garnet-norite.—A variety which differs from the main type is one containing garnet. The garnet is of the andradite variety with no crystal outlines and crossed by numerous irregular fractures. The garnet-bearing variety is most abundant in the border zones near the intruded dark coloured gneisses.

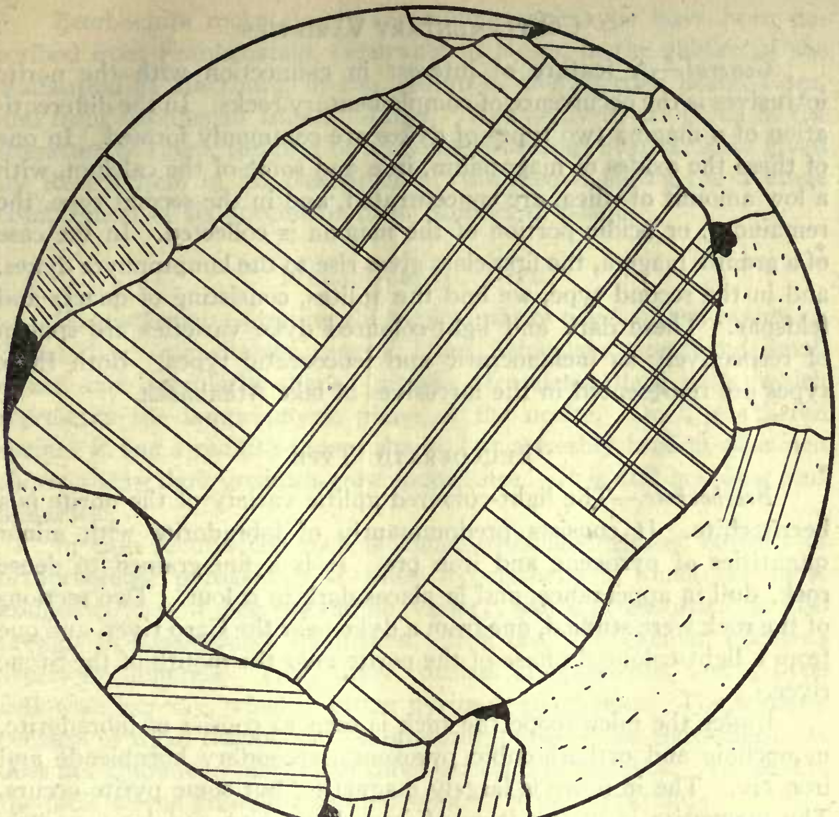
Pyrite-norite.—Another variety of norite is one containing iron ore in abundance. In all the sections studied, magnetite and pyrite occur in varying amounts, and in places in the field considerable quantities of pyrite were found disseminated throughout the rock. One specimen seen by the writer, but not found in place, consists of a fine-grained rock, thickly dotted with crystals of yellow pyrite. The pyrite-bearing zones seem to have no definite relation to the borders of the norite intrusions, but were scattered irregularly through them.

Quartz-norite.—A dyke of quartz-norite was found cutting granite-gneiss, nine miles east of Fond du Lac. Though it is thirty miles from the main norite intrusions at the eastern end of lake Athabaska, it is considered as being genetically related to them. The rock is fine-grained, even granular, and dark grey in colour. It contains large crystals of feldspar, which give it a porphyritic character in places.

In thin section the following minerals are found: iron ore, apatite, zircon, tourmaline, garnet, biotite, amphibole, hypersthene, plagioclase and quartz.

The iron ore consists of magnetite and pyrite in irregular masses. Zircon is represented by a few small crystals. Apatite occurs as small prismoids, as broken rod-like crystals, and as irregular-shaped masses. Tourmaline is represented by a single crystal in the section. It is highly pleochroic in shades from pale violet to deep blue. Garnet is present as small round grains, and as larger broken masses crossed in all directions by fractures.

The biotite is a very deep brown variety, highly pleochroic, and contains abundant iron ore along its borders, and its cleavage planes, and also in small bunches scattered irregularly through it. The amphibole is of the tremolite variety, and is practically colourless. In places it presents a fibrous appearance. Much more abundant than the amphibole is an orthorhombic pyroxene which is slightly pleochroic, hence to be classed as hypersthene. It contains inclusions of quartz.



The feldspar shows both striated and unstriated varieties. Comparison of the index of refraction, however, of the unstriated crystals along the borders of the section shows that they all consist of plagioclase. The twinned plagioclase is a labradorite. The labradorite shows many combinations of albite and pericline twinning. One crystal[1] cut perpendicular to the albite twinning extinguishes at an angle of 37 degrees. Crossing the albite lamellæ is a broad band which represents a pericline twin, since it extinguishes at the same time as the smaller bands on either side of it, which are of known pericline twinning. On this large pericline twin faint albite lamellæ are clearly distinguishable and these in turn are crossed by pericline twins on the large pericline twin.

Quartz is present in the rock filling around the other minerals. It shows undulating extinction showing that it was present before the rock was strained.

---

[1] The crystal is shown in figure 1, where it fills the whole central part of the plate.

Complementary Varieties

General.—A feature of interest in connection with the norite intrusives is the occurrence of complementary rocks. In the differentiation of a magma two types of dykes are commonly formed. In one of these the oxides of magnesium, iron and some of the calcium, with a low amount of silica, are concentrated, and in the second type, the remainder, or acidic portion of the magma is collected. In the case of a granite magma, the first class gives rise to the lamprophyre dykes, and in the second type, we find the aplites, consisting of quartz and feldspar. These dark and light-coloured dyke varieties are spoken of respectively as melanocratic and leucocratic types. Both these types are represented in the intrusives of lake Athabaska.

Leucocratic Type

Beerbachite.—The light-coloured aplitic variety of the norite is a beerbachite. It consists predominantly of labradorite with minor quantities of pyroxene and iron ore. It is a fine-grained to dense rock, dull in appearance, and in places dark in colour. Two sections of the rock were studied, one from a dyke near the Carp river, and one from a light-coloured phase of the norite near the mouth of the Stone river.

Under the microscope the rock is seen to consist of labradorite, monoclinic and orthorhombic pyroxenes, secondary hornblende and iron ore. The iron ore is largely magnetite, but some pyrite occurs. The magnetite is in the form of irregular grains and long, narrow fragmental forms. The hornblende is in very small quantities, and is secondary after pyroxene. The monoclinic pyroxene is slightly less abundant than the orthorhombic variety, and has the properties of diallage. The orthorhombic pyroxene is a slightly pleochroic hypersthene. The dark minerals occur in small quantities scattered irregularly throughout the rock. The structure of the rock is saccharoidal consisting of a mass of interlocking grains of approximately uniform size, the panidiomorphic structure of Rosenbusch. The relative proportions of the minerals present, from determinations by the Rosiwal method, are as follow:—

Magnetite	5 per cent.
Labradorite	65 "
Hypersthene	15 "
Diallage	12 "
Hornblende	3 "
	100 per cent.

Beerbachite rocks closely resembling their type have been described from Frankenstein, Odenwald in Hesse, in the gabbro of the Radauthal at Harzburg, in the gabbro of the Scottish island Rum, and from Monhegan island, Maine. Two analyses are given in the literature of them, the first of a beerbachite from Frankenstein given by Rosenbusch, in his Gesteinlchre; the second shows the average composition of six specimens from Monhegan island.[1]

Melanocratic Type

Hypersthenite.—Cutting the typical norite north of the rapids on Stone river immediately east of Lake Athabaska are found small dykes and irregularly shaped masses of a dense dark rock, which represents the lamprophyric phase of the norite. On a weathered surface it has a reddish-brown shade, but a freshly broken specimen shows a very dark greenish-grey appearance. It is dull in colour and aphanitic.

In thin section the rock is found to consist almost entirely of orthorhombic pyroxenes; of these hypersthene is much the most abundant, but a non-pleochroic variety, which is enstatite, is also present in considerable quantities. Iron ore and feldspar occur as accessory minerals. The former consists of magnetite, and a little yellowish iron ore, which is either pyrite or pyrrhotite. The feldspar consists of small fragments of labradorite between the pyroxenes. It does not amount to more than three per cent. of the rock. In texture the rock is even granular, and has suffered little alteration.

[1] E. C. E. Lord, Amer. Geol., Vol. XXVI, 1900, p. 346.

Beerbachite rocks, closely resembling this type have been described from Frankenstein, Odenwald in Hesse, in the gabbro of the Radauthal at Harzburg, in the gabbro of the Scottish island Rum, and from Monhegan Island, Maine. Two analyses are given in the literature of them, the first of a beerbachite from Frankenstein given by Rosenbusch, in his Gesteinslehre; the second shows the average composition of six specimens from Monhegan Island.

MICRONORITIC TYPE

Hypersthenite.—Cutting the [illegible] norite north of the [illegible] stone river immediately east of [illegible] Mahonska are found small dykes and irregularly shaped [illegible] of a dense, dark [illegible] represents the lamprophyric phase [illegible] the norite. On a weathered surface it has a reddish-brown [illegible] a freshly broken specimen shows a very dark greenish-grey [illegible]. It is dull in colour and aphanitic.

In thin section the rock is [illegible] consist almost entirely of orthorhombic pyroxenes; of [illegible] hypersthene is much the most abundant, but a non-pleochroic [illegible] which is enstatite, is also present in considerable quantities [illegible] ore and feldspar occur as accessory minerals. The former [illegible] of magnetite and a little yellowish iron ore, which is either [illegible] pyrrhotite. The feldspar consists of small fragments of [illegible] between the [illegible] does not amount to more than [illegible] of the [illegible] the rock is even granular, and has [illegible] little alteration.

¹ E. G. E. Lord, Amer. Geol., Vol. XXVI, 1900, p. 346.

A Local Occurrence of Differentiation in Granite on the Churchill River, Northern Manitoba, Canada

By FREDERICK J. ALCOCK, B.A., PH.D.

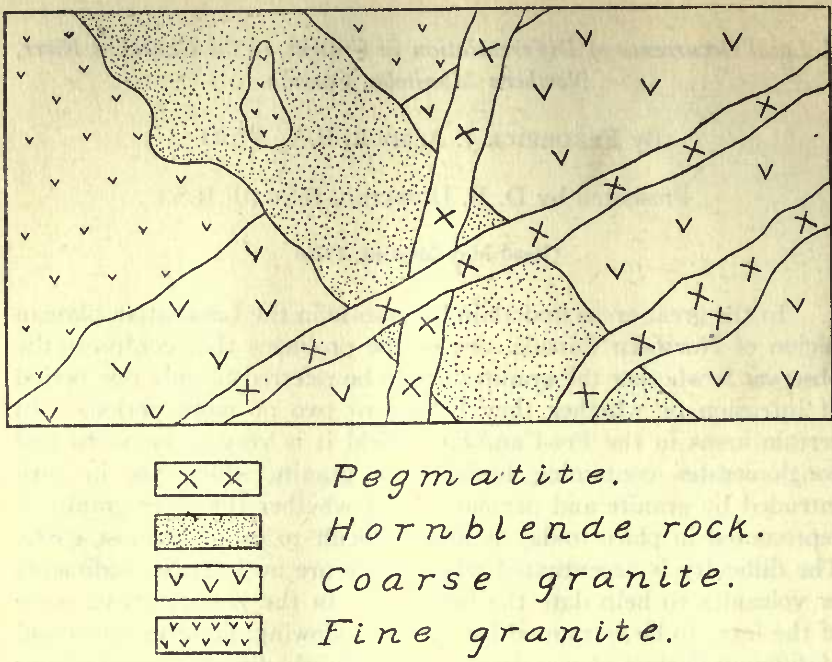
Presented by D. B. DOWLING, B.SC., F.R.S.C.

(Read May Meeting, 1920)

In the great areas underlain by granite in the Laurentian plateau region of Northern Canada, one of the problems that confronts the observer is whether the granites are to be referred to only one period of intrusion or whether they belong to two or more periods. In certain areas in the Pre-Cambrian shield it is very common to find conglomerates containing boulders of granite which are in turn intruded by granite and pegmatite, but whether the older granite is represented in place to-day is most difficult to prove in most cases. The difficulty is accentuated where there are no intruded sediments or volcanics to help date the intrusion. In the granite areas, some of the facts to be accounted for are the following: granites are found of different degrees of coarseness and of slightly different composition; banded gneisses of apparently igneous origin occur in close proximity to rock with a typical granitic texture; certain types are porphyritic and massive in decided contrast to many of the granite-masses. A small outcrop studied by the writer on the Churchill river affords some light on this problem.

The outcrop is found on the north bank of the Churchill river, 25 miles above the mouth of the Little Churchill, at a rapid where a wide exposure of rock is afforded. This part of the river is bordered on either side by banks of boulder clay in places 125 feet in height, and it is only at the rapids that exposures of bed rock are found. Farther up the river the mantle of drift is thinner and outcrops are more or less continuous. The dominant rock type wherever an exposure is seen is a red biotite-granite or biotite-hornblende granite, in places gneissoid, in places typically granitic, varying in texture from coarse to fine grained and locally porphyritic with phenocrysts of pink orthoclase up to 2 inches in length. The relationships of the rock types in the outcrop referred to above are illustrated in the accompanying diagram.

The regional rock is a fine-grained red granite which passes by loss of quartz into a syenite. The rock is more or less gneissoid and is traversed by numerous though small pegmatite dykes. In thin



section it is seen to consist of biotite, hornblende, feldspar and quartz with accessory iron ore, apatite and zircon. The biotite occurs as long shreds and irregular patches and forms about 5 per cent of the rock. The hornblende which is pleochroic in shades of green occurs in slightly smaller amounts. The feldspars consist of orthoclase, microline and albite, the two former in about equal quantities, the latter in smaller amounts.

Intermingled with this fine-grained variety and apparently cutting it is another phase with practically the same composition and microscopic character, but decidedly coarser grained. Its contacts with the former type are quite sharp.

Traversing both of these rocks is a dense, fine-grained black rock whose relations are those of a dyke. It is 150 feet in length, 4 feet in width, and everywhere presents sharp contacts against the red granite phases and contains inclusions of them. A thin section of the rock measured by the Rosiwal method shows it to consist of 35 per cent hornblende, 10 per cent biotite, 35 per cent feldspar and 20 per cent quartz. The feldspars are orthoclase and albite, the latter in subordinate amounts. Accessory apatite, iron ore and zircon are present. The rock accordingly differs from the granite chiefly in the higher percentage of hornblende present.

Cutting this dyke are two sets of pegmatite. The younger is slightly the coarser grained, but both are light coloured and consist of feldspar and quartz with but very minor amounts of ferromagnesian minerals.

The relationships are suggestive of a common origin for all the varieties from the same parent magma. If the pegmatites are the final products from the magma which produced the regional granite, the dark hornblende rock must be a differentiate of a slightly earlier stage. The conclusion is, therefore, that the local differences in composition and structure are due to differentiation and that it is not necessary to postulate successive intrusions of granite of various ages. It also emphasizes the fact that caution should always be used in the separation of granites where there are no sediments to establish their relative ages.

The Turtle Mountain Coal Measures

BY D. B. DOWLING, B.SC., F.R.S.C.

(Read May Meeting, 1920)

The deposits which were formed during the later phases of the retreat of the Cretaceous sea from the central part of the North American continent, are of special interest in that by their variation between brackish, fresh and salt water conditions of deposition, they denote a long period of oscillation for the shore line, or of variation in the depth of the sea. In the western States the direction of retreat appears to have been mainly to the eastward. In Canada the latest marine deposit of any considerable extent reaches a former shore line within the border of the plains and it is supposed did not extend beyond the limits of Alberta, so that the withdrawal of the sea is considered as having been toward the southeast.

The non advance of the later Cretaceous sea beyond the confines of Alberta would naturally suggest a greater elevation of the crust to the north, or if this elevation was relatively small, there would be provided a large area with extremely shallow water in the northern extension. This condition would give rise to the formation of lagoons and the growth of moisture loving plants.

The Edmonton formation, which is a brackish water formation and contains coal seams, reflects the kind of deposit which would be expected over this flat plain within reach of the sea. These deposits extend apparently toward the northeast, but are eroded from the surface east of Edmonton. Deposits of a period of shallowing, which preceded the Edmonton period of deposition are found projected partly across Saskatchewan, and as these originated from the action of similar forces, it may be assumed that the direction of retreat indicated in the deposits of the Belly River Series, and also in the sandy beds of the overlying marine shales, may be considered as resumed in the later uplift. In this way the final contraction of the marine area appears to have been toward the southeast. In North Dakota the latest marine deposits that are not eroded are to be found near Bismarck near the centre of the state, and are cited as evidence of a direction of retreat toward the northeast or east. If the passage beds that lie to the west of this area could be considered as being of the same age as the Edmonton, the withdrawal of the sea could be considered as the formation of an inlet to Hudson's Bay. As the faunal evidence of the Edmonton formation and of the Lance formation of Dakota, a similar series of passage beds, shows that the Edmonton formation was laid down before the Lance. To quote from Barnum Brown,[1] "The vertebrate fauna is distinct from that of the Lance and a few species are common to the two formations. Most of the Edmonton genera are structurally more primitive than those of the Lance and several genera not found in the Lance are common to the Judith River. The faunal facies, as a whole, is intermediate, but closer to that of the Judith River formation than to the Lance."

In considering the shallowing of the sea during the deposition of the Edmonton beds the question of a shore line in the south when the Lance beds are now found may be discarded and the stages of the retreat may be considered as consisting of at least two. The first, a period in which the western margin was fringed with brackish water deposits recognized in southwestern Alberta as the St. Mary formation increasing in thickness to the north and northeast in the Edmonton formation. Probably these formations are bordered to the west by continental deposits containing a Tertiary flora which would be the earliest Eocene in the district. In southern Saskatchewan there is no trace of these deposits so that the contemporary deposits are marine. This first period terminates in a withdrawal of the sea to a line which runs south of the Cypress Hills and then somewhat north of east to probably south of Moosejaw. From this line southward, the deposits of the second stage of the retreat are found in the Lance beds. The limits of this second phase through the western States can not be discussed in this paper, mainly from lack of information, but it is quite possible that in the vicinity of the mountains both stages of the retreat may be recognized. The absence of the Lance formation beneath the Cypress Hills and along the northern flanks of the Wood mountain plateau, and the presence of doubtful Lance beds at the western and southern portion of the Wood mountain plateau, and a possible Lance formation beneath the Fort Union of Estevan, are the determining factors in the above statement that the first period of retreat terminated by a steady withdrawal to a line from south of the Cypress Hills to a point probably east of Moosejaw.

The bed which is taken as a lower member of the Tertiary is the white clay bed which is conspicuous in the Cypress Hills overlying marine sands. In the Willowbunch area, east of Wood Mountain Plateau, Longitude 105°, this white band is at the base of the sections exposed, but the base of the formation seems there to be possibly lower judging by the fact that the border is mapped by Bruce Rose as at some distance both north and west. To the west along the 49th

[1] Bull. Geol. Soc. of America, Vol. 25, 1914, p. 374.

parallel, about Longitude 106°.30′, Lance beds or beds holding Dinosaur remains and approximately 50 feet thick underlie the white band of the base of the Fort Union. At no other place in the district has the Lance been recognized, and eastward the exposures in the Estevan district appear to belong to the upper part of the Fort Union, and there are doubtful exposures of whitish sands that may indicate the presence of these beds in the valley of the Souris. The drillings for coal in this valley indicate, however, that several seams of coal underlie those already exposed but the absence of the white clays in any record of the borings in the measures beneath, leaves the exact horizon in doubt, but with an inclination to consider them as allied to the Lance formation. As exposures of white clays are known to occur at Halbrite, which, according to the log of the Ralph well, should be below the lowest coal seam, there is grave doubt that these coal seams should be considered to be in the Lance and the correlation of the coals of Turtle Mountain may still have to remain for palæontological evidence.

The correlation of the eastern exposures depends to a great extent on the general fact that the deposition of the marine beds beneath was very uniform. In the vicinity of the mountains the continuity of marine deposition was broken by the introduction of stream-borne material from a nearby source, but as a general rule the finer materials forming the muds were spread out by the sea in very even layers, thinning slightly toward the east.

In the eastern part there are two horizons that may be recognized in the material obtained by the churn drill. The first recognizable horizon is given in the change from non-calcareous shales of the Pierre to the calcareous Niobrara, the upper part of the Colorado.

The second is the change from the shales of the Colorado to the sands of the Dakota. For small areas horizons in the Niobrara are sometimes also used.

The Dip and Strike of the Beds in the Pembina Escarpment

This area is reported on by Mr. A. MacLean and several horizons are suggested by him for the small quadrangle in the Pembina escarpment, but for a larger area three points farther apart are also suggested. The horizon that is well marked in the exposures is a limestone ledge 160 feet from the base of the Niobrara, exposed on the Assiniboine river, and on Wilson river at Gilbert plains. This may be assumed as the top of a lime shale 185 feet thick in the well at Deloraine, Manitoba. The elevations at these three points give a strike for this plane of N.41°W, and a dip of 9.27 feet per mile. The southern corner using the same beds for Morden and the Assiniboine river gives a strike of N.45°W. and a dip of 9.45 feet per mile. The larger base from Morden to Gilbert Plains and the Deloraine Well gives an average of strike N.42°W. and a dip of 9.3 feet per mile. For the projected section from the Pembina escarpment to the Turtle Mountain the plane assumed strikes N.41°W. and dips 9.27 feet per mile. For comparison with this a well at Fleming, 150 miles to the northwest of Deloraine, was also used, and the projection of the top of the Niobrara formation which was ascertained in the records was found to agree closely with the former determination which tends to reduce the errors of possible warping in the beds.

On a plane passing through Deloraine on the dip ascertained the sections determined at the Pembina outcrop were projected as well as the divisions already determined by J. B. Tyrrell [1] for the Deloraine well. A projection on a parallel plane passing through Taylorton in the Estevan area is incorporated in the general section, and with it the reports of several wells in the vicinity of the line of section are utilized to place finds of coal in the upper parts of the section between Taylorton and Deloraine. A measure of the thickness of the Pierre beds beneath Taylorton is adopted from the boring at Ralph, sixty miles northwest of Taylorton, and this seems to indicate that the general dip adopted for the Manitoba part of the section continues, although it is known that to the north there is a slight rise in an east-west anticline passing through the vicinity of Weyburn. This is determined by the finding of coal seams, apparently those beneath the Estevan and Taylorton seams at several places to the north. The dip as ascertained assuming the coal seam to be the upper of the two deep seams is from Arcola normal to the line of section 7.1 feet per mile south eastward, from Stoughton in the same direction 8.6 feet per mile and from Ralph to Taylorton 11.5 feet per mile. As these dips are given in order from east to west, there is a gradual steepening of the southeast dip in the approach to the Estevan field. This change of dip and strike is reflected in the outline that has long been given to the outcrop of the Tertiary in this area, and is probably local as the southeastern extension in Dakota follows the general trend of the strike assumed for the plane.

The Section

In the Pembina escarpment, the Niobrara rocks are reported by Mr. McLean to be represented by three subdivisions; at the top the Boyne beds, 138 feet; overlying the Morden beds, 250 feet; and at

[1] Three Deep Wells in Manitoba, Trans. Royal Soc., 1891, p. 93, Pt. IV.

the base the Assiniboine beds, 168 feet—a total thickness of 556 feet. The position of the series is determined by levelling at the Assiniboine river where the top of the Assiniboine beds is placed at 964 feet above sea. The division in the Pierre seems to be quite uncertain in the vicinity of the Pembina escarpment. The recognition of the weathered shales as Millwood or Odanah is not satisfactory, as in the south the Millwood seems to have included in it hard layers that have been mistaken for Odanah, so that the division as given in the Deloraine well is adopted. The positions of coal seams in Turtle Mountain and the Boissevain sandstone depend on levelling observations made by the writer and published on a map of Turtle Mountain included in the Summary Report of 1902. The coal seam near Redvers is reported in local news items as eight feet of coal at a depth of 250 feet, and at Wauchope a six foot seam at 150 feet depth. At Carrievale a small seam of coal is reported at a depth of 231 feet. These are projected from the elevations of the surface in the vicinity of the wells. At Oxbow, several seams were penetrated, but of these there is no accurate record. The Taylorton borehole is here represented by the composite section given by Mr. MacLean in Summary Report 1918, Part A, p. 4. The lower seam is placed at 623 feet below the surface according to a statement in Summary Report, 1917, Part C, p. 40. The record of the Ralph well is given in Memoire No. 116, p. 45.

In these sections the position of the various coal seams above the Niobrara is fairly accurate, so that the correlations of the Redvers seam with the lowest at Taylorton, and the Wauchope seam with the one above, seem reasonable. Their correlation with the seams in Turtle Mountain, while not absolute, being dependent on the record of the Fleming well, suggests that there may be several undiscovered seams in the upper part of that mountain, and would mean a further possibility for a coal supply in the Province of Manitoba.

As there are no exposures from which fossils might be obtained the position of these lignite beds has been assigned to the beds associated with the Tertiary rocks of Estevan. The projection on the section submitted shows that they lie below the exposed Tertiary beds, and are those explored by the drill at Taylorton. Their relation to those of the Lance formations in Dakota is not definite, but they appear to occupy the same relative position as the Ludlow lignitic member. Under Taylorton the drill records do not mention light coloured material, generally grey coloured sands and clays. In the eastern or Turtle Mountain section all the material exposed is yellowish and lighter in colour, so that in Canada there is a colour change in the beds which appear to be Ludlow. This may be an argument for the correlation, since the Ludlow changes from a series comparable to the Fort Union in the southwestern part of South Dakota to a darker series on the Little Missouri in western North Dakota, and to brackish and marine at Bismarck without lignite seams. To the northwest, dark beds are found beneath the Fort Union, south of Wood Mountain, Longitude 106° 30′, and a single brackish water shell is recorded in the lower part of the Estevan exposures near the boundary line at Longitude 103°[1] showing the extreme upper limit of possible salt water. These changes in character are indicative of the subsidence of a small area during the general uplift, and it would seem that there is some evidence of the presence, on the northeast side of this area, of beds derived from an eastern land area. The continuity of the upper coal seams, and the doubtful continuation of the lower coal seams of Turtle Mountain to the west all seem to point to the probable continuation of the Ludlow beds around the north end of the depression in which was deposited the Cannonball marine beds of Dakota.

The boring at Mandan is estimated to have penetrated to near the Dakota, and at 470 feet to have passed through the Fox Hills. The total depth attained was 2,000 feet. Comparing this boring with the Deloraine well the Boissevain sandstone could be compared with the Fox Hill by assuming that the Mandan well reached to within about 200 feet of the Dakota sandstone. The rocks above the Boissevain sand consisting of about 500 feet of beds contain numerous coal seams so that the presence of the Cannonball marine formation in this series seems, therefore, extremely unlikely as the coal seams found at Redvers and Wauchope point to the probable presence of the Ludlow lignitic member, which is in places decidedly Tertiary in aspect.

An assumption, that any of these beds may belong to the period of uprise in which the Belly River and Judith river deposits were found, can with little doubt be negatived. The former series has been traced eastward into Saskatchewan, and exposures are to be found in the valley of South Saskatchewan river. It is there losing any character pointing to fresh-water conditions, and is mainly brackish. The fresh-water deposits are reported as continuing to the north. In the Moosejaw well to the south of this valley certain beds in the Pierre are found to be somewhat sandy in character, but they would appear to be of marine origin. The base of this series in the Moosejaw well appears to be about 1,340 feet below the Fort Union of the Dirt Hills to the south. From the base of the exposed Belly River in the Saskatchewan valley to the base of the Tertiary in Cypress Hills is about 1,500 feet. These comparisons are across

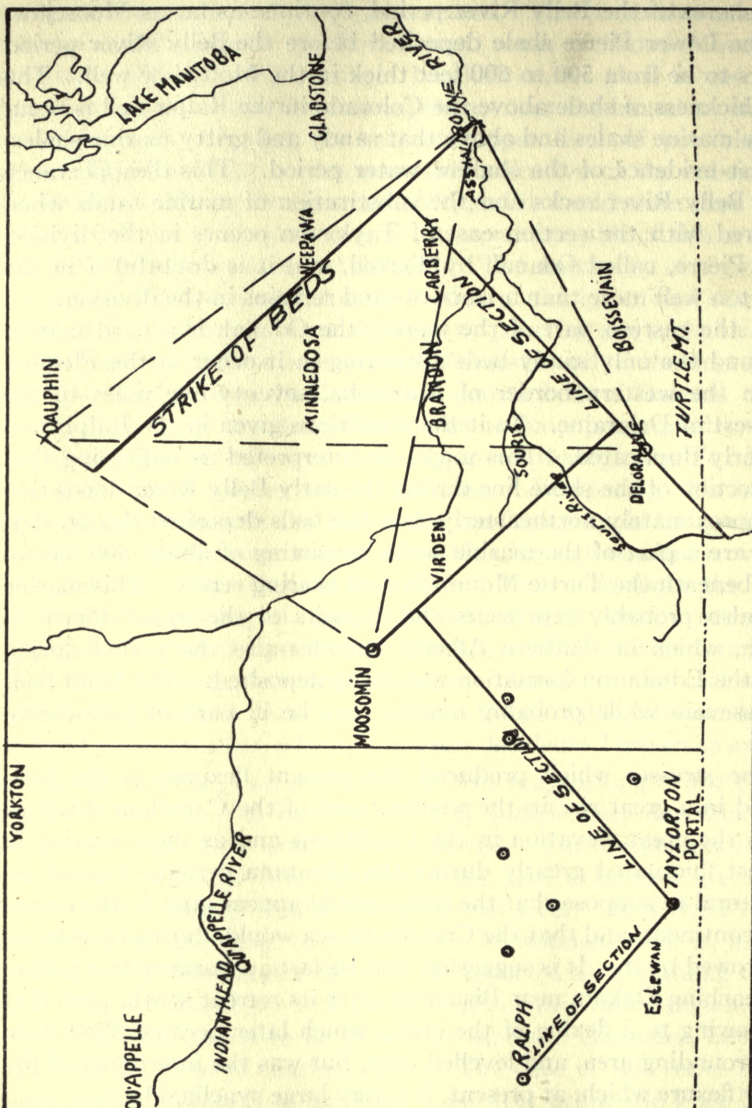
[1] Annual Report, Vol. XV, p. 44F.

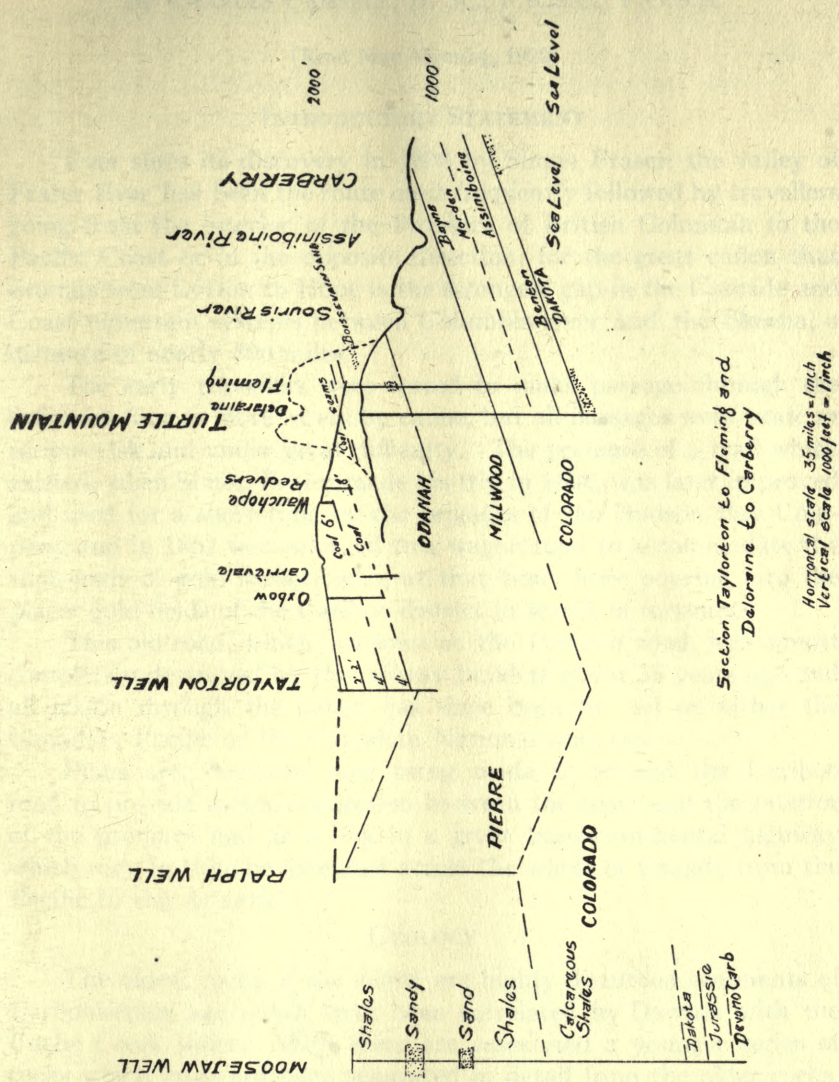
country where there is little change in the strike. Although there is considerable variation in dip near Moosejaw, yet the data mentioned above are sufficient to show that the offshore deposits from the brackish water shores of the Belly River period, continue as far as Moosejaw.

The Lower Pierre shale deposited before the Belly River period appears to be from 500 to 600 feet thick in the Moosejaw well. The same thickness of shale above the Colorado in the Ralph well is occupied by marine shales and above that sandy and gritty marine shales. The last evidence of the shallow water period. This disappearance of the Belly River rocks and the substitution of marine sands when compared with the section east of Taylorton occurs in the division of the Pierre, called Odanah by Tyrrell, and it is doubtful if in the Taylorton well more than a trace of sand remains in the division.

In the eastern part of the section the Odanah is a hard marine shale, and the only sandy beds appearing in it occur in the Fleming well on the western border of Manitoba, seventy-five miles to the northwest of Deloraine. In it the conditions given in the Ralph well are nearly duplicated. This might be interpreted as indicating that the direction of the shore line during the early Belly River deposition was approximately northeasterly, but the beds deposited during that period are a part of the marine series consisting of about 500 feet of shales beneath the Turtle Mountain coal bearing series. This marine series also probably represents the deposits of the upper Pierre of Alberta, which in southern Alberta includes also the period during which the Edmonton formation was being deposited. The Sand beds of Boissevain while probably marine may be in part of continental origin.

The stresses which produced the present flexures in the beds resulted in a great rise in the western part of the Canadian shield as well as the great elevation in the Cordilleras and as the elevation in the west fluctuated greatly during the Montana period, it would be but natural to suppose that the reflex would appear later in the centre of the continent, and that the Cretaceous sea would, during its retreat, be narrowed by it. It is suggested that its last appearance was a mere inlet reaching Dakota near Bismarck after its retreat south, past that point, owing to a flexing of the crust, which later became filled from the surrounding area, and levelled over, but was the forerunner of the greater flexure which, at present, is a very large synclinal basin.


LAKE MANITOBA
GLADSTONE
ASSINIBOINE RIVER
NEEPAWA
CARBERRY
STRIKE OF BEDS
LINE OF SECTION
BOISSEVAIN
DAUPHIN
MINNEDOSA
BRANDON
SOURIS
SOURIS RIVER
DELORAINE
TURTLE MT.
ESTEVAN AND TURTLE MOUNTAIN AREAS
VIRDEN
MOOSOMIN
YORKTON
QU'APPELLE RIVER
INDIAN HEAD
QU'APPELLE
RALPH
LINE OF SECTION
LINE OF SECTION
TAYLORTON
PORTAL
ESTEVAN


CARBERRY
Assiniboine River
Souris River
Fleming
Deloraine
TURTLE MOUNTAIN
Wauchope
Redvers
Carrievale
Oxbow
TAYLORTON WELL
RALPH WELL
MOOSEJAW WELL
2000'
1000'
Sea Level
Bayne
Morden
Assiniboine
Sea Level
Benton
DAKOTA
Boissevain Sand
Coal 6'
Coal
ODANAH
MILLWOOD
COLORADO
PIERRE
COLORADO
Shales
Sandy
Sand
Shales
Calcareous Shales
Dakota
Jurassic
Devono Carb
Section Taylorton to Fleming and Deloraine to Carberry
Horizontal scale 35 miles = 1 inch
Vertical scale 1000 feet = 1 inch

The Origin and History of the Great Cañon of Fraser River

By CHARLES CAMSELL, B. SC., F.R.S.C., F.G.S.A.

(Read May Meeting, 1920)

INTRODUCTORY STATEMENT

Ever since its discovery in 1808 by Simon Fraser, the valley of Fraser river has been the route most frequently followed by travellers going from the interior of the Province of British Columbia to the Pacific Coast or in the opposite direction, for the great cañon that extends from Lytton to Hope is the strongest gap in the Cascade and Coast mountain systems between Columbia river and the Skeena, a distance of nearly 800 miles.

The early travellers were forced to make passage through the cañon on foot or more rarely by canoe, but all passages were made at serious risk and under great difficulty. The pretense of a trail which existed, when Simon Fraser made his trip in 1808, was later improved and used for a short time by the brigades of the Hudson Bay Company and in 1862 was enlarged to a wagon road to accommodate the thousands of gold seekers who, at that time, were pouring into the placer gold fields of the Cariboo district in search of fortunes.

This old road, which is known as the Cariboo road, was almost completely destroyed by the railway builders about 35 years ago and all traffic through the cañon has since been by rail on either the Canadian Pacific or the Canadian National railways.

Plans are, however, now being made to rebuild the Cariboo road to provide motor connection between the coast and the interior of the province and as a link in a great trans-continental highway which may in time be extended across the whole of Canada from the Pacific to the Atlantic.

GEOLOGY

The oldest rocks of the cañon are highly disturbed sediments of Carboniferous age which have been correlated by Dawson with the Cache Creek series. With these are associated a younger series of rocks which have not been separated in detail from the older rocks, but are believed to be of early Mesozoic age. Both of these series have a strike approximately parallel to the mountain ranges.

Granitic rocks, which are intrusive into the older sedimentary series, occupy a great part of the cañon. These form part of the great Coast Range batholith and were intruded in two distinct periods in the history of the region, namely, Jurassic and early Tertiary.

Belts of Lower Cretaceous sediments occur at both the upper and lower ends of the cañon.

Tertiary rocks occur only in the lower part of the river valley and constitute an ancient delta formation extending from Chilliwack to the sea.

Glacial and recent deposits of unconsolidated material occupy relatively small areas in the valley bottom and in patches on its sides.

Topographic Description

The portion of the Fraser valley known as the cañon lies in southwestern British Columbia, the broad physiographic features of which have been so well described by Dawson and others in papers and the reports of the Geological Survey.

The main features of this part of the province are briefly as follows. Commencing approximately at the International Boundary line and extending northward through the central part of the province is the great Interior Plateau region. In its southern part the Plateau has a width of about 100 miles and a general average elevation of about 4,000 feet above the sea. Its northward extension has been defined for about 500 miles where its altitude declines to about 3,000 feet. The period at which the plateau features of this region began to be developed has been referred to the early Tertiary times, and its subsequent modification is due to the great extrusions of lavas and later still to the dissection by river erosion consequent to re-elevation of its surface. The plateau is traversed in all directions by deep valleys which have been incised to a depth of 2,000 feet below its general level and which carry the drainage of the southernmost part of the plateau southward through Okanagan valley to the Columbia river, and of the central part westward by the Fraser river to the sea.

To the west of the Interior Plateau region lie the Cascade and Coast ranges. The former, continuing northward across the International Boundary line from the State of Washington, extends up along the eastern side of Fraser valley gradually decreasing in height until at Nicola river it merges with the plateau region.

The Coast range, commencing on the opposite side of the Fraser river and running northwesterly parallel to the Pacific Coast lies in almost the same axis as the Cascade range, and is overlapped by it at the Fraser river for a length of about 75 miles.

Between the overlapping parts of the two ranges is a narrow gap by which the Fraser river finds its way through a deep narrow cañon from the interior to the coast. This gap is the only break of any significance in the continuity of the mountain ranges bordering the Pacific between the Columbia river and the Skeena, a distance of nearly 800 miles, and not only has it become an outlet to the drainage of the interior, but it forms the only route by which railways can find an easy grade from the interior to the coast.

On its western side the Interior Plateau rises gradually and passes without any abrupt change of slope into the Cascade and Coast ranges where elevations increase to a maximum of about 8,000 feet, and the mature plateau features are entirely replaced by a steep or rugged mountainous topography of a more youthful character.

The Coast range has an average width of about 100 miles and is bounded on the westward by the Pacific Ocean. On their western slopes the mountains dip abruptly down to the sea and are penetrated by a number of deep narrow fiords which run far back into the heart of the range, while at the ends of these fiords the rivers entering them are building up deltas proportionate in size to the volumes of the streams.

The Fraser river, which has a length of about 700 miles and a drainage area of over 91,000 square miles, rises on the western slope of the Rocky mountains and after flowing north-westerly for over 200 miles, to latitude 50°N, bends sharply to the west and south and runs for nearly 400 miles in an almost direct line southward cutting diagonally across the Interior Plateau region and passing down the gap between the overlapping ends of the Coast and Cascade mountain ranges. Having passed beyond and to the westward of the Cascade range the river turns westward around the southern end of the Coast range and emerges on to a level delta plain of its own construction which it traverses for about 70 miles to the sea.

The valley of the Fraser river, from where it bends to the southward near Fort George, down to the sea coast, may be divided broadly into three parts each having characteristics distinctive from the other two, namely (*a*) a plateau portion, (*b*) a mountain portion and (*c*) a delta portion. The part from Fort George to Lytton at the junction of the Thompson river might be referred to as the plateau portion of its course, because it lies entirely inside the limits of the Interior Plateau. This part of the valley is entirely outside the limits of this paper and because of lack of a full knowledge of its characteristics cannot be here described.

Lytton is the point at which the Canadian Pacific Railway first enters the Fraser valley. From this point almost to Agassiz, a distance of 85 miles, the stream flows in a deep valley bordered on the east by the northern prolongation of the Cascade mountain range and on the west by the Coast range. This is the mountain portion and constitutes the Fraser cañon and is that which forms the subject of this paper.

From Agassiz to the sea coast, a distance of 70 miles, is the delta portion. Here the mountains are some distance back from the river course and the stream flows at a greatly reduced rate through a comparatively level plain of its own construction.

The contrast between the mountain portion and the delta portion is most marked, for the former exhibits features that have been produced entirely by the destructive forces of erosion while the latter is mainly the result of the constructive forces of deposition.

In that portion of the Fraser valley defined above as cañon, namely that from Lytton to Agassiz, the stream leaves the plateau region through which it has flowed for hundreds of miles and becomes confined between steep bordering mountains. The change from plateau to mountain topography is by no means abrupt and is not very noticeable from any point within the valley itself because of the depth to which the valley is cut both in the plateau as well as in the mountain portion. The change, however, becomes very evident as the stream reaches the axial line of the Coast-Cascade mountain system between North Bend and Yale, in that portion which forms the gorge.

In this mountain portion the Fraser river acts as the dividing line between the Coast and Cascade mountain systems and although these mountain systems are so separated they nevertheless are very similar in structure and are believed to belong to the same period of uplift.

The main characteristics of the mountain portion of the Fraser valley, distinguishing it from other parts, are expressed in its grade, depth, and shape. The grade ranges from 4 to 8 feet to the mile reaching its maximum in the gorge itself. The depth of the valley is one of its most marked features, being bordered by slopes which rise quickly to heights of 2,000 feet or more and farther back to summits which reach 7,000 feet in elevation. The shape of the valley is U-shaped to flaring and is either terraced in gravel or other unconsolidated material or shows benches of solid rock where it has been deepened by the action of the stream. The slopes of the valley are always well wooded, often to the summits of the hills behind and the hills themselves, except in the case of the very highest, are rounded and show the effect of somewhat mature erosion.

The mountain portion of the Fraser valley is not uniform in character throughout and can be divided in three distinct sections depending on the physiographic characters of each. The upper section, 30 miles in length and extending from Lytton to Anderson river, is characterized by a relatively broad valley with timbered slopes having in its lower parts terraces of gravel and only rarely showing outcrops of the solid rock. The middle section, having a length of 24 miles and extending from Anderson river to Yale, is the gorge. It is the most constricted part of the mountain portion, and in it the river flows with a grade of about 8 feet to the mile between high rocky slopes that are usually so steep that gravel and other loose material have little place for lodgement. The lower slopes of this section are flanked by rock benches rather than by drift terraces, and the stream has cut so deeply into the solid rocks that to the early placer miners this section was commonly known as the "sluice box." The lower section is that extending from Yale to Agassiz a distance of 32 miles. This section has characteristics somewhat similar to the section above the gorge. In its lower part, however, the grade of the stream lessens and its bed is occupied by islands of gravel. The valley also quickly widens and the bordering mountains depart farther from each other to give place to the delta.

Lytton to Anderson River

In the section Lytton to Anderson river the Fraser river occupies a broadly flaring valley, terraced on its lower slopes by benches of gravel, and rising gently on the eastern side to heights of 5,000 feet or more and on the other side to slightly greater elevations. The course of the valley is fairly direct, and the stream flows down a grade of about 4 feet to the mile with a strong steady current cutting here and there into the lower benches and exposing sections of gravel 100 feet or so in height, but only occasionally uncovering the solid rocks beneath.

The trend of this section of the valley coincides closely with the strike of the rocks, and the direction taken by the stream has no doubt been greatly influenced thereby. For a great part of the distance between Lytton and Anderson river the valley has been excavated partly in Cretaceous sediments and partly along the contact between Cretaceous and older sediments; and the location of the valley in that position may have been determined by the softness of the Cretaceous rocks or by the line of weakness at the junction of the Cretaceous and older rocks.

No tributaries of consequence join the Fraser in this section of its course, the most important being the Nahatlatch or Salmon river and Anderson river. The other feeders are short streams of small volume rising at no great distance in the adjacent mountains and descending quickly in a series of rapids or short falls to join the main stream.

Both Anderson and Nahatlatch rivers join the Fraser virtually at grade, but they emerge through narrow rock walled cañons several hundred feet in depth which are impassable either on foot or by boat. Higher up the streams their valleys widen and become more flaring and at the same time the grade lessens.

When viewed from points of vantage on the opposite slope of the Fraser river, these streams are seen to course through hanging valleys that have been so notched by stream action that they now make entry into the main stream virtually at grade. From certain points of observation the notch is not noticeable and the only valley visible is the broad upper valley, the floor of which is 400 or 500 feet above the bed of Fraser river.

The above feature is typical of a great many of the valleys joining Fraser valley in the mountain portion of its course, and while some of the larger streams have already notched the broader upper valley floors, many of the smaller streams have not the power to do so and plunge over falls before joining the main stream. This feature will be referred to again in describing other section of the valley.

Anderson River to Yale

The middle section of the mountain portion of Fraser valley extends from the mouth of Anderson river to Yale, a distance of about 24 miles. This section is the gorge and is often popularly referred to as the cañon though the whole mountain portion from Lytton to Hope more correctly deserves that name. In this section the valley contracts to less than half the width it had above and its slopes become steep and rocky. In contrast to the densely forested even slopes of the valley above Anderson river the slopes of the gorge are sparsely forested and irregular. Steep cliffs and bare rocky knobs are common and even on the lower parts gravel benches are of rare occurrence.

The gorge is in reality made up of a succession of short narrow box shaped constrictions within a larger cañon, and at each of these constrictions the width of the stream is greatly reduced and rushes with tremendous violence between walls of rock that are vertical for 100 feet or more in height. In the intervening stretches of river between these constrictions the width of the stream is greater, the slopes are not so abrupt and there is room for the accumulation of some gravel deposits.

In the main the gorge portion of the valley is steeply U-shaped, but the bottom of the U-shaped valley has been notched by stream action to a depth of about 100 feet, with the result that there is now a narrow V-shaped or almost box-shaped gorge cut into the bed of the upper U-shaped cañon. The result is, that instead of having gravel benches on either side of it, the stream is generally flanked by a rock bench about 100 feet high above the level of high water. The narrowing of the main valley itself is enough to give a cañon effect, but the notching again of this valley has resulted in the formation of a cañon within a cañon.

Whatever may have been the cause of the location of the valley along its present lines, the formation of the gorge appears to be due to one or both of two causes. In the first place the gorge lies entirely within granitic rocks and its narrowness appears to be due to the superior qualities of resistance to erosion that such massive rocks have over the softer sedimentary rocks, thus giving rise to the steep slopes of the valley sides. On the other hand, the gorge lies directly in the central line of uplift of the Coast and Cascade mountain systems and its formation may be due to greater and more recent uplift along that line while the stream was continuing to deepen its bed. From evidence obtained in adjacent regions we know that these two mountain systems were elevated in late Pliocene times [1,2] and their structure shows that this elevation was not cataclastic in its nature, but was in the nature of a slow regional uplift. There is evidence in the cañon itself that there has been an uplift since the valley had been occupied by glacial ice, for there is exhibited in it an unglaciated inner cañon formed in the bottom of a glaciated upper cañon, showing that the inner cañon has been incised since glacial times to a depth of at least 100 feet. That incision could only have been made by a stream revived by uplift.

The grade of the gorge in high water is reckoned at 8.4 feet to the mile and the stream is consequently rapid. The volume of water flowing through the gorge has not been measured, but even in a stage of low water it must be very great, seeing that the river system drains an area of over 91,000 square miles.

Such a volume of water in a stream of 300 or 400 feet in width makes a tide that the most powerful steamer would have great difficulty in stemming, but when that width is reduced by half, as it so often is in many of the constrictions which are found throughout the

[1] Dawson, G. M., Bull. Geol. Soc. Am., Vol. 12, p. 90, 1901.
[2] Smith, G. O., U.S. Geol. Surv., Prof. paper No. 19, 1903.

length of the gorge, it forms rapids and whirlpools that would swamp any craft that attempted to navigate them.

The trend of the gorge is in general north and south, but there are a number of sharp bends and curves in it which, because of the narrowness of the valley, appear more pronounced than they really are. These curves make it impossible to obtain an unbroken view of more than a small part of the gorge. The gorge lies in granitic rocks of the Coast Range batholith and only in one place actually enters stratified rocks. The formation of the curves, therefore, are probably due to lines of weakness in these rocks such as would be produced by fracturing, cleavage, or jointing.

The most important streams emptying into the gorge are Skuzzy and Spuzzum creeks on the west side and Siwash creek on the east. All of these are small, rising in the mountains a few miles back and descending rapidly to the Fraser river. The junction of these streams with the Fraser is similar to that already described for Anderson river—that is to say they occupy hanging valleys whose beds are several hundred feet above the Fraser river, and whose bottoms have been notched by the action of the stream so that the junction is now effected through narrow rock-walled cañons.

In the case of the tributary streams entering the gorge the notching has not been so pronounced because of the relative smallness of the streams and their inability to incise, so that these streams do not enter at grade but plunge over a series of falls or steep rapids to join the main stream.

Of all the tributary streams Skuzzy creek shows the most marked break in grade. Its broad upper valley joins that of the Fraser at an elevation of some hundreds of feet above the bottom of Fraser valley and this upper valley is sharply notched. Again, its waters flow over a rock bench in Fraser valley itself and plunge directly into the waters of the river. The rim of the rock bench is also slightly notched by stream action. The result is that Skuzzy creek is hanging at two different points in its course. Not only is its main upper valley hanging over the main Fraser valley, but its lower notched valley is hanging over the lower inner gorge of Fraser river.

These two closely similar features though belonging to the same stream have been developed under entirely different circumstances. The upper hanging valley like others in northern regions may undoubtedly be attributed to glacial deepening of the main valley, while the lower hanging valley, lying as it is below the limits of glacial influence, owes its formation to a difference in the depths to which erosion has been effected by the two streams following post-Glacial uplift. That there has been uplift in the cañon is evident by the notching of the valley floor by a revival of activity in the stream and that this uplift is post-Glacial is proved by the fact that the notched portion of the valley shows no evidence of glaciation, whereas the bed of the broader upper valley has clearly been smoothed and its whole shape modified by valley glaciation.

Yale to Agassiz

At Yale the Fraser river emerges suddenly from the gorge and enters a broader and more open valley which it follows almost to Agassiz where it enters upon the delta. Yale is the head of navigation on the river and no boats do now, or ever have, run beyond that point. In high water even that point cannot be reached by steamboats which find it impossible to ascend the stream beyond Hope. The grade of the stream between Yale and Agassiz drops from more than 8 feet, which it maintained in the gorge, to 3.7 feet per mile and except for one or two riffles between Yale and Hope the stream flows with a steady, though strong, current.

From Yale to Hope the trend of the river is due south as above, and it occupies a broadly flaring valley having well wooded sides that slope upwards to heights of 4,000 or 6,000 feet above the river.

The rocks in which the valley has been incised are granitic, and from an examination of their composition there seems no reason why the gorge characteristics of the valley should not hold as far down as Hope, but when the structure of these rocks is examined critically it is found that they have been greatly sheared along a north and south line and the stream follows this zone of shearing.

In consequence of the ease with which these rocks are attacked by erosion along this shear zone the valley has been excavated to a much greater width than it could be done where the rocks have not been so affected.

At Hope the stream widens and becomes interrupted by islands of gravel. At this point also it turns abruptly to the west and passing around the southern end of the Coast range maintains a westerly direction to the sea.

For a few miles below Hope the valley also takes a trend across the strike of the rocks and is thus confined to narrow limits, soon, however, to emerge into a broader expanse on approaching the head of the delta.

Origin and Development of the Canon

Since the valley of the Fraser river constitutes the main outlet from the central part of the province of British Columbia to the

Pacific coast the origin and history of its cañon are therefore very important in so far as the development of the drainage of the interior is concerned. In view of the fact also that some of the rock formations of Cenozoic age are not represented in that region a complete history of the course of development of this part of Fraser valley is necessary to obtain a full outline of the geological history of the region. It is very evident, however, that because the physiographic history of Fraser valley is dependent to a large degree on the course of geological events in the surrounding region a study of the physiographic history of Fraser cañon must be carried on conjointly with that of the geology.

Up to the present no attempt has been made to work out a complete history of the origin and development of the cañon though brief statements bearing on this have been made by both Selwyn and Dawson in former publications of the Geological Survey.

Selwyn [1] on the evidence of the high level terraces in the interior of British Columbia, suggests that a series of large lakes existed in that region, and that the removal of a rocky barrier by which one of these lakes was confined resulted in the formation of the cañon of Fraser river. The terraces referred to are of post-Glacial origin and consequently according to this idea the cañon of Fraser river must also be of post-Glacial origin. This view is clearly incorrect, because the cañon shows undoubted evidence of occupation by glacial ice during that period. Other evidence to be presented later is also opposed to this view.

G. M. Dawson [2] in a later report carries the origin of the Fraser farther back in the geological history of the region when he states that "its valley, originally excavated in Tertiary times, in the rocky substratum of the country was subsequently, during the Glacial period, largely filled with drift material, through which, at a still later date, the river had to excavate its bed leaving great series of terraces or benches along its banks in many places."

In a later report on the Kamloops Map Sheet [3] Dawson fixes the date of origin much more closely, when he states that "the excavation of the great valleys now occupied by the Fraser and Thompson rivers is believed to have been accomplished wholly or almost wholly in the interval between the close of the Miocene Tertiary and the beginning of the Glacial period." He also cites the case of horizontal Miocene sandstones and basalts above Pavilion creek, cut through by the Fraser river, as evidence in support of the post-Miocene age of the

[1] Report of Progress, 1871–72, p. 55.

[2] Geol. Surv. Can., Annual Report, 1887–88, Pt. R., p. 25.

[3] Geol. Surv. Can., Annual Report, 1894, p. 302B.

valley. The locality here referred to, however, is in the plateau portion of the valley and about 80 miles above the upper end of the cañon. It is quite possible that the portion referred to by Dawson is Miocene in age and at the same time that the cañon portion is considerably older.

In attempting to carry the origin of the Fraser farther back in geologic time than that assigned to it by Dawson, the writer is able to present some evidence to suggest the possibility of a valley along the course of the cañon as far back as the beginning of Eocene times, a period which brings us back to the closing events of the Laramide revolution.

The presence of bands of Lower Cretaceous sediments in the Cascade range south and east of Fraser valley, and on the eastern slope of the Coast range, indicates that previous to the Laramide revolution a considerable depression, in which sediments were deposited existed in the region of Fraser cañon and probably extended northwesterly from this point along a line now occupied by the eastern slope of the Coast range. It is hardly possible that at this time any river system could have existed along the present course of Fraser river except probably streams flowing eastward into the Cretaceous basin.

The next outstanding event in the geological history of this region is the Laramide revolution, an event which terminated the existing conditions of deposition and elevated the region into a land area on which stream courses would naturally be developed. The effects of this revolution here were to elevate the Cretaceous into a series of folds, and to develop lines of weakness along north and south directions.

The production of such lines of weakness in the solid rocks of the uplifted land area was a necessary preliminary to the development of subsequent stream courses along the direction of those lines, which is also the direction of the greater part of the Fraser cañon and of the plateau portion of the valley. The conditions therefore at the close of the Laramide revolution must be considered to have been favourable for the inauguration of lines of drainage along the course of the Fraser cañon.

The Eocene period is generally supposed to have been one of long continued stable conditions during which the Interior plateau and the region of the Coast ranges suffered erosion to such an extent that the plateau at least was reduced almost to conditions of peneplanation. An enormous amount of material must have been removed from the surface of this region, carried away by streams, and deposited again somewhere else.

It is improbable that this material could have been carried eastward across the lately uplifted Rocky mountains, and there are no notable deposits of Eocene age remaining today towards the north, that could represent such material. There is, however, a considerable area of Eocene lying to the west and south of the Fraser cañon the constituents of which might have been derived from the Interior Plateau and Coast ranges. The Eocene formation of Fraser delta and Puget sound covers an area of over 20,000 square miles and contains deposits the thickness of which is stated to range from 3,000 feet at the Fraser river to 10,000 feet about Puget sound and 20,000 feet farther south.[1] The rocks in it consist of sandstone, shales and conglomerates, the materials of which could readily have been derived from the igneous and sedimentary rocks lying to the north and east. In Fraser delta, Leroy states that the formation indicates estuarine conditions of deposition, or in other words deposition in an arm of the sea running some distance inland to the east. The present shape of the formation as mapped is roughly deltoid, with its apex near the lower end of Fraser cañon, giving a suggestion that it was down that course that the material was carried which was deposited in the Eocene estuary. Slight though it is, the presence of this Eocene area, its shape and composition is the first evidence we have of a stream acting along the present course of the Fraser cañon.

The Eocene beds of the delta have been only slightly disturbed and are still almost horizontal. Their relation to the underlying and adjacent rocks of the Coast range on their northern border suggests that the country bordering the estuary in which these Eocene beds were laid down was at that time one of considerable relief. On the other hand, however, it is believed the Interior Plateau region was, in the same period, reduced to a region of comparatively mature relief. In the Eocene period, therefore, the same contrast in topographic conditions existed as exists at the present time. In other words if, as we have suggested, the Fraser river was in operation in Eocene times its course from the interior to its mouth would have been from a region of low relief through a bordering hilly country of relatively greater relief down to the sea. While this line of drainage might have been developed as a result of the Laramide revolution, during Eocene times it would have passed through all the stages of youth and at the close of that period reached a condition of maturity.

The geological record of the southwestern part of British Columbia shows that there were no great disturbing influences by which

[1] Leroy, O. E., Report on a Portion of the Main Coast of British Columbia and Adjacent Islands, Geol. Surv. Can., No. 996.

the drainage lines of the region could have been changed until the revolution in Miocene times and its accompanying extravasations of lava. It is quite possible and, indeed, has been shown by Dawson that these lava floods caused the Fraser to cut new courses in that portion of its course above the cañon; but in the cañon itself there are no extrusive rocks to be found and it is unlikely that either the floods of lava or the mountain building processes themselves had any influence in blocking the drainage or diverting the course of the stream.

Since no Miocene beds are found covering the Eocene of the delta it is probable that the Miocene Fraser river flowed across the Eocene beds and discharged farther to the west in the Straits of Juan de Fuca or even beyond. Patches of Miocene on the southern shores of the western parts of the straits may represent deposits by such a stream.

During early Pliocene times no disturbances of sufficient magnitude took place to affect the Fraser river. Towards the close of that period, however, a broad uplift occurred which resulted in the elevation of the Interior Plateau region and the upwarping of the Coast and Cascade mountain ranges along an axis striking northwest and southeast directly across that part of the valley now occupied by the cañon. This uplift caused a revival of drainage giving the streams power to deepen their valleys; but it was so slow and gradual that the erosive power of the Fraser river was such that it was able to deepen its valley at a rate equal to the uplift, so that no diversion of its course took place. Relative to the Coast and Cascade ranges then, the Fraser river, like the Skeena to the north and the Columbia to the south, is an antecedent stream. This uplift was really the cause of the development of the Fraser cañon as it is today, and the result, before it became modified by glacial action, would have been a deep V-shaped cañon commencing at the head of the delta and extending on through the axis of uplift into the Interior plateau. Such a valley would have been constricted, as it is now, in the gorge where it cuts through the massive igneous rocks of the Coast Range batholith and more flaring in the softer rocks above and below the gorge. Rock benches about 1,500 feet above the present valley bottoms in both the Fraser and other valleys in the adjacent plateau region are believed to represent the old pre-Pliocene valley slopes and indicate the amount of Pliocene deepening of these valleys.

The Pliocene uplift and the consequent revival of the Fraser drainage probably led to changes in the direction of drainage of other streams in the uplifted region. It is quite possible that the Fraser drainage at this time captured some of the Columbia drainage going by way of Okanagan valley, and it appears fairly certain that the head waters of certain streams, to the north of the Fraser, that flowed westward through the Coast range in broad valleys were diverted by the uplift and became part of the Fraser drainage.

The occupation of the Fraser cañon by glacial ice is clearly proven by the effects of that occupation. The effect of valley glaciation would be to change the sharply V-shape caused by the Pliocene uplift to a more broadly U-shape, to truncate projecting spurs and straighten the course of the valley and probably to deepen it somewhat. Another effect also would be the development of hanging valleys in the streams tributary to the valley. All of these features are exhibited in it.

There is little doubt that Fraser valley throughout was more or less deeply filled with glacial material at the close of maximum glaciation, and in the cañon itself a considerable thickness would have been deposited in the broader parts while in the constricted parts there was little room for such accumulations. This filling was presumably brought about when the general level of the region, above the sea, was considerably lower than at present.

The evidence of a re-elevation of the region since Glacial times is shown on the Pacific coast by abandoned beaches up to 400 feet above sea level, and is clear throughout the cañon and in the valley higher up. This elevation again revived the stream causing it to cut down through the accumulations of glacial material leaving merely remnants on either slope of the valley in the form of terraces or benches. In many places the stream has cut down to its old rock floor, and in the gorge itself and on the Thompson river has cut into that floor to a depth of about 100 feet, leaving rock benches on one or both sides of the old valley. The post-Glacial notching of the old glaciated valley floor in the gorge and not in the valley above and below implies a warping up of the surface across the course of the gorge and along the axis of the Cascade-Coast mountain uplift. This is equivalent to saying that the Coast and Cascade ranges have risen relative to the sea and probably to the Interior Plateau region also since Glacial times.

Another feature of the post-Glacial uplift has been the development, in the gorge, of a second set of breaks in some of the tributary valleys entering it. Hanging valleys had previously been developed by the action of valley glaciers where the streams plunged down over falls to the main valleys, and where these streams ran over a rock bench in the main valley they plunge again in falls over the bench to the bottom of the recently excavated gorge. While the upper break in a tributary stream is due to valley glaciation, the lower break is due to the difference in the rates of erosion of the main and tributary streams.

The history of the cañon above outlined seems to the writer to be the most likely one that can be worked out from the evidence at present to hand bearing on the subject. It is fair to state, however, that N. L. Bowen, in an unpublished report of the Geological Survey on this region, holds a different opinion on the history of that part of Fraser valley below Hope. Bowen considers that Fraser river in the cañon is an adjusted stream, that it at one time occupied the valleys of Silver and Klesilkwa creeks and found an outlet to the sea by way of Skagit valley, and that the westward flowing portion below Hope is the result of capture and diversion which reversed the flow of Silver creek. This conception, however, does not conflict with the ideas presented by the present writer regarding the history of the cañon of Fraser river.

tributary streams is due to valley glaciation, the lower level is due to the difference in the rates of erosion of the main and tributary streams.

The history of the cañon above outlined seems to the writer to be the most likely one that can be worked out from the evidence at present at hand bearing on the subject. It is fair to state, however, that [illegible], in an unpublished report of the Geological Survey on this region, holds a different opinion on the history of that part of Fraser valley below Hope. [illegible] considers that Fraser river in the cañon is an adjusted stream, that at one time [illegible] the valleys of Silver and [illegible] creeks [illegible] found an outlet to the sea by way of Skagit valley, and that the westward flowing portion below Hope is the result of capture and diversion which reversed the [illegible] creek. This conception, however, does not conflict with [illegible] presented by the present writer [illegible] the history of Fraser river.

Sir:

In connection with my paper on the "Origin of the Rocky Mountain Trench, B.C.", published in the Transactions of the Royal Society, Geological Section (4), page 61, I wish to call your attention to the following corrections.

Page 74 - Diagram, Fraser River at Tete Jaune Cache - arrows interchanged.
" 74 - Diagram, Upper Columbia Lake - arrows interchanged.
" 76 - 4th line from the bottom, change "western" to "eastern".
" 79 - Line 15, interchange the words "east" and "west".
" 87 - Last line, 916 feet should be 91.6 feet.
" 90 - Line 18, Pre-Mesozoic should be Pre-Cretaceous.
Line 22, insert after "occupied", - "the site of the present Coast and Vancouver Ranges while the eastern highland was located just west of"

Yours sincerely,

S. J. SCHOFIELD

Dear Sir:

In connection with my paper on the "Origin of the Rocky Mountain Trench, B.C.", published in the Transactions of the Royal Society, 1920, Geological Section (4), page 61, I wish to draw your attention to the following corrections.

Page 74 - Diagram, Fraser River at Tete Jaune Cache - arrows interchanged.
" 74 - Diagram, Upper Columbia Lake - arrows interchanged.
" 76 - 4th line from the bottom, change "western" to "eastern".
" 79 - Line 15, interchange the words "east" and "west".
" 87 - Last line, 916 feet should be 91.6 feet.
" 90 - Line 18, Pre-Mesozoic should be Pre-Cretaceous.
Line 22, insert after "occupied", - "the site of the present Coast and Vancouver Ranges while the eastern highland was located just west of"

Yours sincerely,

S. J. SCHOFIELD

The Origin of the Rocky Mountain Trench, B.C.

By S. J. SCHOFIELD, M.A., B.Sc., PH.D.

Presented by W. McINNES, LL.D., F.R.S.C.

(Read May Meeting, 1920)

INTRODUCTION

In 1889, Dawson presented before this Society a paper entitled, "On the Later Physiographical Geology of the Rocky Mountain Region in Canada with Special Reference to Changes in Elevation and the History of the Glacial Period," in which he outlined in a general way the history of the Cordilleran drainage, especially that of the Glacial period. Since that time, many new facts have been recorded by numerous observers, which open new avenues of thought on the problem concerning the drainage systems of British Columbia, and permit us to trace this drainage with a greater degree of certainty than was possible in Dawson's time. It must not be understood, however, that the problem is in any way completely solved, and it is hoped that this paper will be considered simply as a preliminary contribution to one of the greatest and most interesting problems in Cordilleran geology.

SUMMARY

1. The Rocky Mountain trench is the most remarkable structural feature of the Canadian Cordillera. It extends from the 49th parallel of latitude at least to the boundary between British Columbia and Yukon.

2. At the close of the Jurassic, the Cordilleran topography was made up of two main highlands (the area now occupied by the Coast Range and the area now represented by the Selkirk Mountains and their continuation northward) separated by an interior basin now designated the Interior Plateaus.

3. The drainage naturally was from the highlands to the basins, the products of erosion being deposited as Cretaceous sediments along the flanks of the highlands in the areas now represented by Vancouver Range, Interior Plateaus, the Rocky Mountains, and the Great Plains.

4. The highlands were reduced to a condition of old age or peneplanation, by erosion throughout the whole of Cretaceous time. Towards the close of the Cretaceous, the rivers flowing eastwards from the easterly highland eroded headwards, until it is possible they reached the Interior Plateaus.

5. At the close of the Cretaceous, the two highlands and the Interior Plateaus were uplifted, and the Rocky Mountains were slowly formed along the eastern border of the old land mass. The large rivers which flowed to the east from the old eastern land mass were able to keep their courses across the uprising mountain chain, forming the through valleys of the Peace, Yellowhead, Bow, and Crowsnest Rivers. Thus, the course of the Peace River, which drains eastward from the old land mass across the Rocky Mountains, is normal, while those of the Yellowhead, Bow, and Crowsnest Rivers are abnormal. It is probable that at this time, subsequent streams, tributary to the above-mentioned rivers, occupied the site of the present Rocky Mountain trench; and that, therefore, the first faint beginnings of the trench were made at the close of the Cretaceous or in very early Tertiary times.

6. Faulting along the line of the trench from the big bend of the Fraser, at least to the 49th parallel, in early Eocene times, disconnected the through drainage, and diverted it into the Rocky Mountain trench. The drainage at that time was southwards along the trench and this primeval river, which for our purpose may be called the proto-Kootenay, at this time included the headwaters of the present Fraser and occupied the whole of the trench to the south.

7. The Eocene Columbia River, which did not extend northwards as far as the Big Bend of the present Columbia River, and hence had no connection with the drainage of the Rocky Mountain trench, flowed southwards in a valley whose course, if projected northwards, would intersect that of the Rocky Mountain trench, whose trend is northwest-southeast. The Eocene Columbia River, which had a much lower elevation than the river proto-Kootenay, occupying the Rocky Mountain trench, eroded headwards during the post Eocene times and captured a portion of the proto-Kootenay, diverting part of it into the Columbia, and thus forming the peculiar feature in the Columbia River known as the "Big Bend."

8. The Fraser River flowing over the softer rocks of the Interior Plateaus eroded headwards and captured the headwaters of proto-Kootenay River, forming the "Big Bend" of the present Fraser.

9. Subsequent erosion headwards of the Fraser and Columbia during late Tertiary times gradually shifted the divides in the Rocky Mountain trench to their present position and formed the rapid portions in those rivers.

10. Glaciation subsequently smoothed and removed the interlocking spurs, giving to the trench its modern trough-like characteristics.

The Geography of the Rocky Mountain Trench

The most remarkable topographic feature of the Canadian Cordillera is the Rocky Mountain trench, so designated by Daly,[1] who uses as an analogy a military trench traversing a hilly country. Much information concerning this depression had been gained during that period from 1871–1900 which in the researches of British Columbian geology may be called the exploratory period. It was made noteworthy by the researches of Selwyn, Dawson, and McConnell, who laid the foundations on which all the later workers in the Cordillera have built their superstructures. In the eastern portion of the Cordillera where the Rocky Mountain trench is situated, later detailed investigations have been carried on principally by Daly, but to some extent by McEvoy and Malloch.

The Rocky Mountain trench forms the western boundary of the Rocky Mountains practically throughout its whole length, a distance of over 800 miles, extending from south of the International Boundary line at the 49th parallel of latitude almost to the Yukon-Alaska boundary in latitude 61 degrees. The location of the trench after it crosses the boundary between British Columbia and the Yukon, is not known with any degree of certainty. The trend of this topographic feature, which ranks among the great structural valleys of the globe, is almost constant in a direction north 33 degrees west. This trench is occupied by the following rivers and streams: Flathead (north-flowing), Kootenay (south-flowing), Columbia (north-flowing), Canoe (south-flowing), Fraser (north-flowing), Parsnip (north-flowing), Finlay (south-flowing), Kachika (north-flowing), and the Hyland.

From this point the trench cannot be traced with any degree of certainty, but it may follow the valleys occupied by the Pelly and Yukon, which trend more closely to the northwest.

One of the most peculiar features of the trench, whose walls on both sides rise on an average 4,500 feet above the valley floor, is the fact that it is occupied by streams which vary greatly in size. For example, the Kootenay River enters the trench as a large river from the north, while less than a mile away from this point, the north-flowing Columbia has its beginning in two small lakes. In the same manner, the south-flowing Canoe River rises and continues as a very small river to join the mighty Columbia in the trench. From these examples, which might be greatly amplified, it can be seen that the size and depth of the valleys which unite linearly to form the Rocky Mountain trench bear no relationship to the size of the streams which

[1] Daly, R. A., Geol. Surv., Can., Mem. 38, 1912, p. 26.

occupy them, which is contrary to the results of normal stream erosion.

The general trend of the regional drainage is toward the trench, except in the case of the Kootenay River and the Columbia River, which break through the western wall of the trench, and reach the Pacific, while the Peace River cuts through the eastern wall, and finally reaches the Arctic Ocean. The latter stream is the only one which drains eastwards across the Rocky Mountains, suggesting that it is antecedent in origin. This fact throws a flood of light on the origin of the transverse valleys of the Rocky Mountains.

The width of the trench averages 4-6 miles, but in places such as the St. Mary's prairie near Cranbrook, in southern British Columbia, and in the stretch from Tête Jaune Cache to Fort George, it is much greater. The floor of the trench is usually flat or slightly rolling, and is covered generally by the unconsolidated gravels and silts of the Cenozoic. The walls of the trench usually rise abruptly from the floor, especially on the eastern side, where it is usually precipitous. This feature is most noticeable in the southern part of the trench.

Early Exploration of the Rocky Mountain Trench

The first European to discover the Rocky Mountain trench was Sir Alexander Mackenzie, who entered it in the year 1793 by way of the Peace River, travelled southward to the Fraser, which he followed for a short distance, whence he turned westwards and reached the Pacific coast. Thus Mackenzie was the first man to cross the great Cordillera north of Mexico. This route into the mountains was followed for many years by other explorers, including Fraser in 1806–07, Harmon in 1820, Sir George Simpson in 1828, Capt. W. Butler in 1872, Horetsky and Macoun in 1874. The southern portion of the trench was explored by David Thompson in 1807, Alexander Henry 1811–1814, and Sir George Simpson in 1841. The latter entered it near the Columbia Lakes, the source of the Columbia River, and followed the depression southward along the Kootenay River beyond the 49th parallel. Palliser, who explored the Rocky Mountains during the years 1857–59, was the first observer to remark the peculiar unbroken continuity of this great structural feature. He recorded his observations in the following words:

"This great valley, through which the Columbia River flows, is one of the most singular features observed on the west slope of the Rocky Mountains. It is continued to the south from Columbia lakes, by the valley through which the Kootenay River flows, and the famous wintering grounds in the Bitter Root valley, to which the settlers flock from Colville and other places, is without doubt, the continuation of the same great natural feature. It is the belief that this valley is continued to the north, following the course of Canoe River, that makes me so sanguine that by this route a passage could be effected into the valleys of either Thompson or Fraser River."[1]—A surmise which was entirely justified.

These men were explorers in a geographical sense, and although their travels added greatly to the knowledge of the Cordillera, yet, with the exception of Hector of Palliser's expedition, they made very few geological observations.

General Geological Features

The rock formations exposed in the immediate vicinity of the trench embrace a wide range from the oldest known rocks in British Columbia to the most recent. The following table presents these formations in a broad way:

Cenozoic	Recent	Gravels and sands.
	Pleistocene	Drift, fluvioglacial deposits.
Tertiary	Miocene	Sandstones, shales, and volcanic rocks.
	Laramie	Sandstone and shales.
Mesozoic		
Palæozoic	Carboniferous	Limestones and shales.
	Devonian	Limestones and shales.
	Silurian	
	Ordovician	Limestone shales.
	Cambrian	Limestone shales.
Pre-Cambrian	Beltian	Quartzites, argillites.
	Shuswap series	Mica schists, limestones, and quartzites.

Shuswap Series

The Shuswap series which outcrops along the great valley consists of mica schists, altered limestones, gneiss, and intrusions of granite. These rocks are remarkable for their constant lithological characters throughout their wide distribution from the International Boundary

[1] "Further papers relative to the Exploration by the expedition under Captain Palliser, of that portion of British North America which lies between the northern branch of the river Saskatchewan and the Frontier, and between the Red River and the Rocky Mountains and thence to the Pacific Ocean." Presented to both Houses of Parliament by command of Her Majesty, 1860.

line to the Yukon. Selwyn[1] first recognized these rocks as a unit in the Cordillera and although he applied no specific name to them he stated that they were the oldest rocks observed in the country but did not place them in any geological period.

G. M. Dawson[2] in his report on the geology of West Kootenay district gave the name "Shuswap series" to a similar group of rocks exposed on the western shore of Kootenay Lake which he correlated with the series of schists, limestones, and gneisses occurring around Shuswap Lake. He regarded the Shuswap series as Archæan in age, although no evidence of an unconformity with the overlying series could be detected.

The Shuswap series in the vicinity of the Fraser River from Tête Jaune Cache to Fort George was examined by Malloch,[3] who expresses some doubt concerning their Archæan age in the following words, "the author suggests an alternative hypothesis, that the schists and gneisses are the metamorphosed equivalents of the grey quartzites which occur in the Castle Mountain series." The Castle Mountain series is of Cambrian age.

In 1912, Daly,[4] in studying the geology along the 49th parallel of latitude came to the conclusion that the rocks mapped on the West Kootenay map-sheet (No. 792) by Brock and McConnell as belonging to the Selkirk series of Cambrian or Cambro-Silurian age, are Archæan, applying the name Priest River terrane and correlating this terrane with the Shuswap series of Dawson. Daly states that the Priest River terrane is overlain unconformably by the Summit series, the lower part of which he places in the Beltian.

In 1913, the original Shuswap area of Dawson around Kootenay Lake was examined by the author,[5] who showed that the rocks mapped as Shuswap were Beltian or post-Beltian since they proved to be metamorphosed equivalents of the Purcell series and later rocks. These rocks exposed around the shore of Kootenay Lake strike in the direction of those mapped as Priest River terrane and are equivalent to the Shuswap by Daly.[6]

Drysdale[7] who restudied the Priest River terrane came to the following conclusions: "The Priest River terrane instead of being Archæan is considered to be Beltian and simply the hydrothermally

[1] Selwyn, A. R. C., Geol. Surv., Can., Rept. of Prog., 1871–72.

[2] Dawson, G. M., Geol. Surv., Can., Ann. Report., vol. IV, 1889.

[3] Malloch, G. S., Geol. Surv., Can., Sum. Rept., 1909.

[4] Daly, R. A., Geol. Surv., Can., Mem. 38, 1912.

[5] Schofield, S. J., Geol. Surv., Can., Sum. Rept., 1913, p. 136.

[6] Daly, R. A., Geol. Surv., Can., Mem. 38, 1912, p. 258.

[7] Drysdale, C. W., Geol. Surv., Can., Sum. Rept., 1916, p. 61.

metamorphosed extension of the Purcell series across the Purcell trench as originally shown on the West Kootenay map. The metamorphism is due to batholithic invasion which in this locality appears to conform closely to the regional structure, the formations swinging to parallel the granite contacts. The terrane includes the folded domed Kitchener, Creston, and Aldridge members of the Purcell series cut, here and there, by granite and complementary dykes from the large adjacent masses of granite." The field facts from which the above conclusion was drawn are not given.

In 1914, the author[1] examined the area west of Kootenay Lake and was unable to detect the great fault described by Daly[2] which separated the Beltian rocks from the Priest River terrane and from the field facts came to the conclusion that the Priest River terrane in part at least is a metamorphosed equivalent of the Aldridge, since in the area examined the Priest River terrane of Daly was a conformable part of the Aldridge quartzites and the two formations passed into each other by gradual transition. The Priest River terrane and the Aldridge quartzites differed only in degree of metamorphism.

In studying the section exposed along the Canadian Pacific Railway from Golden to Revelstoke, Daly[3] includes in the Shuswap formations designated by Dawson as belonging to the Cambrian the Niskonlith and the Adams Lake series. The Beltian, according to Daly, rests unconformably on the Shuswap terrane and it may be stated that, although Daly's evidence was examined in the field by several observers, they were not convinced that such an unconformity exists at the point designated.

Without submitting any facts to support his statement Drysdale[4] ventures the following opinion on the above section.

"Future investigation may prove that both the Adams Lake and Niskonlith series of the Shuswap and Albert Canyon regions are a closely folded and faulted series of Cambrian and Post-Cambrian age similar in lithology and chronological sequence to the south Kootenay sections which have been mapped in more detail."

In 1917, Drysdale[5] found Upper Palæozoic fossils in the Laurie formation which Daly[6] had included in the Beltian. The Laurie formation is 15,000 feet thick, and since the horizon in which the

---

[1] Schofield, S. J., Geol. Surv., Can., 1914, p. 31.
[2] Daly, R. A., Geol. Surv., Can., Mem. 38, 1912.
[3] Daly, R. A., Geol. Surv., Can., Mem. 68, 1915, p. 10.
[4] Drysdale, C. W., Geol. Surv., Can., Sum. Rept., 1916, p. 61.
[5] Burling, L. D., Bull. Geol. Soc. Am., vol. 29, 1918.
[6] Daly, R. A., Geol. Surv., Can., Mem. 68, 1915, p. 67.

fossils were found is not stated, the thickness of the strata from the fossil horizon to the unconformity between the Beltian and the Shuswap can not be given. The thickness of the strata from the base of the Laurie formation to the above unconformity is 4,100 feet. This thickness is not nearly sufficient to include the lower Palæozoic, and the whole of the Beltian since the Cambrian[1] alone is 12,000 feet thick while the Beltian[2] is at least 15,000 feet thick. The above facts strongly support the contention that the great unconformity between the Beltian and the Shuswap (Archæan) does not exist in the Selkirk Mountains at least in the position given to it by Daly. Hence the Shuswap of Daly, east of Revelstoke may be Beltian, and possibly, in part, lower Palæozoic. According to McConnell[3], the Shuswap series of Archæan age which consists of schists of various types, and crystalline limestones is overlain on the Omineca River by a band of slates, quartzites, and conglomerates similar in lithological character and in geological position to the Bow River series of the Bow River section and like it, probably referable to the Lower and Middle Cambrian.

From the above discussion it can be readily seen that the present status of the Shuswap series as Archæan is very much in doubt, and the general tendency is to place the greater part of the Shuswap in the Beltian, with some in the lower Palæozoic in certain localities. It does not preclude the possibility that part of the Shuswap may be Archæan in age, although there is no undisputed evidence for this supposition. It is evident that the rocks mapped as Shuswap in the different areas are in some cases of different geological ages, with a strong possibility that there are no Archæan rocks exposed in southern British Columbia. In order to solve the problem of the Shuswap terrane, much careful and arduous field work must be undertaken.

The Beltian

In interpreting any description or discussion by Dawson of the Cambrian (Beltian of later writers) rocks in Canada, it must be remembered that Dawson[4] included in the Cambrian all the stratified rocks which occur conformably below the Olenellus Zone and above the Archæan (Shuswap series). Walcott[5] includes in the Pre-Cambrian (Algonkian or Beltian) those strata which occur below the general unconformity marking the base of the Cambrian whether

[1] Walcott, C. D., Smithsonian Misc. Coll., vol. 57, No. 12, 1913, p. 342.
[2] Schofield, S. J., Geol. Surv., Can., Mem. 76, 1915, p. 25.
[3] McConnell, R. G., Geol. Surv., Can., Ann. Rept., vol. VII, 1894, p. 33C.
[4] Dawson, G. M., Geol. Soc. Am., vol. 2, 1891, p. 11.
[5] Walcott, C. D., Smith. Misc. Coll., vol. 57, 1910, p. 11.

lower, middle, or upper, and above the unconformity separating those strata from the Archæan. In places the Cambrian rests with apparent conformity on the Beltian but Walcott holds that a regional study proves a stratigraphic and time break between the known Pre-Cambrian rocks and Cambrian sediments of the North American continent. Daly[1] does not admit the presence of the unconformity between the Cambrian and the Beltian of Walcott in the Canadian Cordillera; a full discussion of this problem from Daly's point of view is given in the above memoir. Daly[2] uses the term Beltian to include those "strata lying conformably below the Olenellus zone, as well as the rocks which are synchronous with those strata though not in proved conformity with the Olenellus zone. In this paper the question will not be discussed as it is considered irrelevant, but the writer's conclusions[3] on the problem are that such an unconformity exists between the Cambrian and the Pre-Cambrian and hence agrees with Walcott. It is with Walcott's interpretation that the Beltian is used in this paper.

The Belt Series[4] in southern British Columbia in the vicinity of the Rocky Mountain trench is as follows:

MIDDLE CAMBRIAN DISCONFORMITY

Belt Series	Roosville formation	1,000	feet
	Phillips formation	500	"
	Gateway formation	2,000+	"
	Purcell Lava formation	300	"
	Siyeh formation	4,000	"
	Kitchener formation	4,500	"
	Creston formation	5,000	"
	Aldridge formation	8,000+	"

Base unexposed

A columnar section of the Beltian in the Selkirk Mountains along the Canadian Pacific Railway is given by Daly:[5]

	TOP EROSION SURFACE	APPROXIMATE THICKNESS
Lower Cambrian	Sir Donald quartzite	5,000+feet
	Ross quartzite (upper part)	2,750 "

[1] Daly, R. A., Geol. Surv., Can., Mem. 68, 1915, p. 87.
[2] Daly, R. A., Geol. Surv., Can., Mem. 68, 1915, p. 58.
[3] Schofield, S. J., Geol. Surv., Can., Mem. 76, 1915, p. 41.
[4] Schofield, S. J., Geol. Surv., Can., Mem. 76, pp. 25 and 42.
[5] Daly, R. A., Geol. Surv., Can., Mem. 68, 1915, p. 61.

Conformity

Glacier Division............. (Selkirk Series of Dawson)....	Ross quartzite (lower part).......	2,500+	feet
	Nakimu limestone..............	350	"
	Cougar formation...............	10,800	"
Albert Canyon Division....... (Niskonlith Series of Dawson).	Laurie formation................	15,000	"
	Illecillewaet quartzite............	1,500	"
	Moose metargillite..............	2,150	"
	Limestone.......................	170	"
	Basal quartzite..................	280	"

Unconformity

Shuswap terrane.

The discovery of upper Palæozoic fossils in the Laurie formation by Drysdale[1] in 1917 disturbs our conception of this Beltian section as described by Daly and if Daly's structures of the Selkirk Mountains be correct, the formations above the Laurie formation cannot be Beltian, but upper Palæozoic at least. Dawson[2] considered the rocks of the Laurie formation to have a synclinal structure, whereas Daly considers the structure to be monoclinal. From the brief discussion above, it will be seen that much remains to be done before the section of the Selkirk Mountains along the Canadian Pacific Railway can be definitely placed in the geological column. Before this is accomplished, it is extremely difficult, if not impossible, to determine the throw of the great fault at Golden, which was a determining factor in the formation of the Rocky Mountain trench at this point.

Cambrian

The Pre-Cambrian sediments, in great part of continental origin, are overlain unconformably by the Cambrian formations of marine deposition. Locally these two terranes are marked by a disconformity, but from a regional point of view, unconformable relationships may be said to hold.

From a study of the sections given below, it can be seen that the Cambrian formations increase in thickness from north to south and from west to east. The southern sections at North Kootenay Pass, and at Elko, show the Middle Cambrian formations only, with the Devonian resting with a disconformity upon them. At Canal Flats the Upper Cambrian makes its appearance, while on the main line of the C.P.R. at Field, the Lower, Middle, and Upper Cambrian formations together with the Ordovician and Silurian are represented in relatively great thicknesses.

[1] Burling, L. D., Geol. Soc. Am., vol. 29, 1918, p. 145.

[2] Dawson, G. M., Geol. Soc. Am., vol. 2, 1891, p. 174.

SECTION[1] NEAR NORTH KOOTENAY PASS, BETWEEN CROWSNEST BRANCH OF C.P.R. AND INTERNATIONAL BOUNDARY LINE

Devonian	Jefferson limestone	500 + feet	
disconformity			
Middle Cambrian		425 feet	Cambrian 425 feet thickness.
disconformity			
Pre-Cambrian	Lewis series		

SECTION[2] ON THE EASTERN WALL OF THE ROCKY MOUNTAIN TRENCH AT ELKO, CROWSNEST BRANCH, C.P.R.

Devonian	Jefferson limestone	300 feet	
disconformity			
Middle Cambrian	Elko formation	90 feet	Cambrian 170 feet thickness
	Burton formation	80 feet	
disconformity			
Pre-Cambrian	Galton series		

SECTION ON THE EASTERN WALL OF THE ROCKY MOUNTAIN TRENCH, AT UPPER COLUMBIA LAKE

Devonian	Jefferson limestone	500 feet	
disconformity			
Upper Cambrian	Sabine formation	725 feet	Cambrian 2,525 feet thickness
Middle Cambrian	Elko formation	1,800 "	
Base unexposed			

SECTION[3] ON MAIN LINE C.P.R. NEAR FIELD, B.C.

Silurian	Halysites beds	1,850 + feet	
Ordovician	Graptolite shale	1,700 + "	
	Goodsir shales	6,040 + "	
Upper Cambrian	Ottertail limestone	1,725 + "	Cambrian 18,578 + feet thickness
	Chancellor	4,500 + "	
	Sherbrooke	1,375 "	
	Paget	360 + "	
	Bosworth	1,855 + "	
Middle Cambrian	Eldon	2,728 "	
	Stephen	640 "	
	Cathedral	1,595 "	
Lower Cambrian	Mt. Whyte	390 "	
	St. Piran	2,705 "	
	Lake Louise	105 "	
	Fairview	600 + "	
Conformable in some places.			
Pre-Cambrian	Hector	4,590	

[1] Adams, F. D., and Dick, W. J.—Report Commission of Conservation 1915, pp. 8-13.)

[2] Schofield, S. J., Geol. Surv., Can., Mem. 76, 1915, p. 42.

[3] Allan, J. A., Geol. Surv., Can., Mem. 55, 1914, p. 60.

SECTION[1] IN ROBSON DISTRICT, BRITISH COLUMBIA

Ordovician	Robson formation	3,000 feet	
Upper Cambrian	Lynx "	2,100 "	Cambrian 12,100 feet thickness
Middle Cambrian	Titkana "	2,200 "	
	Mumm "	600 "	
	Hitka "	1,700 "	
	Tatay "	800 "	
	Chetang "	900 "	
Lower Cambrian	Hota "	800 "	
	Mahto "	1,800 "	
	Tah "	800 "	
	McNaughton "	500 "	

Unconformity

Belt	Multe.

THE GEOLOGY OF THE TRENCH

1. *At the 49th parallel.*—The geology of the trench in the vicinity of the 49th parallel and at Bull River can best be expressed in parallel columns showing the stratigraphy on each side of the trench.

Purcell Range Western flank	Rocky Mountain System Eastern flank.	
Jurassic—dyke intrusion Kootenay granite	Dyke intrusion.	
Mississippian—Wardner formation Limestone	Wardner formation Limestone	1,000 feet
Devonian—Jefferson formation Limestone	Jefferson formation Limestone	150 "

DISCONFORMITY

Middle Cambrian	Elko formation Dolomitic limestone	90 feet
	Burton formation Shales	80 "

[1] Walcott, C. D., Smithsonian Misc. Coll., vol. 57, No. 12, 1913, p. 341.

DISCONFORMITY

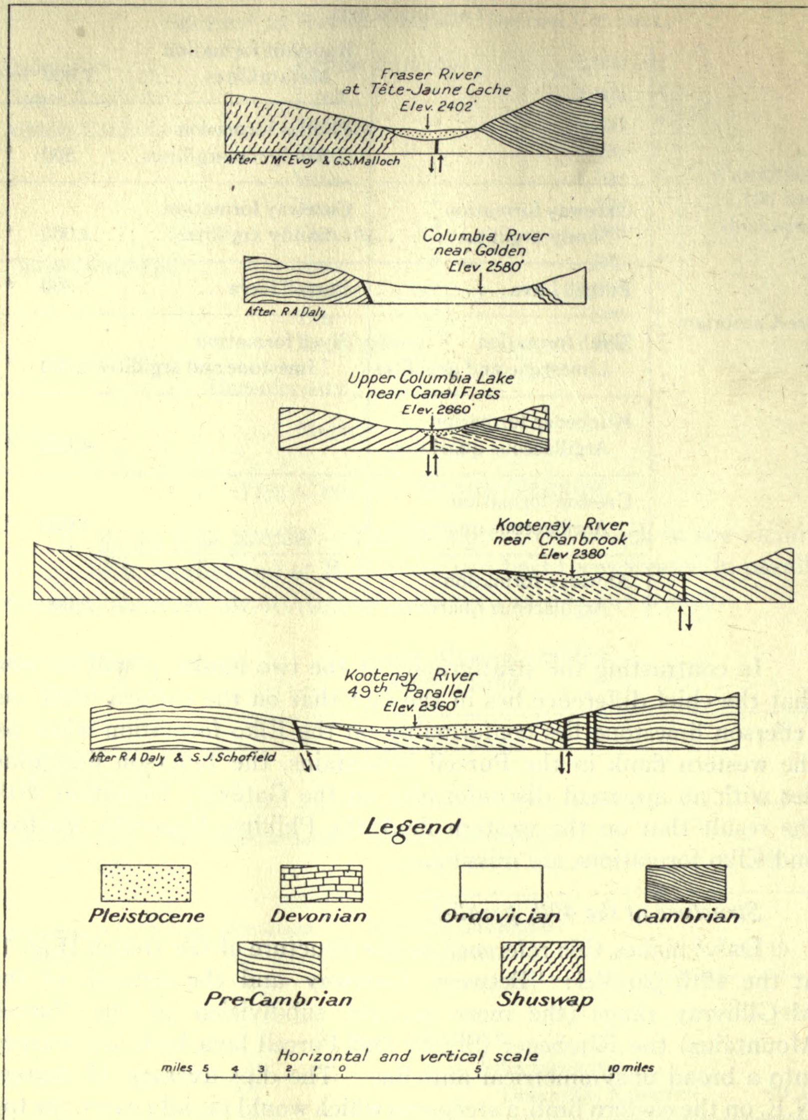
Pre-Cambrian...		Roosville formation Metargillites..........	1,000 feet
		Phillips formation Sandy metargillites...	500 "
	Gateway formation Sandy argillites.......	Gateway formation Sandy argillites.......	2,000 "
	Purcell Lava............	Purcell Lava............	300 "
	Siyeh formation Limestone and argillites	Siyeh formation Limestone and argillites	4,000 "
	Kitchener formation Argillaceous quartzites.	....	4,500 "
	Creston formation Argillaceous quartzites.	....	5,000 "
	Aldridge formation Argillaceous quartzites.	....	8,000 "

In contrasting the stratigraphy of the two flanks, it will be seen that the chief difference lies in the fact that on the eastern flank the Jefferson limestone lies conformably on the Elko formation while on the western flank in the Purcell Mountains, the Jefferson limestone lies with an apparent disconformity on the Gateway formation with the result that on the western flank the Phillips, Roosville, Burton, and Elko formations are missing.

Structure at the 49th parallel.

Daly[1] makes this reference to the structure of the trench (Fig. 1) at the 49th parallel: "Between Gateway and the summit of the McGillivray range (the most easterly subdivision of the Purcell Mountains) the Kitchener (Siyeh) and Purcell lava beds are warped into a broad unsymmetrical anticline. The dips average 35 degrees N.E. on the eastern limb, a steepness which would rapidly carry the top of the Purcell series of sediments far below the level of the Devonian limestone at Tobacco Plains. The distance between the limestone and the most easterly outcrops of Purcell Lava across the drift-covered Rocky Mountain trench is eight miles. We can only conjecture the structures beneath the drift cover. Those actually visible indicate that the Rocky Mountain trench is at the boundary line located on

[1] Daly, R. A., Geol. Surv., Can., Mem. 38, 1912, pp. 112–137.



Structural sections across the Rocky Mountain Trench, British Columbia
By S. J. Schofield

Figure 1

a zone of combined faulting and down flexure. In all probability the faulting has had the dominant control in locating the trench."

Daly[1] gives the following details: "At the western edge of the drift covered Tobacco Plains (Rocky Mountain trench) a block of fossiliferous Devonian limestone has been faulted down into contact with the Gateway formation. On the west and south the limestone is covered by drift and alluvium. The main fault which limits the block on the east can be sharply located, the strikes of the limestone and the Gateway formation being nearly at right angles to each other. This fault is marked on the map sheet where it will be seen to run roughly parallel to the other faults that are responsible for the local graben character of the Rocky Mountain trench. The limestone itself is affected by numerous minor slips so that it is impossible to obtain its thickness; in general the block is monoclinal with an average northeasterly dip of about 45 degrees."

No fault exists in the trench itself at its western side as described by Daly, but the Devonian limestone overlaps the Purcell series. This contact can be seen on the low range of hills which lies immediately west of the trench between the Rocky Mountain trench and the valley of Gold Creek. The valley of Gold Creek which parallels the trench is located along a zone of faulting. The throw which consists only of a few hundred feet has the down-throw on the east side. Hence the block between the fault on Gold Creek and that at the base of the eastern flank of the Rocky Mountain trench acted as a unit in the earth movements which initiated the trench. The block consists of a long, narrow mass which has been tilted on a longitudinal axis which was nearer the western border of the block so that the inclination or dip of the block is to the east. Hence the normal fault of large throw is on the eastern side of the block and the small reverse fault is on the western side of the block in the valley of Gold Creek.

2. *At Bull River.*—The stratigraphic series of the Rocky Mountain trench at Bull River is the same as that at the 49th parallel. Dawson[2] makes the first reference to faulting in the trench (Fig. 1) in the following words: "On the lower part of Bull River near the banks of the Kootenay to the south and elsewhere, rocks of the limestone series occur. The area affording these exposures is outlined in a general way on the map and is supposed to be bounded on the east by an extensive fault which must run near the base of the mountains."

---

[1] Daly, R. A., Geol. Surv., Can., Mem. 38, 1912, p. 112.

[2] Dawson, G. M., Geol. Surv., Can., Ann. Rept., 1885, p. 190B.

The great fault on the eastern side of the trench is a hinge fault since the Devono-Carboniferous limestone exposed at Elko on the wall of the trench gradually descends in going northward until at the Bull River it unites with the Carboniferous limestone which floors the trench. At Bull River the Carboniferous limestone occupies the floor of the trench while the eastern wall of the trench is composed of rocks which may be correlated with the Aldridge and Creston formations of the Purcell series. Hence the throw at this point is very large. The fault on the west side of the trench is a continuation of the fault farther south and which was described in a previous paragraph. Therefore, the structure of the trench at Bull River is a continuation of that farther south at the boundary line.

That part of the trench which lies between Bull River and Canal Flats has not been studied in detail but the two flanks of the trench are composed of rocks of the Purcell series. The floor as far as our knowledge goes is not covered with Carboniferous limestone. That a fault exists in this portion of the trench is almost certain since the rocks of the two flanks belong to different members of the Purcell series in addition to the fact that the strikes of the formations on the two flanks are different.

3. *At Canal Flats* (*Upper Columbia Lake.*)—The stratigraphic succession on the two flanks of the trench at Canal Flats is expressed in the following table:

WESTERN FLANK		EASTERN FLANK
	Devonian	Jefferson limestone
	Disconformity	
	Upper Cambrian	Sabine formation
Beltian—*Kitchener formation*	Middle Cambrian	Elko formation

The rocks of the western flanks belong to the Purcell series and are provisionally correlated with the Kitchener formation. The trench in this vicinity is about 2 miles wide. The eastern wall rises abruptly out of a flat, drift-covered floor. At the base of the wall, the Elko formation outcrops and is overlain conformably by the fossiliferous Middle Cambrian (Sabine) formation which is in turn overlain by the Devonian limestone. The eastern flank does not rise abruptly from the drift-covered floor but gradually ascends, the lower slopes being marked by small hills.

The structure, as shown in Figure 1, is a normal fault with the apparent downthrow on the western side, bringing the Beltian-Kitchener formation in contact with the Middle Cambrian Elko formation. The throw is purely a matter of conjecture and may be in the neighbourhood of 10,000 feet.

The geology of the trench in the vicinity of Golden is described by Daly.[1]

"Eastward from Beavermouth for a distance of about 2 miles, the railway runs over the Cougar quartzites, which are suddenly replaced in the rock-cuttings by shales with subordinate interbeds of limestone (structure section in map-pocket.) These have entirely different habits from any of the formations so far described, recalling the Ordovician Goodsir beds of the Rocky Mountains across the valley. The shales, often calcareous, vary in colour from grey to black. They are friable, heavily jointed, and locally well cleaved across the bedding planes. The limestones weather to a buff-grey and seem to be generally magnesian.

"Beds of the same general character crop out along the line for the next 6 miles, to the eastern end of the local canyon of the Columbia. Throughout this section, strike and dip change very rapidly, indicating structural turmoil. So great is the disorder that no measurements of the true thickness represented is possible nor was the attempt to work out the exact sequence of strata any more successful. Between Donald and Golden, a distance of 16 miles, bed-rock is exposed at only two localities on the railway. At the crossing of Blaeberry River the outcrop is large, showing shales of the Goodsir type. No other notable outcrops were seen, during this reconnaissance, in the floor of the Rocky Mountain trench between Donald and Golden, but it is likely that most or all of it is underlain by the shale-limestone series actually seen along the railway. Without borings it will remain impossible to map in detail the bed-rocks underlying the trench, for they are covered by a remarkably thick and continuous mantle of glacial debris and terrace gravels.

"Fossils were found in the cuttings at and immediately east of the tunnel at the 54.6 mile-post, nearly 3 miles west of Donald. They occur in the cores of small calcareous nodules which have been abundantly segregated in grey shale. On breaking the nodules open longitudinally, fragments of trilobites were found in fair abundance. This material was sent to Dr. C. D. Walcott who kindly examined it and reported as follows: 'The fossils indicate the upper portion of the Upper Cambrian and possibly would be placed in the base of the "Ozarkian" by Ulrich. Two genera are clearly defined. The larger species belong to a genus closely allied to *Dicellocephalus* and there is one specimen of *Illenurus*. There is also another form not yet clearly identified.' At least 1,000 feet of beds are represented at this fossil-bearing locality.

---

[1] Daly, R. A., Geol. Surv., Can., Mem. 68, p. 83.

"It thus appears likely that the trench is floored by Upper Cambrian and Ordovician sediments, which have been faulted into contact with the Beltian Cougar formation (See structural section)."

The structure along the Rocky Mountain trench in the vicinity of Golden (Figure 1) is described by Daly[1] in the following words:

"The origin of the Rocky Mountain trench is certainly connected with the great strike-fault separating the Beltian sediments from the Upper Cambrian-Ordovician beds of the Columbia valley (Map No. 1450 and Structural section). The sharp contact of these two sets of rocks can only be explained by a fault, with a vertical displacement of about 20,000 feet. Probably the contact has not been established by overthrust. No trace of a thrust plane could be found at or near the contact. In the Beaverfoot range, across the trench, the Palæozoic (Ordovician or Silurian) strata are strongly overturned to the south-west, that is, in the direction opposite to that expected if the Beltian rocks of the Purcells had been driven upward and eastward over the Cambrian-Ordovician beds of the trench.[2]

"It seems more likely that the master fault of the trench is normal. with downthrow on the northeast.

"A similar relation between the rocks of the Purcell range and those of the trench has been established at the 49th parallel, where Devonian limestones on the east are dropped down into contact with pre-Upper Cambrian volcanics and metargillites on the west.[3] Schofield has recently determined that the same zone of faulting extends at least 35 miles to the north-northwest, where the Lower Carboniferous limestone on the east contacts with the Cambrian (?) Gateway formation on the west.[4]

"Thus, for at least 250 miles of its length, the Rocky Mountain trench is probably located on a continuous zone of faulting, which is characterized by very great upthrow on the southwest.

"However, it may well be that the trench displacement is not merely that due to normal faulting. This greatest known trench is nearly 1,000 miles in length, stretching from Montana to Yukon Territory, and it lies in rocks of many different ages, though keeping its Cordilleran trend throughout. So far as known it is nowhere a typical graben, with equivalent formations left at the same level on the sides (two) of the fault-zone. Finally, the trench is very narrow

[1] Daly, R. A., Geol. Surv., Can., Mem. 68, 1915, p. 113.

[2] See J. A. Allan, Guide-book No. 8, Congrès Géologique International, Ottawa, 1913, showing structure section across the Rocky Mountains.

[3] Geol. Surv., Can., Mem. No. 38, 1912, p. 118.

[4] Schofield, S. J., Guide-book No. 9, Congrès Géologique International, Ottawa, 1913, p. 53.

in proportion to its length. All of these features suggest that there has been scission and shifting, causing the horizontal movement of the Rocky Mountain system past the Purcell-Selkirk-Columbia-Cassiar Mountain group or vice versa. An analogy is found in the 600-mile San Andreas rift of California which was the locus of the earth-shaking horizontal shift of 1906."[1]

Daly's estimate of the throw of about 20,000 feet along the great fault in the trench cannot be considered as in any way accurate since it is based on the assumption that the Cougar quartzites are Beltian, whereas if they overlie the Laurie formation as Daly states, they must be at least post-Carboniferous. Thus the fault brings the Upper Cambrian and the upper Palæozoic in juxtaposition. Also the provisional determination that the Cougar quartzites are upper Palæozoic in age and not Beltian makes the downthrow side on the east instead of the west.

4. *At Surprise Rapids, 40 Miles North of Golden.*—From Donald north to the Big Bend we are indebted to Coleman[2] for geological observations on this portion of the trench. His description is as follows: "The rocks exposed at Surprise Mount are typical mica and hornblendic schists dipping about 40 degrees to the south-southwest and with a strike of east-southeast and north-northwest (Mag.). In this they differ from the mica schists at the rapids, the latter dipping 50 degrees to 70 degrees toward the south-southeast. The rocks are probably Archæan in age, although they stand several hundred feet higher than the (supposed) Palæozoic slates and quartzites of Lookout Point, less than 10 miles away. There must be a great fault separating the two." This was confirmed by McConnell[3] in 1892.

From Surprise Rapids to Lake Timbaskis according to Coleman the Columbia follows the boundary between the (Archæan ?) schists and the Palæozoic limestones and the course of the river corresponds to the usual strike of the rocks. From Lake Timbaskis northeastward across the divide between the Columbia and the Fraser Rivers to Tête Jaune no critical geological observations have been recorded, but McEvoy[4] states that the valley seems to coincide with the dividing line between the Archæan and Cambrian rocks.

---

[1] The California Earthquake of April 18, 1906, published by the Carnegie Institute of Washington, 1908, vol. 1, p. 48.

[2] Coleman, A. P., Trans. Roy. Soc., Can., vol. VII, 1889, sec. 4, p. 100.

[3] McConnell, R. G., Geol. Surv., Can., Sum. Rept., 1892, p. 11A.

[4] McEvoy, J., Geol. Surv., Can., vol. XI, 1900, p. 40D.

5. *Tête Jaune Cache to the "Big Bend" of the Fraser.*—The following description of the geology of the Rocky Mountain trench near Tête Jaune Cache is given by McEvoy:[1]

"On the southwest side of the valley, opposite Tête Jaune Cache, on Mica Mountain, a great series of mica-schists are found dipping S.45°W., at angles 30° to 50°. This series includes dark glittering mica-schists, easily weathering, thinly foliated garnetiferous mica-schist in massive beds, bands of dark fine-grained micaceous rock apparently of eruptive origin, and layers of fine-grained gneiss which in some instances at least, is certainly intrusive. The whole series, while differing somewhat from the Shuswap series of the southern interior of British Columbia, shows the main characteristics of that series and may be classed as such. The age of this series as given by Dr. Dawson is Archæan. The wide valley intervening between these rocks and those of Cambrian age opposite is covered by superficial deposits and hides the line of contact. It would be necessary to assume a great fault along this valley to explain the attitude of the rocks of the Shuswap series, if the apparent dip of these rocks were the real dip of the original bedding, but such is not the case. The rocks are extremely foliated and all trace of the original bedding is destroyed. This foliation is roughly parallel to that seen in the Cambrian rocks across the valley where the original bedding could still be distinguished. As it was there entirely independent of the dip of the bedding, it cannot here be taken to have any significance in the determination of the thickness of the formation."

In 1909, Malloch[2] made a rapid reconnaissance along the Fraser River from Tête Jaune Cache to Fort George and made the following observations on the geology of the trench in the vicinity of Tête Jaune Cache. "A series of mica-schists, garnetiferous schists, and gneisses, occurring in the mountain range bordering the trough on the southwest, has been referred to the Shuswap group by Mr. McEvoy. These rocks form the upper part of the range from opposite Tête Jaune Cache to the gap of the Rau Schuswap River. Mr. McEvoy[3] states that some of the finer-grained gneisses are certainly intrusive. Mica mountain, where Mr. McEvoy got his specimens, was not visited; and elsewhere no rocks were seen by the writer from which this conclusion could be verified either from a study of hand specimens or from the field relations, and the author is disposed to regard the schists and gneisses as metamorphosed sediments. They dip to the

---

[1] Geol. Surv., Can., Ann. Rept., vol. XI, 1900, p. 38D.

[2] Geol. Surv., Can., Sum. Rept., 1909, p. 126.

[3] Geol. Surv., Can., Ann. Rept., vol. XI, pt. D, p. 37.

southwest at comparatively high angles, and overlie beds of garnetiferous schists, some of which contain large crystals of staurolite. These in turn overlie beds of impure crystalline limestone, resting on mica schists, the sedimentary origin of which is revealed by weathered surfaces where rounded grains of quartz can be detected. A similar section was seen at other points on the same side of the trough, and the author suggests as an alternative hypothesis that, the schists and gneisses are the metamorphosed equivalents of the grey quartzites which occur in the Castle Mountain series; while the trough may have been eroded along the outcrop of the soft calc schists at the base of the formation. In a region where faults are numerous the evidence to support this hypothesis is far from being conclusive. The gneisses are cut by large dikes of pegmatite holding crystals of muscovite, some of which measure over 20 inches across."

The writer's observations on this section, in 1918, showed that the rocks exposed in the floor of the trench were badly broken and strong shearing had developed in a direction coinciding with the trend of the trench. This shearing and crushing was later in age than the metamorphism developed in the Shuswap rocks. It is considered to be related in age to similar shearing and faulting which have been determined in the trench to the south, although no direct evidence on this point has been recorded. Before this is attempted a critical study of the so-called Shuswap series must be completed and its position in the geological column established. According to Malloch, the Bow River series borders on the northeastern slope of the trough from Tête Jaune Cache to the high mountain opposite the mouth of Goat River. From this point northwards, the Castle Mountains series crosses the river at the foot of Goat River rapids. On the northeastern flank, gneisses and schists of the Shuswap series extend northwards as far as Rau Shuswap River where they are succeeded by the rocks of the Castle Mountain series. At Grand Canyon, Devonian rocks outcrop and occur on both sides of the trough.

The Age of Faulting in the Rocky Mountain Trench

The faulting which occurs in the Rocky Mountain trench can be correlated with that period of tension which follows the period of compression in mountain building. It has the northwest-southeast trend and characteristics of the other normal fault valleys in the Rocky Mountains one of which, the Flathead valley, has been described in some detail by Daly[1] and Mackenzie.[2] The Flathead valley

[1] Daly, R. A., Geol. Surv., Can., Mem. 38, 1912, p. 87.

[2] Mackenzie, J. D., Geol. Surv., Can., Mem. 87, 1916, pp. 36 and 38.

occurs in southern Alberta at the 49th parallel and is situated along a line of faulting. Mackenzie's conclusions on the origin of the valley are as follows:

"The structure of the Flathead map-area may be succinctly described as that of a downfolded, warped, monoclinal fault block, with northeast strikes, and for the most part, southeast dips; bounded on the northeast and southwest by normal faults with a northwest strike, the upthrown sides being on the northeast, and southwest, respectively.

"The upthrown blocks form the limestone mountains in the southwestern part, and these just north of the map-area, and with their southwestward dipping strata partake of the structure of the Macdonald range to the west. Between these older rocks is a downthrown block of younger beds, which in the western portion of the district, lie with moderate dips diverging from a low north-south anticlinal axis, less pronounced toward the south, which is located a mile or so east of the western edge of the map-area.

"To the east of this axis for a short distance the strata lie in low, undulating, minor folds, then dip more sharply to the eastward, giving this fault block its essentially monoclinal character.

"Apart from the major breaks mentioned, faulting is not pronounced, and no other breaks have been certainly observed. It is probable, however, that strike faults of relatively small displacement will be found during the development of the coal seams, and may prove a factor of some consequence in mining operations.

"The structure of the Tertiary Kishinena formation is only imperfectly known. Dips up to 50° have been observed, also local unconformities, so that it is plain that those beds have been strongly deformed, and probably more than once. As all the dips are toward the east or southeast, a tilting in that direction is apparent. The inference seems clear that the beds were formed in part before the slipping along the great fault on the east of the Flathead valley was completed, and that slipping occurred during their period of accumulation. This interpretation places the date of the beginning of normal faulting as early Eocene, which is earlier than the Miocene date assigned to it by Willis.[1] The major part of the normal faulting may be assigned to a period immediately succeeding the Laramie revolution, as it occurred as soon as the compression of that organic disturbance ceased. Later, lesser slipping continued into the Eocene, and perhaps for a longer time."

[1] Bull. Geol. Soc., Am., vol. 13, 1902, p. 344.

It is rather unfortunate that the age of the Kishinena formation cannot be dated more closely. Mackenzie gives the following information: "Fossils collected by the writer have been determined by Dr. W. H. Dall, who reports finding 'Two species of *Planorbis*, crushed flat . . . . and the remains of a species of Physa. The shells are specifically indeterminable owing to their bad state of preservation, but the larger one recalls *Planorbis utahensis* White, and the smaller multispiral one *Planorbis cirratus* White, the former from the Bridger group, and the latter from the Green River beds of Wyoming. Only a guess is permissible, yet a probability of Eocene age is existent so far as I dare express an opinion.' "

Fossils collected by Daly[1] were examined by Dr. T. W. Stanton, who reported the collection to "consist entirely of freshwater shells belonging to the genera Sphaerium, Valvata (?) Physa, Planorbis, and Limnaea. Similar forms occur as early as Fort Union, now regarded as earliest Eocene, but there is nothing in the fossils themselves to prevent their reference to a much later horizon in the Tertiary, because they all belong to modern types that have persisted to the present day, though it should be stated that their nearest known relatives among the western fossil species are in the Eocene." From the above statements concerning the fossil evidence, the age of the Kishinena formation can only be stated as probably Eocene. Hence the normal faulting in the Flathead valley is probably Eocene in age, and since it is very probable that the normal faulting which succeeded the period of compression in the Rocky Mountains is of one general age, the faulting along the line of the Rocky Mountain trench is also of probable early Eocene age.

Finlay River Section

"The Finlay River section is much inferior to that afforded by the Omineca, as the direction of the river for long distances is parallel or nearly so to the strike of the rocks. No exposures occur along the lower part of the river. From its mouth up to the Omineca, the Finlay winds through a low alluvial plain without touching the bordering highlands or mountains. Above the mouth of the Omineca the banks increase in height, and where cut into by the stream, show glacial sands, gravels and clays, holding numerous scratched and polished boulders.

"A mile and a half below Fort Grahame, an exposure of hard grayish contorted limestone appears on the west bank of the river, underlying mica-schists and gneisses. The limestone strikes N.40°W., and dips to the west at an angle of 70° or over.

[1] Geol. Surv., Can., Mem. 38, 1912, p. 87.

"An examination was made of the mountains bordering the valley in the vicinity of Fort Grahame. The valley here has a width of about five miles, and is terraced on both sides of the river. The main terrace has a height above the stream of 175 feet. The other terraces, although plainly visible from a distance, could not be distinguished during the ascent, Water-worn pebbles were found up to a height of over 2,000 feet above the river.

"The rocks observed consisted of lustrous mica-schists, mica-gneisses, and hornblende-schists, bedded diorites, quartzites, and occasional bands of whitish crystalline limestone, all belonging to the Shuswap series.

"At the base of the mountains the rocks dip to the south-west at a high angle, but farther up the dip diminishes and at the summit the beds are nearly horizontal. The strike is approximately N.40°W., or parallel to the direction of the valley.

"The mountain west of the valley was ascended by Mr. Russell and is reported by him to consist of mica-schists, gneisses, and limestones, similar to those east of the valley, dipping at high angles.

"No glacial striæ or grooves were noticed on either slope, but the rocks in places appeared to have been smoothed and rounded by ice moving in a southeasterly direction. From Fort Grahame to the mouth of the Ingenica, a distance of about twenty miles, no exposures were noticed along the valley. The bordering mountain ranges, judging by the material brought down by numerous tributary streams, are built mainly of gneiss and mica-schists. The latter outcrops in a couple of places a short distance above the mouth of the Ingenica.

"Six miles above the mouth of the Ingenica, plant-bearing conglomerates and sandstones of Laramie age appear in the valley. These beds are similar in character to those in the Omineca, previously described. They appear to be confined entirely to the great valleys of the district and to be absent from the highlands, and if ever deposited on the latter, have been entirely swept away. They rest partly on an Archæan, and partly on a Palæozoic floor, and have participated to some extent in the later folding which has affected the region.

"The pebbles of the conglomerates seldom exceed half an inch in diameter and consist of rounded and sub-angular fragments derived from the disintegration of the schists, slates, and quartzites of the neighbourhood. Below Deserters' Cañon, a ridge of hard conglomerate and sandstone, through which the stream has cut a narrow gorge, crosses the valley. At the lower end of the cañon the walls are vertical in places, but farther up, the banks have weathered into a steep slope.

"Deserters' Cañon has the appearance of a recent channel, and probably owes its origin to an alteration in the course of the stream during the glacial period, as the easily eroded material of which its banks are formed could not have withstood the assaults of a large, swift stream heavily charged with sediment, such as the Finlay, for any lengthened period.

"The Tertiary conglomerates and associated rocks are replaced, a short distance east of the Deserters' Cañon, by the gneisses and the mica-schists of the Shuswap series, but extend in a westerly direction for four or five miles, or as far as the base of the mountain range bounding the valley in this direction.

"Above the Deserters' Cañon, the valley is bordered on the west by a conspicuous range of white mountains from 2,000 to 3,000 feet in height. On closer examination these proved to be composed of a fine-grained, whitish, compact limestone. This rock weathers in places to a light yellow or rusty colour, and occasionally is very siliceous. No fossils are found in it, but from its position relatively to the Shuswap series, it was referred to the Cambrian. The limestone is very much disturbed and probably lies along a line of faulting running with the valley.

"The schists and gneisses of the Shuswap series form the bordering mountain ranges on both sides of the Finlay below the mouth of the Ingenica, but above that point, while still continuing on the east, they recede toward the west, and are replaced by the limestones referred to above.

"From Deserters' Cañon to Paul's Branch, a distance of thirty miles in a straight line, the Finlay winds through the centre of its valley without touching the bordering mountain ranges. The valley in this stretch is floored throughout with Laramie conglomerates, sandstones, and shales, exposures of which occur at intervals all along. These rocks, here, are little indurated and occasionally hold small lignite seams. Fossil plants occur in many of the beds.

"Ten miles below Paul's Branch, banks of glacial deposits 225 feet high occur at the bends of the stream. The banks are sloping below, but are capped with steep bluffs above, consisting mostly of coarsely stratified gravels interbedded with bands of hard boulder-clay filled with scratched boulders. The boulder-clay bands often pass into gravels when traced along their outcrop.

"At Paul's Branch, the river approaches the mountains on the east, and an opportunity was afforded for a short trip inland. Paul's Branch enters the Finlay through a deep narrow cañon, cut through the hard rocks of the outer range. Farther back, its valley becomes enlarged, and the stream soon splits up into several tributaries which wind through the wide marsh-filled valleys separating the hills and ridges of the district.

"The eastern range, here, as elsewhere along the valley, consists of the limestones, gneisses, and schists of the Shuswap series. A band of hard compact limestone outcrops at the water's edge, while farther back, bands of mica-gneisses, lustrous mica-schists, hornblende schists, and occasionally quartzose schists, alternate across the range. These rocks all dip to the southwest at angles from 50° to 60°, and strike N.73°W.

"The Shuswap series has a width at Paul's Branch of two miles. It is succeeded towards the east by argillites, calc-schists, and limestones of Cambrian age, dipping in a southwest direction under the older rocks. The contact between the two formations is apparently a faulted one, the Shuswap series being thrust eastward over the younger formation.

"The ridges forming the central part of the Rocky Mountain range were not examined closely, but, judging from their appearance and from the wash of the streams flowing from them, they are evidently composed of massive limestones, similar to those found in a corresponding position in other parts of the range.

"From Paul's Branch to the Quadacha, a distance of ten miles, the Finlay follows the eastern bank of the valley, and occasional exposures of the schists of the Shuswap series occur. A short distance below the mouth of the Quadacha, Laramie conglomerates outcrop on the left bank.

"At the Quadacha, the Finlay bends to the west and soon after leaves the great valley which it has occupied from its mouth to this point. The valley continues northward, and is occupied, after the Finlay abandons it, by the Tochieca, a tributary.

PART II

Physiographic Development

The study of the physiographic development of the Rocky Mountain trench may be prefaced by a statement of certain physical facts concerning the present trench (Figure 2).

1. The size of the valley in most cases bears no relation to the size of the present streams which occupy it.

2. The divides in the trench have a uniform low elevation, Fraser-Peace-Fraser-Columbia (approx.) and the Columbia-Kootenay 2,650 feet.

3. The "Big Bends" in the Fraser and the Columbia are striking and abnormal features.

4. The Kootenay River enters the trench from the east as a large river cutting through the most westerly range of the Rocky Mountains in the vicinity of Upper Columbia Lake and flows southward. It has a gradient of 4.2 feet to the mile and flows in a wide flood-plain bounded by terraced banks.

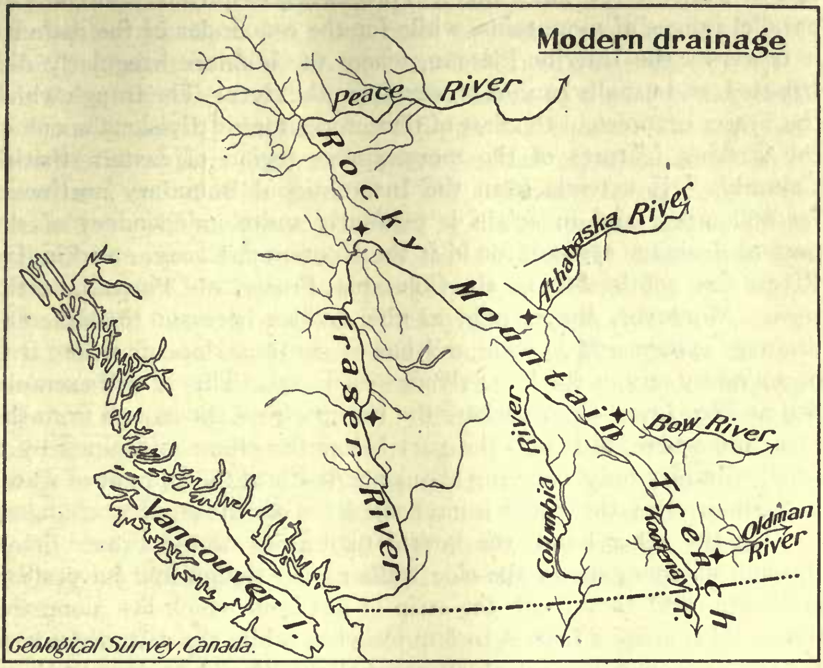


Figure 2

5. The Columbia River rising in Upper Columbia Lake (elevation 2,650), pursues a very meandering course northward as far as Golden (elevation 2,561) through swampy land containing many ox-bow lakes. The gradient in this section is 1.3 feet to the mile which is so small that erosion has not penetrated through the unconsolidated materials to bedrock. North of Golden and around the "Big Bend," the gradient is 19.3 feet to the mile and is sufficient to cause erosion to penetrate through the surface into bedrock producing a series of rapids at many points along the course of the river.

6. The Canoe River, a tributary of the Columbia from the north in the trench, has a gradient from the Fraser-Columbia divide (elevation 2,600 feet, approx.) to its junction with the Columbia (elevation 2,050) of 916 feet to the mile.

7. The McLennan River which flows northward to join the Fraser in the trench from the Fraser-Columbia divide has a gradient of 25 feet to the mile.

8. The Fraser River is described by Malloch[1] in the following words:

"Topographically, the portion of the Fraser valley examined falls into two main divisions. From Tête Jaune Cache down to the Grand Cañon—100 miles above Fort George—it runs between two parallel ranges of mountains, while for the remainder of the distance it traverses the Interior Plateau, where the hills are irregularly distributed, and usually cannot be seen from the river. The trough which the Fraser occupies in the first of these topographic divisions is one of the striking features of the mountainous region of eastern British Columbia. It extends from the International Boundary northwest for 800 miles, and in origin is evidently quite independent of the present drainage system; for in it the Kootenay, Canoe, and Findlay Rivers flow southeast, and the Columbia, Fraser, and Parsnip, northwest. Moreover, the trough, at the divides between the different drainage systems, is as wide and has as gentle a slope as where it is occupied by any of the large rivers mentioned. This is well exemplified at Tête Jaune Cache, where the Fraser enters the trough from the east, and where, although the part below the elbow is drained by a small tributary only, carrying about one-tenth of the amount of water in the main river, the trough is not contracted nor the gradient changed.

On the other hand, the lateral tributaries of the Fraser break through narrow gaps in the side walls of the trough and have steep gradients until they reach the strip of flat land which lies along the river. This strip is from 3 to 5 miles wide, while the distance across the trough from peak to peak averages about 10. The ranges flanking the trough are lower than the succeeding ones, and decrease in height from Tête Jaune Cache to their northern ends near the Grand Cañon. At the former place they rise 7,000 feet above the valley, while near the latter they are not much more than 4,000 feet above it. There is, however, a break in this general decrease in height. The range on the northeast side at a point opposite the mouth of Goat River, and the range on the southwest side at a point below the gap of Dome Creek, suddenly increase in elevation. From these points the ranges become lower, but the rate of decrease is much more rapid on the southwest side, so that the range there ends above the Grand Cañon; whereas the range on the other side extends to Toneyquah Creek. From the river a few glimpses were caught of a long range extending

[1] Malloch, G. S., Geol. Surv., Can., Sum. Rept., 1909, p. 123.

northwest from near the mouth of the Big Salmon River; this is, doubtless, the continuation of one of the walls of the trough beyond the wide break through which the Fraser escaped from it. The continuation of the trough in that direction is described by Mr. R. G. McConnell.[1]

The Fraser pursues a most tortuous course in the strip of flat land in the centre of the trough, swinging from side to side in broad, sweeping curves, and sometimes approaching within short distances of the enclosing ranges. In many cases very narrow necks are all that remain to separate a higher from a lower bend, and numerous "ox-bow" lakes along the course of the river bear witness to the frequency with which similar necks have been cut through in the past. The tortuous course of the river is due to the excessive load of sediment which it carries, and not to a low gradient. The sediments consist largely of flakes of mica and rock flour produced by the grinding of large glaciers on the micaceous schists and gneisses, of which the mountains are chiefly composed. Glaciers are comparatively rare on the side walls of the trough, but are common in the higher ranges on either side of them. The Fraser is not particularly turbid at Tête Jaune Cache, but several of its tributaries, especially Sand Creek and Rau Shuswap River, are heavily loaded with silts. The latter is the largest tributary the Fraser receives in this part of its course, and drains a high, mountainous country, in which many large glaciers were seen. On the other hand, many of the smaller tributaries are clear, except after heavy rains. Many of them do not head in glaciers, or else have lakes on their courses which act as catchment basins for sediment derived from glaciers.

As has been stated, the country through which the Fraser flows from the Grand Cañon to Fort George belongs to a second topographic type known as the Interior Plateau, and differs from the first in the absence of regular mountain ranges. It is characterized by extensive upland areas intersected by an irregular system of comparatively broad valleys. Numerous lakes occur both in the uplands and in the upper reaches of the valleys, and the streams are clear and become quite warm in summer.

9. The Fraser, Kickinghorse, and Elk Rivers which enter the trench from the Rocky Mountains to the east have very steep gradients. This is in marked contrast to the gradients of the Athabaska, Bow, and Oldman Rivers which flow eastwards from the Rocky Mountains to the Great Plains. This feature has been observed by all the early explorers who entered the Rocky Mountain trench.

---

[1] Geol. Surv., Can., Ann. Rept., vol. VII, 1894, pp. 18–19C.

10. The Peace River which rises on the eastern flank of the Coast range pursues an unbroken course across the Rocky Mountain trench and the Rocky Mountains.

Cretaceous History

In order to understand the present drainage system, it is necessary to trace the geological history of British Columbia from at least the close of the Jurassic period to the present.

The fundamental factor in this history is the delineation of the areas of erosion and sedimentation at the close of the Jurassic period.

The orogenic movements which took place at the close of the Jurassic period compressed the stratified rocks of the Jurassic and Carboniferous periods into folds trending northwest-southeast and permitted the intrusion of vast quantities of granitic material, over an area which roughly extended from the western edge of the Rocky Mountain trench, westwards to the Pacific Ocean whose shore may have been situated some distance west of Vancouver and the Queen Charlotte Islands. From the distribution of the Cretaceous sediments which occur in three main belts separated by highlands of pre-Mesozoic rocks, it can be seen that present distribution of the mountains of British Columbia (except the Rocky Mountains) was already outlined at the close of the Jurassic period. The western highland occupied the site of the Rocky Mountains. Separating these two main highlands was a less elevated tract or interior basin now occupied in great part by the Interior Plateaus. After the building of these Jurassic mountains they were subjected to erosion, the products of which may be seen in the Cretaceous rocks which occur along the Pacific coast on Vancouver and Queen Charlotte Islands, in the Interior Plateau region, and in the Great Plains and the Rocky Mountain region. The granite pebbles which occur in the Cretaceous formations in the three main regions mentioned above prove that the two main highland areas were subjected to erosion during the Cretaceous and that the granitic cores of these areas at that time were unroofed. It is probable that the drainage at this time would be towards the Cretaceous basins which occur on both sides of the two elevated highlands. Erosion during the whole of the Cretaceous reduced these highlands to a state of old age or peneplanation.[1] The products of this erosion of the eastern highland were carried by rivers and in part deposited in the great geosynclinal which occupied the site of the present Rocky Mountains and the Great Plains where they may be

[1] Schofield, S. J., Geol. Surv., Can., Mem. 76, 1915; Trans. Roy. Soc. Can., vol. 13, 1919, p. 23.

seen at present. It is evident from a study of the modern drainage system that the east-flowing Cretaceous rivers of the eastern highland, eroded headwards until before the close of the Cretaceous they had penetrated through the ancient highland and were draining the interior basin. Much rearrangement of the drainage would take place at this time but at present nothing is known concerning it. It is probable that the ancestral rivers of the modern Liard and Peace were present in Cretaceous times, as well as the ancestors of those streams which flowed eastward through the Yellowhead, Kicking-horse, and Crowsnest Passes, but have since disappeared for the most part. The Columbia, Kootenay, and Okanagan Rivers in southern British Columbia as well as the Fraser River have an ancestry in the Cretaceous epoch although they have passed through many changes during the successive periods. A rough idea of the distribution of these Cretaceous rivers is given in Figure 3.

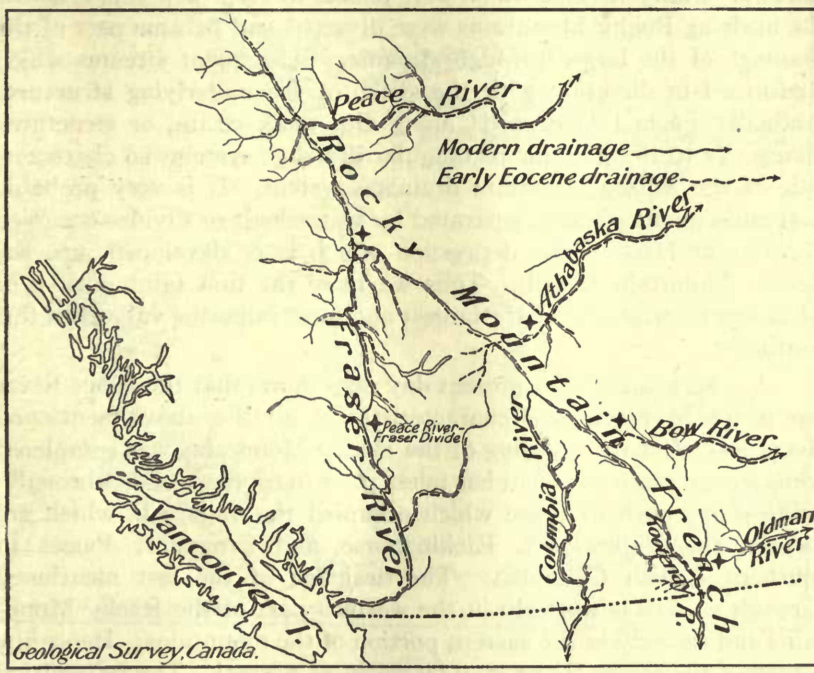


Figure 3

At the close of the Cretaceous, as mentioned above, the two main highlands as well as the Interior Plateaus were in a state of old age or peneplanation which was characterized by a rolling landscape over which the rivers meandered sluggishly. At the close of the Cretaceous, the Rocky Mountains which now border the eastern edge of the ancient highland were slowly raised. The western portion of the Rocky Mountains is characterized by open folds while the eastern portion has a structure in which overthrust faulting is the predominant feature. At the same time the two ancient highlands as well as the Interior Plateaus suffered an uplift in which folding and faulting played a minor role. This uplift rejuvenated the Cretaceous streams and they began to entrench themselves in the uplifted land mass. With the increased velocity and with the material derived from the accelerated erosion the main streams were able to keep their course across the uprising Rocky Mountains thus forming the great "through" valleys which traverse the Rocky Mountains from west to east at right angles to the structure. Such valleys are the Peace, and the valleys occupied by the Grand Trunk Pacific, the main line of the Canadian Pacific Railway and the Crowsnest branch line of the same railway. Many streams which were unable to keep their course across the uprising Rocky Mountains were diverted and became part of the drainage of the larger through streams. Subsequent streams which conformed in direction with the strike of the underlying structures gradually pushed headwards along the weak strata, or structures giving rise to the peculiar rectangular drainage systems so characteristic of the Rocky Mountain drainage system. It is very probable that subsequent streams separated by watersheds or divides occupied portions at least of the depression which later developed into the Rocky Mountain trench. Thus we have the first faint outline of what was to prove one of the largest and most imposing valleys on this continent.

An examination of a present day map shows that the Peace River has a course which was characteristic of all the above-mentioned rivers just after the building of the Rocky Mountains was completed while a great rearrangement has taken place in courses of the "through" going rivers such as those which occupied the valleys in which are located the Yellowhead, Kickinghorse, and Crowsnest Passes in southern British Columbia. The drainage of the last mentioned through valleys is westerly in the western part of the Rocky Mountains and easterly in the eastern portion of the mountains. Hence the course of the Peace River may be taken as normal. The recognition of this fact gives us a point of departure from which may be attempted a discussion of the origin of the peculiar characters of the abnormal courses pursued by the other rivers.

The Eocene History

The normal faulting which occurred in the Rocky Mountain trench as stated in a previous chapter, took place probably in Eocene. This faulting produced not only a depression along the line of the trench from the neighbourhood of the Big Bend of the Fraser southwards to the International Boundary at the 49th parallel, but also a zone of shearing which would also be a zone of weakness along which rivers would tend to erode rapidly. The Fraser, Yellowhead, Bow, and Crowsnest Rivers which crossed the trench previous to the faulting would have their courses interrupted by the depression caused by the faulting, and their waters turned into the trench. That the drainage of the trench was evidently southwards is supported by the following (Figure 4):

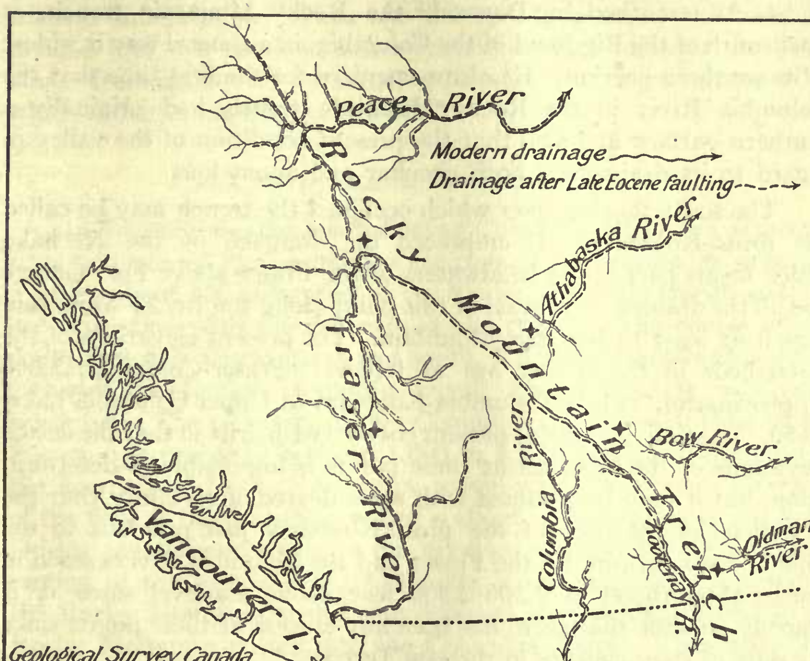


Figure 4

1. The Spillimacheen River, a tributary of the Columbia, rises about 12 miles south of the main line of the Canadian Pacific Railway on the west side of the trench and flows southwards for 30 or 40 miles in a valley almost parallel to the Columbia River which flows northwards.

2. Upper Columbia Lake, the source of the Columbia River, stands several feet higher than the south-flowing Kootenay River and is only prevented from draining into the Kootenay by a deposit of gravel and sand. Some years ago a canal was constructed joining this lake with the Kootenay River.

3. "The Columbia River above the Surprise Rapids, which here receives a stream of considerable size from the east, forms a narrow lake-like expansion. In this part of its course there is only a comparatively low wooded ridge separating the Columbia from a wider valley to the northeast, which is occupied by a tributary flowing in the opposite direction and joining the Columbia just below Donald. This is perhaps another hint that the Upper Columbia once flowed southeast, before it had dug its way through the walls of slate above Beaver." [1]

4. As remarked by Dawson,[2] the Rocky Mountain trench, at least south of the Big Bend of the Columbia, in a general way is widest in its southern portion. He also recognized for the first time that the Columbia River in the Rocky Mountain trench had originally a southern outflow and also that the present condition of the valley in regard to its drainage is both peculiar and anomalous.

The south-flowing river which occupied the trench may be called the proto-Kootenay. It embraced the drainage of the Nechako which forms part of the headwaters of the Fraser above Fort George and all the drainage southeast of this point along the Rocky Mountain trench at least to Jennings Mountain. The present elevations of the watersheds in the trench are as follows:—Fraser-Columbia, 2,600 (approximate), and the Columbia-Kootenay at Upper Columbia Lake, 2,650. These divides are at present covered with drift so that the actual elevations of the bed-rock at these points is impossible of determination, but it may be assumed with some degree of certainty that the elevations of the floor of the proto-Kootenay just previous to the time of river capture by the Fraser and the Columbia Rivers stood in the neighbourhood of 2,500–2,600 feet above sea-level since it is scarcely possible that there has been any erosion at these points since the date of river capture in the late Tertiary.

The diversion of the drainage into the trench caused small streams to flow towards the trench from the "through valleys" mentioned above and by headward erosion during the later Tertiary times pushed the watersheds eastward along these valleys. Thus the

[1] Coleman, A. P., Trans. Roy. Soc., Can., vol. VII, 1889, p. 99.

[2] Dawson, G. M., Geol. Surv., Can., Ann. Rept., vol. I, 1885, p. 290.
Dawson, G. M., Trans. Roy. Soc., Can., vol. 8, 1889, sec. IV, p. 12.

present streams such as the Fraser, Kickinghorse, and Elk Rivers were formed. These rivers flow westwards into the trench with very steep gradients in contrast to the gradients of the Athabaska, Bow, and the Oldman Rivers which flow eastwards in the old "through valleys" as small remnants of the large rivers which occupied these valleys in Eocene times before the faulting occurred along the Rocky Mountain trench. These events caused the continental divide to shift its position from west of the Rocky Mountains to its present position east of the trench and gave rise to the formation of the Yellowhead, Kickinghorse, and Crowsnest "passes."

The faulting did not extend to any distance north of the "Big Bend" of the Fraser. McConnell[1] in his examination of the Finlay River section did not find any evidence of faulting. This explains the fact that the Peace River crosses the Rocky Mountain trench without interruption. Thus the Rocky Mountain trench may be divided into two portions, a northern one which includes the Peace River drainage due to normal river erosion, and a southern portion which is due to faulting, primarily.

The Post-Eocene History (Figure 5)

In Eocene times the south-flowing Columbia River, a Cretaceous river rejuvenated by the uplift at the close of the Cretaceous, occupied a valley about 100 miles west of the Rocky Mountain trench and had no connection with the drainage of the trench. The course of this river, since it is almost north and south, if projected headwards would intersect the Rocky Mountain trench whose trend is northwest-southeast. The elevation of this Columbia valley at the close of the Eocene was probably between 1,000 to 1,500 feet below the level of the floor of the Rocky Mountain trench since the present elevation of the floor of the Columbia valley is about 1,000 feet above sea-level. During post-Eocene times, in the Miocene or Pliocene, the headward erosion of the south-flowing Columbia River eventually intersected the Rocky Mountain trench and diverted part of the waters of the Rocky Mountain trench into the Columbia River. Thus the "Big Bend" of the Columbia was formed. Subsequent headward erosion southwards along the trench produced the rapids and falls which occur as far south as Donald and the cañon in the Beaver River on the west side of the trench as it approaches the Rocky Mountain trench.

The history of the Fraser River and the origin of the "Big Bend" of the Fraser is difficult to decipher since the information concerning

[1] McConnell, R. G., Geol. Surv., Can., Ann. Rept., 1894, vol. VII.

this portion of the trench is not as full as that concerning the southern part of the trench. The Nechako River and a portion of the Fraser River north of a point in the vicinity of Soda Creek in late Cretaceous times is believed to have drained northwards by way of the present Crooked River into the Peace. This is indicated by the abnormal northwesterly direction of the tributaries of the Fraser River from Soda Creek northwards to the Big Bend of the Fraser.

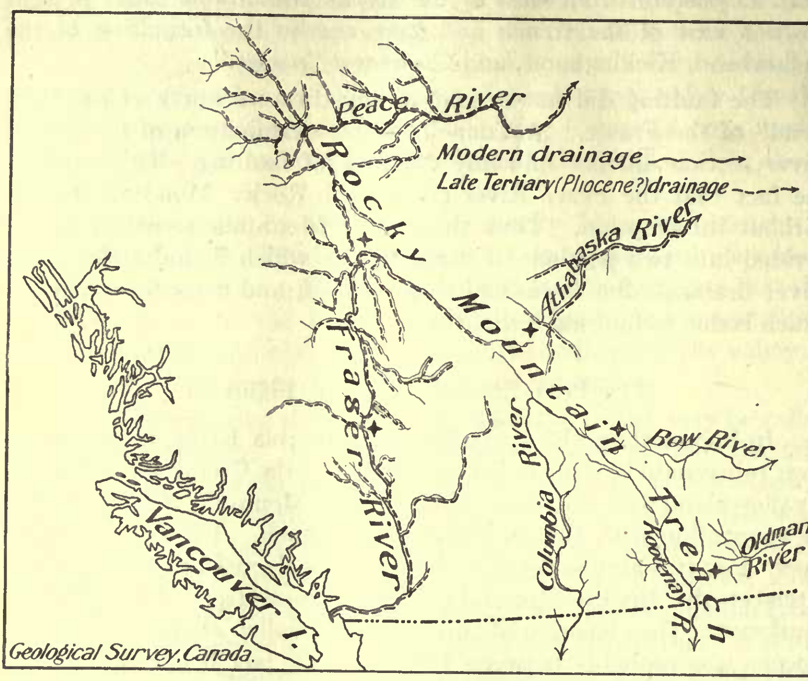


Figure 5

These tributaries almost without exception flow in an upstream direction as regards the Fraser River, which is contrary to the normal or downstrean direction of the tributaries in a normal drainage system. The tributaries of the Fraser south of Soda Creek all enter the Fraser in the normal way. From these facts it is concluded that in late Cretaceous times a divide existed south of Soda Creek between the drainage of the south-flowing Fraser and the north-flowing river which formed part of the drainage system of the Peace River. That the Fraser River was present in Cretaceous and early Tertiary times is shown by the presence of Cretaceous and early Tertiary sediments in the Fraser valley in the lower part of its course near Vancouver. A graphical illustration of the above description is shown in Figure 3.

The post-Eocene faulting caused an interruption of the drainage in the vicinity of the Big Bend so that the north-flowing portion of the Fraser as well as that of the Nechako, both of which flowed into the Peace, were diverted into the Rocky Mountain trench to become part of the proto-Kootenay River. Subsequently in the late Tertiary, the south-flowing portion of the Fraser eroded headwards and captured the above-mentioned portion of the proto-Kootenay, thus forming the "Big Bend" of the Fraser.

Pleistocene and Recent History

The history of the Pleistocene and recent drainage of British Columbia has been recorded so well by Dawson that reference to these periods will not be undertaken. The reader is referred to Dawson's paper read before this Society in 1889: "On the later physiographical geology of the Rocky Mountain region in Canada with special reference to changes in elevation and history of the Glacial Period."

Transactions of The Royal Society of Canada
SECTION V.

SERIES III | MAY, 1920 | VOL. XIV

PRESIDENTIAL ADDRESS

Plant Pathology: Its Status and its Outlook

By J. H. FAULL, B.A., Ph.D., F.R.S.C.

(Read May Meeting, 1920)

Plant pathology is one of the youngest of the biological sciences, a botanical development of the last fifty years, but especially of the last quarter of a century. It came into being about the same time as the science of bacteriology, but because of its less obvious relationship to the preservation of human life, fewer workers were attracted to it, and its advance was at first very slow. Within recent years, however, it has gained enormous momentum, and to-day a larger number of botanists are devoted to the study of plant diseases and the means of coping with them than to any other single phase of plant life. This quickening has been especially marked in America, where a generation back the recognized plant pathologists could have been counted on the fingers of one hand. Twenty years ago they were beginning to make themselves heard; in 1908 they were strong enough to organize a society devoted to plant pathology with an enrolment of 130 charter members; by 1918 the membership of the American Phytopathological Society had more than tripled and included 45 per cent of the botanists of the United States and Canada.

The reason for the late development of plant pathology is not far to seek. Certainly it has not been because the ravages of plants by disease had not been observed, for frequent references to blights and mildews and rusts are to be found in the Hebrew, the Greek, the Latin and other early literatures as well as in the more modern. The fact is that up to the middle of the last century science was incapable of solving phytopathological problems; no progress had been made in understanding the causes of plant diseases or in devising satisfactory means of control. The foremost scientists regarded them as consequent upon unfavorable weather conditions, and the superstitious considered them to be visitations of supernatural origin. The possibility that fungi or bacteria might in some cases be responsible for plant maladies was occasionally suggested, but without sufficient demonstration to serve as the basis of a working hypothesis. It is true the fructifications of fungi were often seen on the surfaces of diseased plants, but they were thought to be excretions or transformations of the sap of the host plants, for no one had as yet distinguished bacteria or fungal hyphæ in diseased tissues—something not to be wondered at when it is remembered that the cell theory itself was not proposed before 1838. Evidently as long as it was not possible to differentiate the general causes of disease in plants a beginning in plant pathology was out of the question.

In tracing the early history of a science it is rarely, if ever, possible to designate any one man or any single event as the starting point; in fact many men and many events in greater or in less degree, more or less independently have shared in the inauguration of every science. So it has been with the science under discussion. Yet there is one name in the early history of plant pathology that stands out above all others as that of a fertile investigator of fundamental principles and as a marvellously fructifying influence whose potency is still felt. I refer to the botanist DeBary. DeBary brought new methods to bear on his subject; his point of view was new. His methods were developmental rather than anatomical; for with the aid of pure cultures wherever possible, following the practices of Pasteur, he traced the life histories of the parasites under investigation step by step from spore to spore, observing closely at the same time their relationship to and effects on their hosts. The result was that his researches made possible for the first time the distinction between biotic and abiotic causes of disease in plants; they demonstrated for the first time the existence of parasitism among fungi; they revealed the way in which infection takes place, and explained the phenomena of epidemics. Such of his papers as those on smuts (1853), the potato blight, its cause and its prevention (1861), and the heteroecism of wheat rust (1863) opened up new lines of inquiry that were epoch making. But even more important still he imparted to his own students and to botanical students the world over a burning enthusiasm that still persists, and which more than any other influence has been responsible for the laying of those solid foundations of scientific fact and method on which the science of plant pathology rests.

With DeBary's name, however, we should couple that of Millardet, for it was Millardet perhaps more than anyone else who first turned to practical account the new discoveries on parasitism. DeBary showed how to work out the etiology of a plant disease, Millardet showed how to control it. This he did especially in the use of Bordeaux mixture, a spray of his own compounding (1882). Millardet, who had received some of his earlier training in DeBary's laboratory, was commissioned by the French government to investigate two newly imported diseases of the grape, native to America, which were rapidly devastating the vineyards of France and causing widespread ruin, phylloxera and mildew. He solved the phylloxera problem by introducing the resistant American stocks on which the wine-producing European vines were grafted—a notable phytopathological achievement in itself. He solved the mildew problem through the use of a spray of copper sulphate and lime. Millardet saved the vineyards of France. Bordeaux mixture at once attracted general attention, for it was a means in the hands of the plant pathologist of preventing not only grape mildew but also many others of the commonest and most destructive plant diseases. But plant pathology is under a still deeper obligation to Bordeaux mixture, for its use has compelled the public to recognize the value of prophylactic methods and in return has secured to the science such a measure of monetary support as to assure its development.

The accomplishments of DeBary and of Millardet typify as it were the characteristics of the two interdependent stories of the phytopathological edifice. The one type of research lays the groundwork in determining the nature and the causes of a disease, the other builds thereon an inquiry into the means of coping with the disease. The work of these two men represents in a word the content and the spirit of plant pathology.

My reference to the public support given to plant pathology is of more than passing interest and should be emphasized. Strange as it may seem, plant pathology is mainly a government-nurtured science, and in my judgment governmental support should be ranked along with the contributions of DeBary and Millardet in an appraisement of the three most important factors in the development of phytopathology. Every progressive government in every land that fosters agriculture and forestry has from the first drafted plant pathology into its service. One of the most significant features in this connection is the fact that there has been universal recognition of the pre-eminent place of research in the profession of plant pathology. The call continuously has been for research men in this field. This general insistence on research denotes two things, first that the science has justified its past, and second that governments recognize the fact that there are still worth-while problems to be solved. This recognition of and provision for research has been of inestimable importance from every point of view. To the country it has meant a fruitful focussing of constant attention by skilled scientists on its plant industrial problems; to the plant pathologist it has meant, theoretically at least, equipment and time for investigation practically free from the distractions of teaching, extension work or office routine; to the science it has meant a constant stream of invigorating discoveries that account in the main for the virility and enthusiasm of its promoters. Reflexly it has also meant that the plant pathologist has come to his work only after many years of careful preparation.

Looking now to the future of government work in plant pathology so generally satisfactory in the past, it may be well at this point to call attention to a situation that is comparatively new. The manufacturing and the commercial interests are at last alive to the value of productive research and in consequence there is a competition for capable investigators such as did not exist a few years ago. If, therefore, governments are to maintain a highly efficient research science it will be absolutely necessary to tangibly recognize ability in research and to weed out or allot suitable tasks to those who do not show capacity in that direction.

Passing now to the briefest survey of the achievements of plant pathology you will agree with me that the strongest testimony to the substantial benefits that have accrued from fifty years of research in this science is the universal adoption by producers of the methods of control that have been worked out by phytopathologists. Whetzel and Hessler speaking for the farmers and fruit growers remark in the preface to their Manual on Fruit Diseases, "As evidence that the practising agriculturists are rapidly becoming acquainted with the value of scientific knowledge regarding diseases of plants, it is only necessary to point to their interest and co-operation in the matter of obtaining accurate information under field conditions. The prejudiced and critical attitude of the grower is now for the most part of no consequence. Little self-protection is now needed by the experimental plant pathologist; the grower's attitude is no longer antagonistic, but he is friendly and, what is more encouraging, he seeks with confidence the advice of the phytopathologist." Obviously it would be out of the question here to recount all of the achievements of plant pathology; my purpose will be served by reviewing three examples, one from each of three different types of plant industry.

Referring first to truck crops, there is no more striking example in the entire history of phytopathology of the beneficent results issuing from the scientific study of plant diseases than the conquest of the late potato blight. Here was a disease that swept again and again like a plague over potato-growing countries. In 1846, for example, it so completely destroyed the potato crop in Ireland, on which the majority of the 8,000,000 inhabitants of that country absolutely depended, that 200,000 to 300,000 died of starvation, more than 1,200,000 of the survivors emigrated—mainly to the United States—initiating an exodus that has cut the population of Ireland in half. DeBary determined the cause of the blight, control measures have been discovered, and to-day, though known everywhere, and as virulent as formerly, it no longer carries with it the terror or the menace of famine.

Or citing a case from cereal diseases—thirty years ago the growers of wheat and oats not infrquently suffered losses running up to 50 per cent or more of their crops through the attacks of certain grain smuts. Brefeld after many years of patient investigation determined the habits of these fungi. Means of control have been worked out, at first clumsy, but now so efficient that with little trouble and at trifling cost the seed grain can be so treated as to almost guarantee immunity from these pests. In Canada alone the grain producers have it in their power to save millions of dollars every year.

To cite a third example pertaining to the fruit-growing industries—prior to 1885 fruit growers could but helplessly look on when their crops were devastated by mildews and decays, the meaning of which they little understood and for the prevention of which no one could give them advice. Take the grape industry as an illustration. I have already referred to the plagues of mildew and phylloxera that all but devastated the vineyards of France, threatening social as well as financial ruin, and to the way in which Millardet saved the situation. It may be a surprise to some to learn that in America, according to Whetzel and Hessler, efforts to grow this fruit on a commercial scale were "almost without exception unsuccessful" up to 1887, at which time American pathologists for the first seriously turned their attention to the study of grape diseases. Most of you are familiar with the fact that the early colonists on the Atlantic seaboard, deceived by the profusion and luxuriance of wild grapes, essayed repeatedly to establish the culture of grapes in America, but invariably without success. Groups of colonists even came to America for the express purpose of practising viticulture, but their experiments always ended in disaster. While the experiences in apple, peach and other fruit cultures have not been so uniformly unfortunate, yet they, too, include numerous chapters of failure. To-day, in consequence of the researches of a corps of pathologists extending over many years, it is estimated that 75 per cent of the millions of dollars of annual losses from fruit diseases can be avoided by spraying alone, not to speak of other control measures applicable to diseases not amenable to sprays. Indeed, it is safe to say, that it is now possible in every region in which soil and climate are suited to produce any kind of fruit abundantly if scientific methods are adopted.

These three examples of successfully solved phytopathological problems chosen from different departments of plant industry must suffice; they could be multiplied many tmes, for I know of no crop of cereals, textiles, fruits, vegetables or fodders of any kind outside the tropics, or of any of the more frequent decorative plants to the diseases of which some attention has not been given by phytopathol-gists and for the control of some of which in nearly every instance some measures have not been devised.

Summarizing, I would say that the status of plant pathology is measured by an ardent spirit of research, and an inspiring array of beneficial achievements.

What now can be said of its outlook? A clearer conception of the nature of the immediate tasks of plant pathology will be gained by an analysis first of data on current losses from plant diseases.

Estimated Reduction in Yield of Staple Crops Due to Diseases in the United States in 1917*

Crop	Production (bushels)	Disease	Losses Percentage	Bushels
Wheat.......	650,828,000	Bunt............	3·06	21,971,000
		Loose smut.......	1·65	11,809,000
		Stem and leaf rusts	2·32	16,561,000
		Scab............	1.48	10,578,000
		Other diseases.....	·50	3,575,000
			9·01	64,440,000
Rye..........	60,145,000	Ergot...........	1·77	1,115,000
		Smut............	·75	471,000
		Rusts............	·75	471,000
		Other diseases.....	1·00	628,000
			4·27	2,685,000
Barley.......	208,975,000	Smuts............	3·34	7,385,000
		Other diseases.....	2·20	4,867,000
			5·54	12,252,000
Oats.........	1,587,286,000	Smuts...........	5·26	91,655,000
		Rusts............	1·58	27,493,000
		Other diseases.....	2·00	34,825,000
			8·84	153,973,000

* The Plant Disease Bulletin, Suppl. 6; Aug. 1, 1919. Bureau of Plant Industry, U.S. Dept. of Agr.

Crop	Production (Bushels)	Disease	Losses Percentage	Bushels
Corn.........	3,159,494,000	Smut...........	3·26	108,647,000
		Other diseases.....	2·00	66,697,000
			5·26	175,344,000
Potato.......	442,536,000	Late blight........	4·39	24,609,000
		Fusarium wilt......	4·54	25,401,000
		Other diseases.....	12·00	67,164,000
			20·93	117,174,000
Bean.........	18,129,000	Anthracnose.......	1·76	364,000
		Blight...........	2·48	511,000
		Other diseases.....	8·	1,653,000
			12·24	2,528,000
Sweet Potato.	87,141,000	Stem rot..........	1·47	1,890,000
		Black rot.........	4·36	5,616,000
		Storage rots.......	24·60	31,717,000
		Other diseases.....	1·93	2,484,000
			32·37	41,707,000
				Bales
Cotton.......	10,949,000 (bales)	Wilt.............	2·33	299,000
		Anthracnose......	2·84	364,000
		Root knot.........	2·07	265,000
		Other diseases.....	7·32	938,000
			14·56	1,866,000
				Tons
Sugar Beet...	6,237,100 (tons)	Nematode.........	4·72	332,804
		Other diseases.....	6·85	483,391
			11·57	816,195
				(Bushels)
Peach........	45,066,000 (bushels)	Brown rot.........	6·27	3,731,000
		Leaf curl.........	7·12	4,240,000
		Other diseases.....	10·9	6,488,000
			24·29	14,459,000
Apple (1918) .	173,632,000		9·9	19,273,000

1918—Smut losses:

Wheat— 25,500,000 bushels
Oats— 110,000,000 bushels
Barley— 6,000,000 bushels

"It should be pointed out that last year (1917) was not an especially serious one as far as diseases were concerned. No serious epidemics were experienced such as it sometimes the case. The loss from black stem rust of wheat in 1917 was small compared with the loss in 1916 when about 200,000,000 bushels of wheat were destroyed. The damage caused by late blight of potatoes in 1917 was nearly 25,000,000 bushels but in some years the disease has been known to take many times that amount of the crop."

(1) Historically the first problems of plant pathology solved were those of parasitism; a host of them still confront us, not the least of which is the nature of parasitism itself. They consist of the life histories of parasitic fungi and bacteria, their origin, extent of their virulence, the effect of environmental factors upon their capacities for infection, the susceptibilities of their hosts to infection, the factors that determine immunity and susceptibility, etc. It is true that an enormous amount of excellent work in this field has been accomplished by DeBary and the many botanists who have succeeded him; no other part of plant pathology has been so well worked over. But few realize the vast extent of the ground to be covered. The economic plants are of so many different species, and while some parasites extend their attacks to various host species, that is not generally the case. Moreover, each host species is subject to many different kinds of diseases. Consulting Whetzel and Hesler's Manual of Fruit Diseases, written primarily not for the student but for the growers, I find 32 diseases for the apple described, 19 for the peach and 11 for the grape; and in Rankin's Manual of Tree Diseases of the same series, 13 for the maple, 19 for the oak and 23 for the pine, not including damping off and various other seedling diseases. While these are the commoner diseases and the ones that merit closest attention there are many others of which the expert should have some knowledge, for while they may be obscure, apparently unimportant, or restricted to other lands some of them are endowed with the potentialities of virulent parasitism given right conditions. Including saprophytes upwards of 55 kinds of fungi are listed as growing on wheat, 335 on the grape, 100 on the potato and 250 on the apple. Because of the unlimited scope of the subject the plant pathologist unless content to remain a mere cataloguer is perforce compelled to become a specialist either on some limited choice of parasites or on the diseases of a limited number of hosts; thus we have the Fusarium specialist, the rust specialist, even the *Puccinia graminis* specialist on the one hand, and the specialist on fruit diseases, on cotton diseases, on potato diseases, etc., on the other. Both kinds are necessary. The life histories of some fungus parasites

are so intricate, their range of hosts so extensive, or their taxonomic relations so complicated that intensive studies on them are indispensable. Conversely much is to be said for host specialization, for after all unless the normal structure of a host, its physiology and ecological relationship are intimately known, progress in a knowledge of its abnormal physiology remains uncertain.

In dealing with life histories it is pertinent to point out that in spite of all that has been learned of the more important parasites there is scarcely one the life history of which is known in complete detail, and very often the gaps in our knowledge are the very ones to be filled in before most effective control measures can be applied. Thus we are still puzzling over the ways in which the stem rust of wheat may be carried over from one season to the next, exact information on which is essential in the campaign against that most destructive species of the cereal fungi. We are still uncertain as to the exact conditions under which apple scab infection takes place, a feature that is directly related to spraying operations. We are still confronted with the unsolved problems of biological strains or species. That this phenomenon exists in certain rusts and powdery mildews has been absolutely demonstrated, but a beginning only has been made and many important fungi in which this phenomenon probably occurs have yet to be scrutinized from this angle. Here are problems of vital significance in breeding for resistance, since experience seems to show that resistance is to be spoken of in terms of the relation of the host to biological strains and not to morphological species. These examples will suffice to show that investigators may turn again to the best and longest known parasites in the expectation of uncovering new facts of value; they, too, have the advantage of new points of view and an improved modern technique.

(2) But a complete knowledge of the parasite is only one step in understanding the phenomenon of parasitology. Experience teaches us that the factors of the environment are to be considered along with the parasite among the conditions that are responsible for disease. Some pathologists even give the place of first importance to environmental factors such as temperature, moisture and soil content, and they are probably right in the case of many diseases. It is a well known fact that where these factors are more or less controllable, as in commercial greenhouses, attention to heating, watering and lighting is all that is necessary to avoid losses from such pests as gray mold of lettuce, geraniums, etc., or the sooty mold of tomatoes. That climatic and soil conditions, singly or combined, regulate epidemics or the prevalence of diseases seems to be true beyond question. It is stated

that the commoner fruit tree diseases of the east are rare in California, that on the contrary certain soil diseases, crown gall, and gummosis are frequent there; that the late blight of potatoes is especially prevalent in Nova Scotia, but gradually becomes less frequent to the south; that cabbage yellows develops very rapidly in dry, hot weather following transplanting, while the black rot of cabbage flourishes in damp, cool weather; that the sooty mold of tomatoes is frequently abundant on outdoor tomatoes in the southern States, while it is found in greenhouses only in the north; that the stinking smut of wheat is propagated by soil borne spores west of the Rocky Mountains, but only by seed borne spores east of the Rockies; that clover dodder has repeatedly found its way in foreign seed into Ontario, has grown for one season and then died out. In short, environmental factors probably play a very important part, if not a predominent one, in nearly all parasitic diseases. The interesting part about it is that in some diseases the greater effect appears to be on the susceptibilities of the host, in others they act more strongly on the parasite—its capacities for germination, infection and growth. The fact of the matter is that there is a complexity of relations peculiar to each disease, and that up to the present in few instances only have these relations been analyzed separately and in detail. Yet the solution of these problems would often be of the greatest practical value, directly influencing prophylaxis. The lack of knowledge of this type is strikingly shown in the inability of pathologists to forecast with reasonable certainty the probable course of introduced fungi. Take for example the blister rust of white pine, which is highly destructive in parts of Europe. In spite of the fact that it has been known now for a generation it is still impossible to say whether or not the conditions in the white pine areas of North America are favorable to its becoming a devastating plague. We must wait for an answer now by actual testing out in experiment plots, meanwhile permitting it to roam at large to do its worst; there are obvious disabilities attendant on such a means of discovery.

So far I have been referring to environmental factors with reference to growing crops, but they also continue to operate on their products up to the time of their actual utilization by the consumer and throughout this latter period they should be largely controllable. It has been stated by Adams in his book on Marketing Perishable Farm Products that "at least 25 per cent of the perishables sent to wholesale markets is hauled to the dump pile"; and another authority is responsible for the statement before the International Apple Shippers Association that "frequently one-half or more of a perishable crop is lost by careless handling." A large part of the losses that accrue between the grower and the consumer result from decay due to molds or other fungi. For instance it is estimated that 10 per cent of the apple crop and one-half of the sweet potato crop are lost after harvesting, chiefly from fungous diseases—a matter of direct concern to producers, railroad and express companies and handlers, not to mention consumers, who in the end must pay the piper. Attention has been given to this subject by plant pathologists and control measures would, if applied, effect the saving of a considerable part of this deplorable waste. But many problems, not the least of which is Education, are still unsolved.

(3) Turning from the parasitic diseases we find another group of diseases of unknown origin to which the name "physiological" or non-parasitic is applied. Not only are some of these diseases prevalent and highly destructive but they present some of the most attractive problems in the whole field of plant pathology. I need but refer to the so-called mosaic diseases of tobacco, potatoes, beans, etc., spike disease of sandal, leaf roll of potatoes and yellows of peach and raspberries. The solution of the problems of etiology and of environment in this group call for the most refined methods employed in studies on parasitology, and special training in physiology and bio-chemistry. That there is hope of the formulation of successful preventive measures has apparently been fully demonstrated by the Canadian Department of Agriculture judging from the satisfactory results of investigations on moasic and leaf roll of potatoes. The following tables illustrate the ecomomic importance of these two diseases in Canada:*

Mosaic of Potatoes

The following experimental data show losses from mosaic of potatoes (as reported from various districts in Canada).

Variety	Diseased yield per acre Bushels	Healthy yield per acre Bushels	Per cent loss	Average per cent loss	Reported by
Bliss Triumph	113·4	294·3	61·5	50·7	E. J. Wortley
Green Mt.	138	500	72·4		G. C. Cunningham
Green Mt.	116	200	42		Paul Murphy
Bliss Triumph	160·7	220	27		E. J. Wortley

These figures are quite in accord with what appeared to be the common opinion, viz., that mosaiced plants give on the average only about half the yield of healthy ones.

* Emergency Board—American Plant Pathologists. Report of the Conference on Diseases of Potatoes and Seed Certification, Buffalo, Aug. 16-17, 1918.

Leaf Roll of Potatoes

The amount of loss from leaf roll is indicated in the following table. It may be taken as a general rule that the reduction in yield is about 65 per cent, although it may greatly exceed this.

Variety	Diseased yield per acre Bushels	Healthy yield per acre Bushels	Per cent loss	Average per cent loss	Reported by
Chile Garnet..	63	198	68·1	69·1	E. J. Wortley
Average of 3 yrs. with mixed varieties......	58	200	70·1		Paul Murphy

(4) Before passing on to the problems of prevention I cannot refrain from making brief reference to forest pathology, a branch of pathology replete with problems, few of which have even been approached in America. The life histories of many timber diseases have not yet been worked out, almost nothing is known of their ecological relations, there are few data on their distribution or the extent of their destructiveness and little done towards making practical application of the knowledge we have in hand. That the losses from native fungous diseases alone in the forests are enormous is beyond question, aside altogether from the striking devastations wrought by such introduced plagues as the chestnut blight. Heart rots and root rots in particular, the most important without exception of all timber enemies in this part of America, are widely prevalent; and in some of the forested areas of Canada at the present time it is reasonably certain that the annual increment is more than offset by the inroads of these fungous diseases. Moreover, they bear a direct relationship to forest fires in that the vast amount of highly combustible debris on the floor of the forest consists of the remains of trees that have fallen a prey to disease. The time is fast approaching when real forestry will have to be practised in America, and when that time comes, the health of the forest will be the central consideration. Meanwhile pathological surveys of our forest resources and intensive investigations on the more serious forest diseases will be a wise preparation.

(5) Turning to problems of disease control it is scarcely necessary to repeat that herein lies the heart of the entire subject. Nor is it necessary to further point out the established economic success of the science. Its applications are indispensable and there is no more likelihood of their abandonment by the practices of agriculture and

other plant industries than there is of the abandonment of antiseptics in the practice of surgery. The use of thoroughly tested measures of control mean the exclusion of new diseases on the one hand, and on the other increased yield and improved quality by protection from those already established. The lack of means of control has meant again and again in the history of the past the wiping out of crops and even the destruction of plant industries in many localities with resultant disastrous social changes, while the application of means of control has saved threatened areas from a similar fate, as in the case of Millardet's rescue of the vineyards of France, and has made possible the restoration of destroyed industries, as in the case of potato growing in parts of Nova Scotia, or cabbage culture in Wisconsin.

The problems of plant control fall under several rather distinct heads, as:

(*a*) Sprays and dips
(*b*) Improvement of environmental conditions
(*c*) Eradication
(*d*) Exclusion
(*e*) Breeding for resistance.

(*a*) Dips and sprays and fumigations, that is chemical means of disease control, including hot water treatment, have long been the backbone of agricultural and horticultural phytopathological practice. Nevertheless there is a call for more specialized investigations on this subject. The method suited to one locality may require adaptations if employed in other areas. Thus we find an outstanding potato disease expert recently stating with reference to established spray methods for late blight: "in Nova Scotia it is nearly impossible to grow white potatoes even with spraying." Why? There is an answer to that question. The same pathologist states that by improved methods "we have grown white potatoes and kept them sound there in places in Nova Scotia where such a thing was never known before." Too often investigators on plant diseases have treated the spray question as an incidental easily disposed of. One of the most absurd cases in point was that of the sooty mold of tomatoes. Recent tests have shown that the causal fungus of that disease flourishes undisturbed in standard Bordeaux mixtures and other sprays that had from time to time been recommended as prophylactics. Here as elsewhere the fundamentals still offer wide scope for research.

(*b*) The group of control methods falling under the head of "improvement of environmental conditions" includes control of moisture and light conditions both in the green house and in the field, control of soil fertility, methods of cultivation, crop rotation especially with reference to "sick soils," and in addition such sanitary measures as the disposal of debris that harbor fungus or bacterial disease germs, in fact it includes the control of all conditions that favor normal optimum plant development. Intelligent attention to nutrition and sanitation, that is to those factors that make for strong, vigorous, highly productive growth, goes a long way towards the maintenance of healthy crops. It is just here that the services of the plant physiologist can be of inestimable value.

(*c*) Of all the methods of control those of eradication are perhaps the most difficult of application. We are trying them on the wheat rust problem by pulling out the barberry and the mahonia—perhaps a hopeless undertaking in the eastern part of America; we made a feeble and unsuccessful attempt on the blister rust of the pine; but we apparently were successful in Canada in the case of the European potato canker. While in most instances complete eradication is too much to expect, yet the degree of success attainable may fully justify the measures employed. Such appears to be true with respect to potato mosaic and leaf roll, as I have already indicated in an earlier part of this paper. One of the main problems encountered here, as in other instances after complete or partial eradication, has been the maintenance of healthy seed, but even this difficulty is being overcome by *inspection* and *seed certification.*

In dealing with eradication problems let me refer to disease surveys though they are of importance in various other connections. An organized disease survey such as has been launched for the first time in America, an outgrowth of the activities of the War Emergency Board of American Plant Pathologists, promises to be a valuable aid in locating new and especially newly-imported diseases before they have spread so far as to make eradication difficult or impossible, and on this and many other grounds such surveys are worthy of support.

(*d*) The problems of disease exclusion are manifold and often intricate and perplexing. One of the most important and feasible means of exclusion lies in the selection of sound seed. Though some diseases can be avoided by seed treatment, yet that is not true of several of the most serious; the safest and best rule is always healthy seed. The most perplexing problems have to do with the exclusion of diseases from other countries—the problems of *international phytopathology*—and the exclusion of diseases from other provinces or states, or even from other localities within the same state. Here we are confronted with legislative problems, with inspection problems—too often left to entomologists who have little or no knowledge of plant diseases—with quarantine problems, with ignorance of the actual or potential phytopathological enemies in foreign countries, with seed and plant introduction problems, with transportation problems, and with unintelligent opposition from the seed and nursery trades.

That some of the most devastating diseases have been imported is known to everyone. The late potato blight, and the grape mildew from America to Europe, the chestnut blight and asparagus rust from Asia and from Europe respectively to America are a few of many that might be mentioned. These diseases have cost the countries into which they have been introduced many hundreds of millions if not billions of dollars. Yet at least some of the problems of exclusion are capable of solution. Canada for example appears to be successfully excluding the European potato canker, and has so far held at bay the Australian stripe smut and "take all" of wheat (said to cost Australia one-quarter of her wheat crop). International phytopathological congresses have already been held and a beginning has been made on the international co-operative solution of problems of world-wide concern. At home better legislation, better inspection, better quarantine, and more intelligent convinced co-operation of seedsmen and nurserymen are some of the things that will be brought about in time.

(*e*) Naturally, the ideal for both producer and pathologist, other things being equal, is disease resistant crops. Towards this ideal promising progress has been made. Thus there are practical cotton wilt, cow-pea wilt, flax wilt, bean rust, asparagus rust and cabbage yellows resistant varieties, products of direct efforts to produce disease resistant strains. Similarly there are hopeful reports of progress from time to time of experiments in breeding strains resistant to other diseases. The problems confronting the breeder in such endeavours are manifold, for he has to contend with biological strains of the parasite, biological strains of the host, with endless complications in preserving desirable qualities other than disease resistance, and after the end is attained with the maintenance of a constant and abundant production of the seed of the precious variety—a sine qua non condition of ultimate success—advance under such circumstances is bound to be slow, but the attainment of the desired goal is a veritable phytopathological triumph.

I trust that I have made clear that the phytopathologist's menu of problems is substantial, varied, and tempting; but at the same time let me emphasize the fact that it is one to which only strong men will do justice. I cannot refrain in this connection from expressing the wish that public service in this and in other lines of scientific activity may be made so attractive that the public will be assured of a choice of capable men to minister to its welfare.

In conclusion let me say that I have had a very definite object in bringing this subject to the attention of the Fellows of The Royal Society of Canada, who represent in a way that no other body does the scientific men of Canada. Your support is essential. Plant pathology is a science of national concern, the advancement of which is imperative if we in this dominion of vast and widely spread resources are to keep pace with other agricultural and forested countries, and with this end in view it is important that there be close co-operation between the administrative, the educational and the scientific forces of the country. To the federal government we look first and foremost for the prosecution on an extensive scale, through the agency of highly trained specialists, of unfettered researches on pathological problems of economic importance to the country; for the dissemination of helpful information through bulletins and circulars; and for administration with respect to international phytopathological relations and problems of inspection and quarantine. To the provincial governments we look for the maintenance of experiment station work, especially the demonstration of phytopathological measures of control suited to the respective areas under their jurisdiction; for the administration of provincial inspection, quarantine, or eradication measures; and particularly for *extension* work. To our Universities and Colleges we look for the teaching of plant pathology, and for the training of investigators. The greatest results can be obtained only through the combined forces of all these agencies. During the difficult times of war there was a call for co-operative effort, in these difficult times of peace the call seems to be even more insistent if we are to keep stride with the forward movement of civilization.

Abscission of Fruits in Juglans Californica Quercina[1]

By FRANCIS E. LLOYD, F.R.S.C.

(Read May Meeting, 1920)

During the study of abscission of fruits in the cotton (*Gossypium herbaceum*), a brief account of which was presented to this Society in 1915,[2] it was found that those fruits which were shed were always undersized to an amount approximately corresponding to the period required for abscission. It is apparent that the slowing up of growth is to be referred to a cause which indirectly results in abscission. This cause is to be found in limited water supply. One factor involved in bringing about this limitation is the capacity of the stem tissues to transmit enough water to keep up the constant distension necessary, and this becomes the more difficult as the number of fruits and other water-absorbing parts on a particular stem increases. MacDougal[3] found the water deficit of the stem supporting the fruits to be 25 per cent of its volume in the species under consideration. It is evident that when several fruits are borne in a raceme, as is the case in this species, the possible discrepancy as between the transmission capacity of the stem and the demands of the fruits must frequently lead to poor development and loss. That this condition obtains in *Juglans californica quercina* seems clear, for, though several fruits pass through the earlier periods of development, sooner or later usually all but one are lost by abscission. Practical proof of this was obtained during the course of taking auxographic records of fruits during the summer of 1918 at Carmel, Calif. Dr. MacDougal was kind enough to place at my disposal two records of growth in fruits which finally dropped off. These records (for the periods June 19–30 and July 2–5, 1918) are unique, the former more especially, in presenting graphically the growth behaviour previous to and during the abscission period. They were obtained by means of a compound lever, amplifying 10 to 40 times, according to setting, the taking arm resting on the fruit as it lay properly supported on its side on a firm base. The dimensional changes recorded were, therefore, linear and transverse to the axis of the fruit. The fruits, the growth of which was thus measured, were about 15 mm. in diameter. The writing arm made the record on a revolving drum.

---

[1] Babcock. Digest, Annual Rep. Carn. Inst., Wash., 1918, p. 76.

[2] Trans. Roy. Soc. Can. ser. 3. 10: 55–61, S. 1916.

[3] D. T. MacDougal. The Daily Course of Growth in Two Types of Fruits. Carn. Inst. Wash. Ann. Rep. 1919, p. 69.

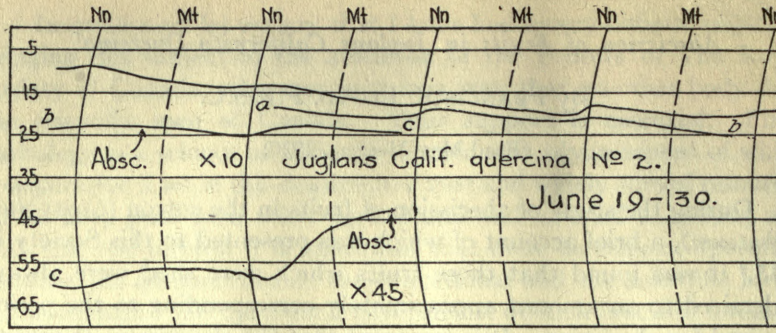


Fig. 1. Growth records of a fruit (No. 2) of *Juglans californica quercina* for 11 days. During the latter part of the period abscission took place.

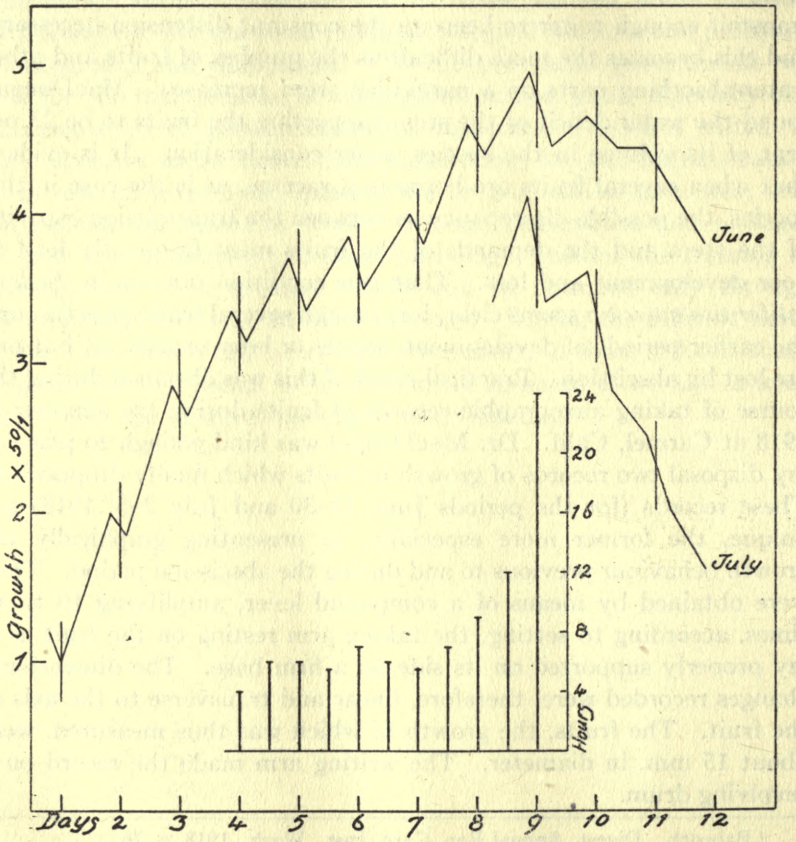


Fig. 2. Graph integrating the record in Fig. 1 (June) and of Fig. 3 (July). The durations of the periods of shrinkage of fruit No. 2 (Fig. 1) are indicated by the vertical lines of the inset.

Of these records, a tracing of the former is presented in Fig. 1. In Fig. 2 a graph (marked June) is given in which the amounts of growth and shrinkage for successive periods during the eleven days of the record have been plotted. In the inset, the durations of successive daily periods of shrinkage have been expressed in vertical lines. The graph marked "July" integrates the record for the fruit of which the auxograph is exhibited in Fig. 3.

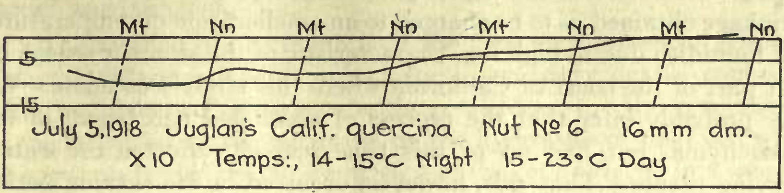


Fig. 3. Growth record of nut No. 6 for nearly four days.

The time required for the abscission response under stringent conditions is three days. This was determined by placing cut twigs bearing the nuts in a moist chamber. It is known, however, that under the conditions in the field which procure abscission, the response is usually not so prompt.[4] This is probably to be explained on the theory that the stimulus is not as a usual thing, a single intense one but less intense and repeated, with cumulative effect. The gradual reduction of soil moisture, or repeated water deficit in the stem, may be conceived as operating in this way. Only when the stimulus consists of severe wounding of the appropriate sort, or of some other strong stimulus, does abscission follow with the utmost speed possible.

With this in mind it is possible to interpret the graphs before us (Fig. 2). We consider the June record first. During the first three days the growth and shrinkage appear to have been quite normal, and accord with MacDougal's observations on the growth of the nuts in which "enlargement begins after noon and continues until sunrise at which time a retardation or shrinkage sets in, which continues until midday."[5] In the nuts to which the record in Fig. 1 pertains, however, the periods of shrinkage extended, normally, till the 14 or 15 hour, beginning at about 8 hour.

The third day was marked by somewhat lessened growth, and the succeeding two by less growth and by daily shrinkage much greater than before. This is obviously to be referred to hindrance to the

[4] Lloyd, F. E. Environmental Changes and Their Effect Upon Boll-shedding in cotton (*Gossypium herbaceum*). Annals N.Y. Acad. Sci. 29: 1–131. 1920.

[5] MacDougal., *l.c.*

service of water to the growing fruit. It seems entirely probable that the consequent considerable deficit of water, resulting, as it does, in a corresponding degree of wilting of the fruit, procures an internal condition, probably overheating, which constitutes the stimulus to abscission.

The sudden change of behaviour on the two subsequent days, during which a somewhat higher growth rate with normal amounts of shrinkage obtained, is to be charged to an amelioration of temperatures and humidity due to high fog, characteristic of the summer season on that part of the coast of California where this study was made. We may probably infer that the process of abscission had begun in the parenchyma, but had up to this time scarcely affected the water-carrying tissues. That this, however, occurred in the ensuing period is evident, for during the last three days there was only one period of slight enlargement, while the duration of the shrinkage periods became prolonged (inset, Fig. 2). During the last two days there was no enlargement at all. The process of abscission was found to have been completed shortly before the record terminated.[6]

That the total amount of shrinkage recorded was not very great was due simply to the circumstance that the trees, which are low and shrubby in habit, were situated in a gulch where the humidity is generally high, especially in the night, and the nut was exposed, during the last part of the abscission period, to this high humidity. A further record would have been of withering only.

It may be concluded that among the various conditions which lead directly or indirectly to abscission, water deficit beyond a certain limit is one, and that this is the condition which led to the abscission of the fruits under consideration. After abscission has proceeded sufficiently to break down the vascular tissues, no growth at all is possible, and, at this point, the process may be regarded as complete, so far as the fate of the part involved is concerned. The usual loss of all but one fruit in a raceme is to be charged to the inadequacy of the stem in supplying the water lost by transpiration from the exposed fruit surfaces.

It may, therefore, be concluded that the active period of abscission was included within the last three days of the record. This is substantiated by the second record (Fig. 3), replotted in the graph

[6] At one point the record is not quite readily to be interpreted, namely, for the period 8–14 hr. beginning the 11th day (Fig. 1). It seems entirely probable that this irregularity was due to some shifting of the fruit caused by the loosening. At all events, the irregularity represents a total movement of 0·025 mm. of the taking arm of the lever.

marked "July" in Fig. 2. This is essentially like the graph for the nut whose behaviour has already been described. The record is short, and embraces only two days on which growth occurred, in much reduced amount on the second day when abscission was beginning to make itself apparent. On the third and fourth days shrinkage was continuous, being, as would be expected, more marked during the daytime. Abscission was found to have drawn to completion at 8 a.m. when the record was removed.

The method of abscission is of the type exemplified in *Mirabilis Jalapa*,[7] differing only in unimportant secondary details connected with the thicker cell walls such as the persistence, in a living condition, of the cells which have separated by the hydrolysis of their cell walls. The process begins by the elongation of the cells (Fig. 5) in a more or less irregular zone (Fig. 4), following on the alteration of portions of their walls, including both primary and secondary material, the innermost layers only persisting to keep the protoplasts enclothed.

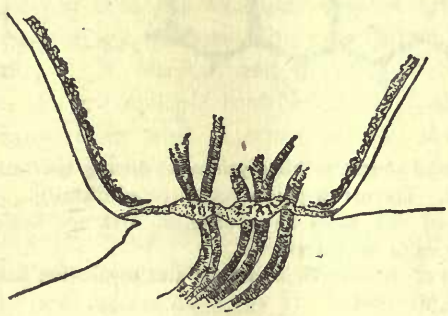


Fig. 4. Diagram indicating the position of the abscission zone at the base of the fruit.

The zone of cells involved is irregular, and lies very slightly above the base of the fruit, the earliest abscission activity occurring in the pith. If the fruits are allowed to be exposed to high humidity for some time at the close of abscission, considerable proliferation and loosening of abscission cells occurs, and this condition is, therefore, more pronounced in the inner regions of the abscission zone (c, Fig. 5).

It may be concluded that, in the species herein discussed, abscission is brought about by the repeated too great water deficit in the tissues of the growing fruits resulting from competition between them, the stem being inadequate for the transmission of sufficient water. The process occupies, in all, three to five days, the major portion of

[7] Lloyd, F. E. Abscission in *Mirabilis Jalapa*. Bot. Gaz. 61: 213–230. March, 1916.

abscission activity being confined to three days. During these three days, there is little or no growth, and this results from the direct limitation of the water-supply by the disruption of the vascular tissues.

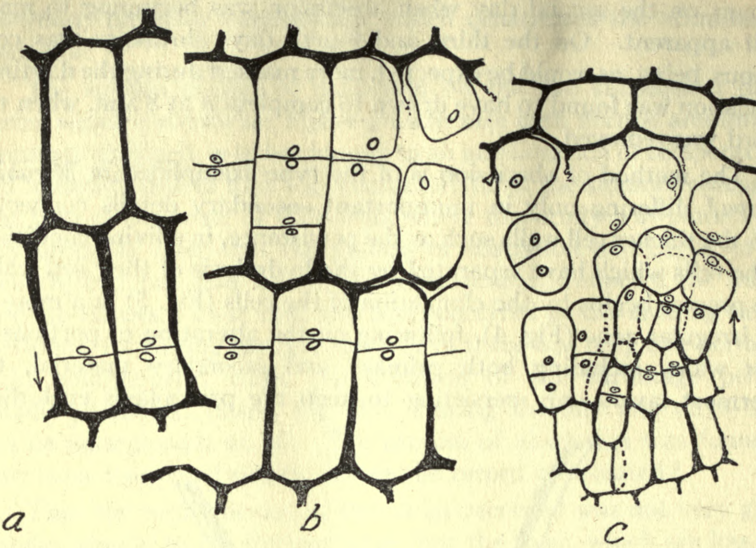


Fig. 5. Successive stages of histolysis seen during the progress of abscission. Semi-diagrammatic. The arrow-points are directed distally.

(*a*) Longitudinal cell walls have softened and are beginning to lengthen; transverse septa have appeared.

(*b*) Elongation of these walls is marked and separation has begun. Two rows of cells are involved.

(*c*) Separation is complete, and living cells have been set free. Remains of the original primary and secondary cell walls are evident in both *b* and *c*.

On the Mutual Precipitation of Dyes and Plant Mucilages

By FRANCIS E. LLOYD, F.R.S.C.

(Read May Meeting, 1920)

It has become increasingly evident during the past very few years that the behaviour of the emulsoid contents of plant tissues, aside from those of the living protoplasm, affect, in a probably complex way, the internal economy of the organism. These, for the most part pentose materials, among other behaviours, play a doubtless important part in growth, one factor of their activity being found in affecting the distribution of the water as between themselves and other contingent or associated colloidal (emulsoidal) masses, especially the protoplasm. An important example in the field of animal physiology of such behaviour is afforded by the role of gum (acacia) in gum-saline solutions when injected into the vascular system after shock.[1] In the field of plant physiology, attention may be drawn to the work of MacDougal, Spoehr, E. B. Shreve, and myself, briefly summarized in the Year Books of the Carnegie Institution of Washington, to the earlier work of Borowikow and of some others, therein cited, as indicating the general importance of the subject of the role of colloids in plants, and the scope of the studies already made.

There are, however, many difficulties of observation—interpretation aside for the time being—which have yet to be compassed. These have more recently been adverted to by H. A. Spoehr,[2] who mentions among others the difficulties of observation and identification of carbohydrate emulsoids in tissues and their elements. It was during initial investigation into this phase of the subject that the peculiar relations to be presently described came to light.

Some years ago I found that mucilage bodies derived from the cell wall by hydrolysis, as during abscission,[3] appeared after treatment with ruthenium red to have been flocculated. At the time no more than a suspicion that the dye had been the casual agent was entertained. This was enough, however, to direct my observation to the effect of dyes in contact with emulsoids such as plant mucilages especially when, in the summer of 1918, I endeavoured to find a satisfactory specific stain for the mucilage of the cacti (*Opuntia*).[4] On this score

[1] Bayliss, M. M. Jour. Pharmacol. and Exp. Thera. 15 : 29–73. March, 1920.

[2] The carbohydrate economy of cacti. Carn. Inst. Wash. Publ. 289, 1919.

[3] Abscission in *Mirabilis Jalapa*. Bot. Gaz. 61 : 213. March, 1916.

[4] Year Book Carn. Inst. Wash. 1918, p. 72.

there was some success, but not by procedures in accordance with the statements of the text books. What also emerged was the discovery that certain stains, of which ruthenium red may be cited as an example, caused flocculation of cactus mucilage, so that, in the course of time, its viscidity entirely disappeared.[5] It was further determined that those dyes which are adsorbed by the mucilage have this effect in common, while those which are not absorbed do not in the least affect the viscidity; and, finally, that the vigour with which the viscidity is lowered is directly related to the degree of adsorption.

These facts, in a general sense, were determined by a series of experiments leading to and culminating in the following. Small cubes of tissue were cut from fresh joints of *Opuntia Blakeana*. These were allowed to lie in water for some hours till each was surrounded by a drop of clear, dense mucilage derived by the hydration of the mucilage of such cells as broke out under the swelling of the contained matter.[6] At this point the mucilage is very viscid, so that, upon lifting a bit of tissue out of the water a long rope hangs therefrom, but does not break. The tenacity of this rope is constant for a long period of days, but the effect of any reagent which affects its viscidity becomes apparent in its lessened diameter, in its beading, or in its entire loss of tenacity. A measure, albeit somewhat rough, was thus had of alterations in viscidity.

Into each of a series of small glass vessels a single cube of tissue with its adherent mucilage was placed, and sufficient solution of dye of moderate concentration added to surround but not to cover the blob of mucilage. If the dye was adsorbed, this fact became apparent in the deeper colour of the mucilage as compared with that of the surrounding fluid. If not, after diffusion was complete the mucilage was indistinguishable as to colour. After some time the cellulose walls of the tissue also adsorbed the stain or not, and the fact could be readily determined by inspection. Such stains as were available at the Coastal Laboratory of the Carnegie Institution of Washington were tried. The experiment ran for ten days, during which period day-to-

---

[5] After the viscidity of the mixture has disappeared, the emulsoid may be precipitated by alcohol, when it is found to have become a jelly showing limited swelling in water. (ruthenium red; neutral red.) It should be added that when the density of the mucilage is high enough (as in an unopened mucilage cell) the colour is adsorbed without flocculation. I have observed analogous behaviour in tannin cells (Tannin-Colloid complexes in the fruit of the Persimmon. Biochem. Bull. 1 : 7–41. S. 1911.)

[6] Lloyd, F. E. Origin and Nature of the Mucilage in Cacti. Am. Jour. Bot. 6: 166. April, 1919.

day changes could be noticed in at least some of the cases, in those, namely, which were most pronounced in their action, *e.g.* ruthenium red, neutral red, etc.

Within a very short time it was noticed that some dyes were being rapidly adsorbed, and at the end of twenty-four hours it was clear that fuchsin, erythrosin, corallin, orange G, and methyl orange were not adsorbed, while ruthenium red, neutral red, vesuvin, gentian violet, methylene blue and safranin were, on the contrary, adsorbed, but not with equal vigour. The order in which they are named may be taken as a rough index of their relative vigour; methyl green and methyl blue, of doubtful effect, may be tentatively added. On the seventh day the differences in the viscidity of the mucilage were pronounced, differences which in some instances (ruthenium red, neutral red, vesuvin) could be readily detected much earlier. On the tenth day it was found that the viscidity remained unaltered in orange G, methyl orange, fuchsin, corallin. To these were added, but not without doubt at the time, *viz.* methyl blue, erythrosin, and methyl green. This doubt I removed later as far as erythrosin is concerned. The viscidity was materially lowered or lost entirely in ruthenium red, neutral red, vesuvin, methylene blue, gentian violet, and safranin, the earlier named being the most vigorous. In the preparations in which the first two, at least, occurred, a distinct precipitation of the mucilage on its outer border could be noticed early, and this was so extensive in the case of neutral red that it was clear that the adsorption of the dye accounted for its disappearance from the surrounding fluid. As the precipitation advanced, the outer zones of the adsorption complex disappeared as a suspension. Aside from other details of this kind, which need not be presented, it became evident that those dyes which are adsorbed by the mucilage of *Opuntia* lower its viscidity with a rapidity directly related to the vigour with which they are adsorbed. Those dyes which are not adsorbed do not alter the viscidity. A considerable number of experiments, done before and after the one above recounted, served to verify the conclusion arrived at. Because of the very minute amounts of ruthenium red at my disposal, my observation of its behaviour was confined to small amount of solution of low concentration, but it was clear that this dye is extremely vigorous, forming flocks and precipitation membranes very quickly. The mucilage of the mallows behaves quite as that of *Opuntia*, and, it may be added, has an exactly similar cytological origin. That of tragacanth, also, judging from a small series of observations.[7]

---

[7] Lloyd, 1919, *l.c.*

Further experimentation has been carried out with mucilage extracted from dried material of *Opuntia Blakeana* obtained at Tucson (on the domain of the Desert Botanical Laboratory). The material was ground in a mill and sifted to remove coarser bits of tissue. It was then allowed to stand in water till the mucilage had swelled to a highly viscid mass. The supernatant water, which was somewhat brownish, was poured off, and distilled water added. When sufficiently swelled, the whole was strained through cloth to remove the bagasse. This extract forms a culture medium for bacteria or yeasts, some of which attack the mucilage, as is evidenced in time by the gradual lowering of viscosity,[8] accompanied by odour, probably due to protein breakdown.

With a given preparation as above made it was found that when 5 cc. of mucilage was mixed with 10 mg. of dye, the following occurred. Eosin and cerise did not affect the viscosity, Congo red, vesuvin, neutral red and methylene blue, on the other hand, did so. It was also observed that Congo red and vesuvin especially caused a marked increase in turbidity, which is present in less degree in the original extract, while in the neutral red preparation an initial turbidity was soon followed by the formation of a clot, leaving the greater volume of the fluid quite limpid. Of the dyes which appeared non-effective, eosin produced no alteration in optical properties, even after 23 days, whereas cerise produced some increase in turbidity. Ultramicroscopic examination revealed the presence of suspensoids and flocks of coagulum in the preparations with cerise, vesuvin, methylene blue and Congo red. The coagulum in the neutral red showed its origin to have been from similar suspensoids, the surrounding fluid being optically empty.

Extracts were prepared of *Linum* mucilage (from the seed integument) and of *Opuntia*, and these, when ready for use, had approximately similar viscidities and opalescence. A parallel series was set up of these two mucilages. Each member of the series consisted of 10 cc. of mucilage to which 50 mg. of stain was added. The dry weight of the *Linum* mucilage was 33 mg. per 10 cc., of *Opuntia* 70 mg. per 10 cc. After 12 days no change was observable in either mucilage treated with methyl orange, fuchsin and eosin. Methyl orange dissolved only very slightly and lay on the bottom of the vial even after many shakings. Fuchsin dissolved finally, but only very slowly. Eosin dissolved quickly, but an amount of stain remained undissolved. When the mucilage was decanted off and water was added to the undissolved dye, it went into solution to a much higher concentration than that in the original preparation, from which it would seem that the presence of the emulsoid interferes with the solution of these dyes.

[8] Spoehr (*l.c.*) did not succeed in observing yeast fermentation to occur.

Vesuvin, Congo red, neutral red and methylene blue, on the other hand, had a marked effect. As seen in the previous experiment, there occurred a great increase in turbidity, less rapidly consummated in the vesuvin mixture than in the others. Nor did the change proceed with equal rates in the two mucilages. The Congo-red-*Linum* mucilage mixture assumed the character of a jelly in an hour or so, and in 24 hours a shrunken clot had formed, floating in a perfectly limpid solution of the dye. The *Opuntia* mixture showed no rapid change, but was quite turbid in 24 hours. Exactly the reverse was true of neutral red, which formed a clot with *Opuntia* mucilage and a turbid mixture with that of *Linum*. Methylene blue produced a turbid mixture in both cases.

Vesuvin in the course of six days lowered the viscidity of the mucilage so that it became watery, and this was equally true of both *Linum* and *Opuntia*. With *Linum* mucilage Congo red had formed a curdy mass or clot on the bottom of the vial; with *Opuntia* mucilage, a dense curdy clot, three-fourths the total volume. This curd adhered to the sides of the vial above the fluid like the curdy casein in buttermilk. The viscosity of the mixture appeared rather higher than that of the control.

Neutral red formed a curd with both *Linum* and *Opuntia* mucilage, the viscosity of the supernatant fluid being approximately that of water. The viscosity of the methylene blue preparations was in both instances near to that of water.

Eighteen days later the viscosity of the control had been materially lowered, and this, as the odour attested, was due to the activity of organisms. That of the methyl orange, eosin and fuchsin was but slightly lowered, albeit these preparations were not entirely free of organisms, this being true of both mucilages. Secondary changes which had also taken place in the remaining preparations, referable I have no doubt to the activity of organisms as evidenced by odours, prevent attaching weight to the changes observed. Only to the retention of viscidity in the presence of the dyes mentioned above is attention directed, as further evidence of the non-effect of these dyes on the physical properties of the mucilages.

It was evident from the foregoing experiment that both *Linum* and *Opuntia* mucilage are affected in the same way but in different degrees by certain dyes and not by others. Either coagulation or flocculation occurs, according to the quantitative conditions or character of the dyes, the coagulum being more continuous in the *Opuntia* mucilage than in that of *Linum*, doubtless because of the lower state of dispersal in the preparation of the latter. To integrate an avowedly preliminary inquiry into the matter, it was necessary to determine whether quantitative relations really existed between the dye and the emulsoid. The following experiment was designed to do this.

To each of seven vials containing each 5 cc. of *Opuntia* mucilage of the same kind as used above, 5 cc. of neutral red were added in a series of concentrations beginning with the highest, *viz.* 50 mg. in 10 cc. of water, in each member of the series the dye being reduced in concentration by one-half. The lowest concentration was, therefore, that of 1·5 mg. in 10 cc. water. The absolute amounts of the dye available to each quantum of mucilage was 25 mg. and 0·75 mg. for the extremes of the series. The dye solution was floated gently onto and remained supernatant on the mucilage.

There soon appeared a dark zone at the tension surface between the two, which developed a thickness roughly proportional to the concentration of the dye. This dark zone was obvious evidence of flocculation.

Eighteen hours later the mucilage in contact with the lower concentrations of the dye had increased in volume, while that in contact with the higher concentrations had decreased.[9] Twelve hours later still, the relative volumes with one exception had remained too little changed for measurement, but five days later considerable changes in the original dimensions had occurred. In the highest dye concentration the mucilage had shrunk to a rounded clot lying on the bottom of the vial. The accompanying table shows the gains and losses in percentages of the original total volume of which the mucilage and dye solution each occupied 50 per cent. Number five did not fit into the series very well, but it must be admitted that the measurement offered a certain amount of difficulty. The general trend of the figures is, however, unmistakable. Ultimately (*i.e.*, at the end of a five-day period), in Nos. 6 and 7 a continuous firm clot was formed, while the supernatant fluid was limpid and optically empty (no Tyndall effect or suspensoids). In all the others (1 to 5 incl.) the fluid was turbid (especially on shaking) and accordingly a pronounced Tyndall effect appeared. When examined ultramicroscopically it was found that No. 1 showed a few suspensoids, their numbers being increased progressively in the series with the concentration of the dye. No flocks were present in No. 1, but small ones occurred in No. 2 and more and larger ones progressively in the series. At the same time,

[9] This may indicate osmotic relations, the flocculation zone serving as a semipermeable membrane. I have observed that when Congo red is allowed to diffuse into gelatine, a dense adsorption zone is formed, after which the rate of diffusion, through this zone is of necessity very much lowered and at length is reduced to zero.

the viscidity[10] was highest in No. 1 and decreased progressively with the series, till, in Nos. 4 and 5 it was reduced to that of water approximately. In Nos. 6 and 7 the viscosity has increased *in the clot*, and it will be seen that the original system had separated into two by syneresis. An additional feature may here be mentioned tentatively at least, namely, that in Nos. 4 and 5 there appeared a marked green fluorescence, which is absent from neutral red alone. Whether this was a true fluorescence I do not know, but the green colour was evident enough in a strong beam of light playing on the edges of the fluid.

DEPTH OF MUCILAGE AND OF SUPERPOSED ZONE OF DYE SOLUTION AFTER PERIODS INDICATED

Vial No.	Containing, in Zones	Thickness of Zone After		
		18 hours	30 hours	5 days
1	Dye, (0·39 mg.)	33	33	24
	Mucilage	67	67	76
2	Dye, (0·78 mg.)	42	42	33
	Mucilage	58	58	67
3	Dye (1·56 mg.)	42	42	49
	Mucilage	58	58	51
4	Dye (3·12 mg.)	51	51	58
	Mucilage	49	49	42
5	Dye (6·25 mg.)	55	55	55
	Mucilage	45	45	45
6	Dye (12·5 mg.)	67	67	79
	Mucilage	33	33	21
7	Dye (25 mg.)	88	94	100
	Mucilage	12	6	clot

That the suspensoids and flocks seen in the above were due to the interaction of the dye (neutral red and methylene blue) and

[10] The terms viscous and viscid appear to have been used in the literature more or less interchangeably. I am here using viscid to describe the tenacity, or internal pulling power of cactus mucilage, absent from *Linum* mucilage, which has viscosity. Assuming these to be different properties it should be stated, to avoid confusion, that the dyes which affect the viscidity of cactus mucilage also affect the viscosity of Linum mucilage and the viscosity of Cactus mucilage after the viscidity has disappeared.

mucilage was shown by allowing them to mingle while under ultra-microscopic observation, when an abundant coagulation could be followed, as in the case of casein when acted on by HCl.

We may, therefore, conclude that the change in viscidity caused by the dye is due to the mutual precipitation. When the dye is in insufficient quantity only partial coagulation (flocculation) accompanied by slight lowering of viscidity occurs. When the dye is in sufficient quantity a continuous coagulum is formed within which the viscidity is raised by syneresis. The series described parallel the changes in viscosity of albumin on heating. Dyes which are not adsorbed do not affect the viscidity.

A somewhat analogous behaviour is seen in gum acacia when treated with Congo red, though towards vesuvin (electro negative), methylene blue and neutral red (both electro positive) there appears to be no reaction. With Congo red in constant concentration, there is produced with increasing concentrations of the gum an increasing turbidity, due to the formation of a brown suspension. When rendered slightly alkaline, the turbidity clears away, and the clear red colour of the dye is produced.[11] With change to slight acidity, the turbidity does not at once reappear. The gum is not a pure substance, but contains some resin. The dye is adsorbed by filter paper, while the brown suspensoid, like Congo blue, is not adsorbed. The viscosity is not so easily estimated as in the case of cactus mucilage, but a lowering of viscosity on the introduction of the dye was fairly evident.[12]

The Effects of Salts.—Spoehr (*l.c.*) was unable to salt out cactus mucilage for chemical study. In connection with the above observations, I have tried the effects of a few salts to obtain preliminary data. Solutions of the mucilage in high concentration, forming a very ropy mass, were subjected to cupric chlorid, copper sulphate, iron alum, barium chlorid, potassium dichromate and mercuric chlorid, in ca. 6 per cent solution ($HgCl_2$, sat.) and the viscidity gradually disappeared, but most rapidly in the copper salts, and least in the mercury salt. The change occupied 12 hours to seven days, the rate being approximately in the order in which the salts are named above. There was, however, no evidence of clotting or flocculation, and chemical change is not excluded.

---

[11] Cactus mucilage does not adsorb neutral red when alkaline, though it diffuses through the living protoplasm and accumulates in the sap, colouring it scarlet.

[12] I have not yet studied the behaviour in the absence of impurities (salts). It will be profitable to pursue the relation of Congo red to mucilage further in the light of the interesting work of Bayliss (Proc. Roy. Soc. ser. B. 84 : p. 81).

The above observations suggest possible methods of identification of the chemically similar but physically different substances of carbohydrate nature as they occur in plant tissues, while they afford a hint as to the role played by such intravitam staining substances as methylene blue in therapy. The evidently important relations determined by adsorption interactions of emulsoids and other substances, with their hydration and dehydration, colloidal protection, and other effects are also indicated in this avowedly preliminary study, which has been interrupted by unavoidable conditions.

Histoire d'une Escouade de "Petits Soldors"

Fantaisie entomologique

Par le chanoine VICTOR-A. HUARD, D.SC., M.S.R.C.

(Lu à la réunion de mai 1920.)

Il y a une soixantaine d'années, nous—les gamins de Saint-Roch de Québec—donnions ce nom de "petits soldors" à de minuscules coléoptères que nous trouvions en abondance attachés aux tiges frêles de Renouée, dont il y avait en certaines rues des touffes verdoyantes. L'heureux temps, l'heureuse ville, où l'Herbe-à-cochon (qui était et qui est encore, je crois, l'appellation populaire de la Renouée) pouvait pousser tranquillement dans les rues, et où les petits enfants pouvaient, faisant de l'entomologie sans le savoir, passer de belles heures à ramasser des "petits soldors," et se porter des défis à qui en ramasserait le plus.

Ces souvenirs lointains me sont revenus l'autre jour, c'est-à-dire au mois d'avril 1919, lorsque j'ai trouvé, entre les châssis intérieurs et les châssis extérieurs de l'une de mes fenêtres, une colonie de ces petits coléoptères en pleine activité.

L'occasion s'offrant d'elle-même de faire aisément des études de moeurs sur un groupe d'insectes, j'ai proclamé territoire réservé tout l'intérieur de cette fenêtre, et interdit jusqu'à nouvel ordre qu'on y promenât l'eau et le savon sous aucun prétexte.

Le lecteur a-t-il eu comme moi, dans sa petite enfance, l'avantage de pareils amusements entomologiques ? Connaît-il seulement quelle sorte de "petites bêtes" je désigne, et nous désignions, par ce nom de "petits soldors ?"

Ne fréquentant plus guère la toute jeune population de Québec, j'ignore absolument si l'appellation dont il s'agit est encore en usage chez elle. Mais dans nos rues aujourd'hui pavées en asphalte, cherchez donc maintenant des coins où puisse croître l'Herbe-à-cochon, au vert sombre tout parsemé de gouttelettes écarlates qui étaient les petits coléoptères dont je parle.

Car ces insectes sont d'un rouge vif, et c'est bien pour cela que nous leur donnions le nom pittoresque de "petits soldors. "Il faut dire, et cela intéresse la philologie, que le mot "soldor" était dans notre vocabulaire la désignation du soldat. Il faut dire aussi, et cela intéresse l'histoire de la domination britannique en Canada, qu'il y avait en ce temps-là une garnison anglaise à Québec. Ces militaires portaient la tunique rouge écarlate bien connue, et c'est pourquoi nous appelions "petits soldats," "petits soldors," les petits coléoptères dont il est ici question.

Ces insectes sont demi-sphériques: leur surface inférieure est plane et noire. *Adalia bipunctata* est leur nom scientifique. L'adjectif de cette dénomination fait allusion aux deux points noirs qui s'étalent sur leur dos bombé. M. Maheux, entomologiste de la province, a précisément signalé ces coléoptères dans l'intéressante étude sur les noms populaires des insectes, qu'il a lue au cours de l'une des dernières séances publiques du Parler français au Canada.

Trois semaines durant, à partir du 21 avril 1919, mes cinq *Adalia*, car ils étaient au nombre de cinq, ont paradé sur la vitre où ils sont apparus l'un des "quatre matins" de ce temps-là. D'où pouvaient bien venir ces petits Coccinellides?—car c'étaient des membres de la famille des Coccinellides. J'ose à peine dire que la provenance de ces coléoptères est pour moi l'un des problèmes les plus obscurs qu'il y ait —comme s'il n'y avait pas déjà assez de problèmes insolubles dans toutes les sciences. En tous cas, disons que la fenêtre, où se trouvèrent ces insectes, n'avait pas été ouverte de l'hiver, et acceptons avec résignation d'ignorer tout de leur passé. Tout au plus, disons que la théorie la plus communément adoptée, c'est que ces Adalies étaient arrivées là dès l'automne dernier, et qu'elles y ont passé l'hiver en état de léthargie, pour se ranimer aux chauds rayons du soleil d'avril.

Ce qui est pour le moins aussi déplorable, c'est que, ignorant tout de la première phase de leur vie, nous allons ignorer également, après leur apparition de trois semaines, à peu près tout de la suite et de la fin de leur existence. Car, au bout d'une vingtaine de jours, mes *Adalia* disparurent presque en même temps, vers le 15 mai. J'en ai revu deux le 21 septembre, et un le 6 octobre de la même année. Que sont devenus les autres, et comment sont-ils tous disparus depuis le 6 octobre 1919?

On sait qu'il ne manque pas d'espèces d'insectes qui, arrivés à l'état parfait, n'ont plus besoin de s'alimenter. On peut dire que ces insectes ne vivent plus que de "l'air du temps." Quel bel idéal, et quelle excellente manière il y a là de résoudre le problème actuel de "la vie chère!"—Au cas où cette hypothèse serait la bonne, mes Adalies seraient mortes de leur "belle mort," comme nous disons. Et alors, sentant s'approcher la fin de leur vie, qui n'est d'ailleurs généralement pas longue chez les insectes, elles seraient aller se cacher dans quelque fente d'alentour pour y passer de vie à trépas. Des cas de ce genre ne sont pas rares dans la série animale, où l'on a comme la pudeur de la mort, et où pour mourir, ce qui est l'acte extrême de faiblesse pour l'être vivant, l'on se cache autant qu'il est possible.

Mais il peut se faire, d'autre part, que les Adalies soient de ces espèces d'insectes qui ne cessent pas de se livrer aux plaisirs de la table, parce qu'elles sont arrivées à l'état adulte, et alors mes cinq spécimens seraient morts de faim, les uns plus tôt, les autres plus tard. Ce triste événement, que je déplorerais le cas échéant, ne me causerait pourtant pas de remords. Car je prie qu'on me dise quelle sorte de cuisine j'aurais bien pu organiser pour mes cinq pensionnaires d'occasion. . . . .

Du reste, et à ce propos, de quoi se nourrissent ces petits coléoptères, et en général les Coccinellides, famille dont les Adalies font partie ? Au moins dans leur période larvaire, ces insectes vivent aux dépens des pucerons qu'ils dévorent à belles dents, si l'on peut dire ainsi. D'autre part, les pucerons se nourrissant des sucs végétaux, il n'est pas étonnant de les voir passer leur vie sur les plantes mêmes, qui leur fournissent ainsi le gîte et la nourriture. Et par voie de conséquence, il n'y a pas non plus à être surpris de voir les Coccinellides, Adalies et autres membres de la famille, se tenir habituellement sur les plantes.

Or, nos voisins des Etats-Unis, qui sont reconnus pour être les gens les plus pratiques et les moins habitués à piétiner sur place qu'il y ait au monde, n'eurent pas plus tôt appris des entomologistes que les Coccinellides sont les ennemis naturels des pucerons, qu'ils résolurent de leur confier le soin de tenir en échec les armées de pucerons qui font tant de ravages dans certaines parties des Etats-Unis, comme l'Orégon, par exemple, où ces minuscules brigands détruisirent complètement la récolte de lentille en 1918.

"Au cours d'une expérience poursuivie en 1918," dit le Prof. A.-C. Lovett, de l'Oregon Agricultural College, "on a ramassé 210 livres de pucerons dans un champ de lentille de 12 acres. On a estimé que cette quantité constituait 60 pour cent de tout ce qu'il y avait de pucerons sur le champ en question. Il y avait donc sur ce morceau de terre 350 livres de pucerons. On compta un gramme pesant de ces petits insectes, et l'on trouva le chiffre de 513. Par conséquent, une livre en contiendrait environ 254,000, et donc il y en aurait eu 88,900,000 dans le champ de 12 acres. Il en résulte que 25 millions de Coccinelles, qui dévoreraient chacune son maximum quotidien de 200 pucerons, réussiraient à tenir en échec les pucerons sur une étendue de

77 acres. Quand on pense aux centaines d'acres de lentille et aux milliers d'acres de grain que les pucerons ont dévastés l'année dernière, on voit quelle tâche incombe aux insectes utiles et en quel nombre il importe qu'ils soient." Ce qui rend l'affaire tout à fait digne d'attention, c'est que l'on porte le dommage causé par les pucerons aux cultures des Etats du Pacifique septentrional à un montant de dix à vingt millions de piastres par année! Or, comme on sait, les habitants des Etats-Unis ne sont pas gens à perdre vingt millions de piastres par année, sans au moins essayer . . . . de ne point les perdre. Ils ont bien pris la peine, déjà, d'envoyer chercher dans les pays d'Orient des parasites capables d'arrêter chez eux certaines espèces d'insectes nuisibles, importés aussi de là accidentellement, et qui, libres en leur nouvelle patrie du contrôle de ces ennemis naturels, s'en donnaient à cœur joie sur les cultures du continent américain.

Or il se trouva, et bien à point, que l'on découvrit la façon dont les Coccinelles passent l'hiver dans l'Ouest américain. Dès que les froids s'annoncent, ces insectes s'en vont dans les montagnes, s'installent dans les crevasses des rochers ou autres abris, et s'y endorment pour l'hiver. Dès lors, voici le plan de campagne que l'on a résolu de suivre en l'année 1919. On tâcherait de découvrir le plus que l'on pourrait de ces colonies de Coccinelles endormies, où elles existent même par millions; on les recueillerait dans des sacs que l'on emmagasinerait dans des locaux où l'on maintiendrait une température constante voisine du point de congélation. Puis, vers la fin de l'hiver, on les distribuerait dans les localités où l'on est particulièrement aux prises avec la voracité des pucerons. Et quand les pucerons, la température s'échauffant, se mettraient à l'œuvre de leur phénoménale multiplication, ils trouveraient . . . . à qui parler. En d'autres termes, les Coccinelles, déjà éveillées de leur sommeil, seraient là pour les croquer à mesure et les empêcher de promener dans les cultures leurs ravages habituels. C'est ainsi que, dans le seul Etat de Washington, l'on devait, au printemps de 1919, faire une distribution de cent millions de Coccinelles!

Il n'a encore, au moment où j'écris, été publié aucun rapport sur les résultats de l'expérience. Si l'événement a justifié les espérances que l'on entretenait à ce sujet, on pourra voir là le plus grand triomphe que l'entomologie ait jamais remporté. Ce sera le pendant du succès dont l'entomologie américaine peut aussi se faire gloire, dans la lutte heureuse qu'elle a faite contre le fléau de la fièvre jaune. Comme on se le rappelle, l'entomologie médicale s'aperçut que les germes de ce fléau étaient inoculés par la piqûre de certaine espèce de moustique; l'animalcule qui cause le fléau doit passer dans le corps du moustique l'une des périodes de son existence. Il n'y avait donc, pour empêcher la diffusion du fléau, qu'à exterminer les moustiques eux-mêmes dans les régions exposées au péril de la fièvre jaune. Les moustiques passant leur état larvaire dans les pièces d'eau quelconques, lacs, étangs, marécages, il a suffi de répandre sur ces eaux, à certaine période de l'année, une couche très légère de pétrole, pour détruire d'un coup toutes les larves de moustiques d'une région déterminée et faire cesser dans la contrée le fléau de la fièvre jaune.

Ce ne sont pas là les seuls faits qui démontrent les grands services que la science encore jeune de l'entomologie a rendus à l'humanité. Mais ce sont bien, en tout cas, les preuves les plus frappantes et les plus originales de l'importance des études entomologiques au point de vue des intérêts économiques des nations. Aussi il n'y a pas lieu de s'étonner si aujourd'hui, dans les pays les plus éclairés, les pouvoirs publics favorisent les études entomologiques, organisent des bureaux entomologiques officiels, et retiennent les services d'entomologistes de carrière, qui sont chargés de diriger la lutte contre les espèces nuisibles d'insectes.

L'Etoile de Mer: Son Utilité Comme Engrais

Par l'abbé ALEXANDRE VACHON, PH. M., M.A., etc.

Présenté par A. B. MACALLUM, M.S.R.C.

(Lu à la réunion de mai 1920)

Lorsque je fus invité, il a cinq ans, à me joindre aux travailleurs de la Commission Biologique du Canada, à St-Andrew's, N.B., on m'a demandé de faire une étude spéciale des Astéries, appelées vulgairement étoiles de mer, d'en faire l'analyse et de me rendre compte si elles ne pourraient pas être utilisées pour amender les terres. En effet, ces échinodermes causent des ravages énormes aux bancs d'huîtres, de sorte qu'il faut nécessairement les faire disparaître des régions habitées par le précieux mollusque.

On se demandait s'il n'y aurait pas moyen de les employer telles quelles comme engrais ou d'en extraire la potasse qui pourrait s'y trouver en assez grande abondance. Après que le commerce avec l'Allemagne fut interrompu, la potasse fut un produit dispendieux et difficile à obtenir: on sait que des recherches coûteuses ont été faites afin de trouver une autre source d'où l'on pourrait extraire avantageusement cette substance nécessaire au développement des plantes.

Les grands dépôts de potasse, près de Stassfurt et Magdebourg, ont fourni ce produit au monde entier jusqu'au commencement de la guerre. En 1913, les Etats-Unis ont importé pour une valeur de 15 millions de dollars de potasse. En 1914, l'importation canadienne de cette substance se chiffrait à près de six cent mille dollars. Beaucoup de travaux ont été faits pour détruire ce monopole et extraire la potasse des minéraux qui la renferment, surtout du feldspath orthose; on y a réussi par un procédé long et coûteux.

Les montagnes de leucite du Wyoming et le glauconite du New-Jersey et de la Virginie contiendraient 2,034,000,000 tonnes de potasse (K_2O) d'après les calculs du Docteur Henry S. Washington du Carnegie Geophysical Laboratory. Le même prétend que les laves des six principaux volcans de la Côte ouest de l'Italie renferment 10,000,000,000 tonnes de potasse.[1]

Les plantes marines, les varechs, de la côte du Pacifique ont été exploitées par des compagnies américaines qui ont réussi à en extraire une grande quantité de potasse à un prix élevé, comparé à ce que

[1] *Scientific American*, 1918, p. 262.

coûtait cette substance avant la guerre.[1] Les sources de potasse sont très nombreuses,[2] sans parler des cendres de bois dont on se servait à peu près exclusivement autrefois pour la préparation du carbonate de potassium et qui ne sauraient suffire aujourd'hui à préparer la centième partie de la potasse utilisée dans l'industrie. Toutes ces sources, cependant, ne peuvent être exploitées qu'en faisant subir à la matière première des traitements qui élèvent énormément le coût du produit.

A part la potasse, les autres éléments nécessaires à la vie des plantes sont le phosphore et l'azote. On savait déjà que la partie organique des étoiles de mer renferme de l'azote. Le phosphore pouvait s'y trouver aussi en assez grande abondance. Par conséquent, les astéries, dont il fallait auparavant coûteusement débarrasser certains fonds marins dans l'intérêt des huîtres, au lieu d'être une cause de dépenses, pouvaient devenir une source de revenus.

L'analyse a démontré que les trois éléments mentionnés existent dans les étoiles de mer mais en quantité trop petite pour qu'elles puissent être utilisées seules et à une certaine distance du lieu où elles se rencontrent. Nous donnerons donc les résultats de nos analyses, après avoir décrit brièvement l'étoile de mer et montré comment elle vit et comment elle peut se multiplier par scissiparité.

(1)

On appelle Astéries (Asterias) ou étoiles de mer, des animaux marins de la famille des radiaires échinodermes, dont la circonférence présente des angles ou des lobes; ces lobes sont disposés en rayons divergents comme les dessins qui représentent les étoiles. Leur corps est mobile en tous les points; il est orbiculaire et couvert d'une peau coriace. Le dessous du corps est aplati. La bouche, qui sert en même temps d'anus, est située au centre de la face inférieure. De là partent des gouttières ou sillons longitudinaux qui vont aboutir à l'extrémité de chaque rayon. Ces sillons sont bordés de centaines d'épines, courtes, frêles, mobiles, ainsi que d'une infinité de petits tubes que l'animal peut retracter et faire sortir lorsqu'il est dans l'eau. Ces tubes font l'office de ventouses au moyen desquelles l'étoile peut s'attacher à un corps quelconque et se mouvoir lentement. La surface inférieure d'une Astérie est jaunâtre; la partie supérieure coriacée est diversément colorée; elle est rouge, violette, orangée, jaunâtre, etc.

Parmi les huit cents espèces différentes d'étoiles que le Docteur Mead affirme exister dans le monde entier, nous n'avons analysé que

[1] Scientific American Supplement No. 2238–1918, p. 336.

[2] Confer Scientific American Supplement No. 2198–1918, p. 103. La Nature, 1776, 8 juin, 1907; 1862, 30 juin, 1919; 2192, octobre 2, 1915. Bull. Soc. Ind. Mulhouse, avril, 1912. Nature, jan. 25, 1913, et août 28, 1915.

les deux espèces qui se rencontrent en plus grande abondance à St-Andrews, *l'Asterias forbesii* et *l'Asterias vulgaris.*

L'étoile de mer est vorace et se nourrit d'huîtres, de colimaçons, de bernacles, de conques, de moules et de différentes sortes de coquillages. En 1888, bien qu'on ait enlevé 42,000 minots d'étoiles des côtes du Connecticut, Collins a évalué qu'elles ont dévoré pour $631,500 d'huîtres.

L'étoile a une façon à elle de se nourrir. On dit quelquefois de certains petits gourmands qui empilent différents mets autour de leur assiette sans pouvoir les manger qu'ils ont les yeux plus gros que l'estomac. L'estomac de l'étoile se conforme à l'appétit de l'animal dont la bouche est souvent trop petite pour permettre l'ingurgitation de sa proie; l'Asterias, sans cérémonie, projette son estomac au dehors, en enveloppe l'animal à dévorer, digère la nourriture séance tenante, et se rentre de nouveau l'estomac après le diner; c'est très commode et prémunit contre les indigestions, mais pour cela il faut être organisé comme l'Asterias et tous ne sont pas des étoiles. Elle peut sortir son estomac à une distance égale à la longueur d'un de ses bras.

La plupart des animaux qui constituent le menu de l'étoile de mer sont recouverts d'une coquille dont elle doit les débarrasser avant de les manger. On a imaginé toutes sortes d'hypothèses plus ou moins plausibles pour expliquer comment un animal comme l'étoile de mer pouvait ouvrir les coquilles d'une huître. Les uns ont dit que l'étoile prenait l'huître par surprise lorsque sa coquille étaite ouverte, mais l'huître, douée d'une prompte sensibilité, se referme en peu de temps tandis que l'étoile se meut très lentement; d'autres ont prétendu que l'étoile injectait dans le mollusque un poison qui le faisait mourir ou un acide qui dissolvait la carapace calcaire, mais l'analyse n'a jamais révélé la présence de ces prétendus liquides sécrétés.

C'est le Docteur Paulus Schiemenz qui a trouvé le secret par des recherches qu'il a faites à la station zoologique de Naples.

L'étoile entoure sa victime de telle sorte que les suçoirs qui se trouvent sur la partie inférieure de son corps s'appliquent bien sur les coquilles bivalves. Les suçoirs sont nombreux et tiennent solidement. L'étoile fait un effort constant pour se redresser les bras et il en résulte une tension en des directions contraires: cette tension, si elle est prolongée assez longtemps, force l'huître à s'ouvrir. Le mollusque peut résister à un rude effort, mais il cède nécessairement à un effort long et continu, comme celui qui est produit par l'étoile.

Pour donner une idée de la voracité de l'étoile, qu'il me suffise de dire qu'on a constaté qu'un seul *Asterias* a dévoré 50 moules en six jours. Cette constation fit le désespoir des gastronomes et surtout des commerçants d'huîtres: 50 huîtres! c'est presque le repas d'un bon client et l'Astérie dévore tout cela en six jours.

Pour se débarrasser de cet ennuyeux échinoderme, pour lui prouver que la force prime le droit, des hommes, payés par les gouvernements et les compagnies ichtyologiques, allèrent ramasser les étoiles et sans prendre la peine de les apporter à terre pour les brûler ou les laisser se corrompre, les déchirèrent sur place en deux ou trois morceaux et les jetèrent de nouveau à la mer. On constata avant longtemps que les étoiles augmentaient en nombre au lieu de diminuer. Les hommes, en voulant détruire les Astéries, les multipliaient, car ils avaient oublié, ou peut-être ne savaient-ils pas, que ces animaux peuvent se régénérer par scissiparité et qu'au lieu de faire disparaître une étoile lorsqu'ils la déchiraient en deux ou trois parties qu'ils jetaient à la mer, ils donnaient naissance à une ou deux nouvelles étoiles. Les Astéries devaient bien s'amuser de l'ignorance des hommes et de leur manière de faire la guerre.

Il y a longtemps qu'on a constaté la scissiparité de l'Asterias. Cuvier écrivait en 1817 dans son livre "Le règne animal distribué d'après son organisation"—Tom. IV, p. 8: "Elles (les Astéries) ont une grande force de reproduction, et non seulement reproduisent les rayons qui leur sont enlevés isolément, mais un seul rayon conservé peut reproduire les autres." De Lamarck dit à son tour dans son "Histoire naturelle des animaux sans vertèbres"—Tom. III, p. 232: "Les Astéries sont sujettes à perdre un ou plusieurs de leurs rayons par divers accidents auxquels elles sont exposées; mais elles ont la faculté de les régénérer. Elles repoussent même avec tant de promptitude leurs parties perdues que, dans l'été, deux ou trois jours suffisent pour reproduire les rayons qui leur manquent. Ce qui est bien plus remarquable, c'est que ceux des rayons qui ont été entièrement détachés par quelque accident, repoussent eux-mêmes à leur origine d'autres petits rayons et deviennent une Astérie complète, semblable à celle dont ils proviennent. Une simple portion de rayon détaché ne jouirait pas de cet avantage."

H. Milne-Edwards nous assure que le phénomène a été constaté bien avant Cuiver. "Tous les observateurs qui fréquentent le bord de la mer ont eu souvent l'occasion de remarquer la facilité avec laquelle les rayons de certaines Astéries se rompent, et de voir que ces organes, dont la structure est très complexe, repoussent rapidement: un seul rayon peut reconstituer un individu complet s'il conserve à sa base une portion du tronc ou disque. Ces phénomènes furent étudiés expérimentalement en 1741 par Bernard de Jussieu et par Guettard; plus récemment ils ont été observés par beaucoup d'autres naturalistes"

(Leçons sur la Physiologie et l'Anatomie comparée de l'homme et des animaux par H. Milne-Edwards, Tom. IX, p. 305).

Récemment des travaux ont été faits par le Docteur A.-D. Mead et Madame Helen Dean King; ceux-ci en sont arrivés à la conclusion qu'une étoile mutilée peut reproduire ses parties perdues, mais pour cela il faut un rayon complet et un cinquième au moins du disque central; même dans ce cas, la régénération est une exception. Une Astérie reproduit facilement un ou deux rayons, surtout si le disque est peu endommagé. On n'a jamais constaté qu'un rayon, qui n'aurait pas au moins la cinquième partie du disque, pût régénérer une étoile complète; un tel rayon cependant peut vivre une quinzaine de jours dans les conditions les plus favorables.

II

Voyons maintenant la composition chimique de l'Astérie et considérons son utilité, comme engrais, dans le développement de la vie végétale.

Les analyses dont nous allons donner le compte-rendu ont été faites avec l'aide précieuse d'un de nos professeurs de chimie, Sir Georges Garneau, que nous nous faisons un devoir de remercier pour son généreux concours.

Nous avons d'abord fait l'analyse des étoiles de mer telles qu'on les retire de l'eau, avec les plantes marines, les coquillages, les matières organiques ou minérales qui y adhèrent nécessairement ainsi qu'avec l'eau salée qui les imbibe, car, pratiquement, c'est dans de telles conditions qu'elles devraient être utilisées. Ensuite nous avons analysé des Astéries qui avaient été débarrassées de toute matière étrangère et bien lavées à l'eau courante afin de nous rendre compte si les éléments trouvés dans la première analyse étaient bien dans les étoiles et non dans les substances qu'elles entraînent avec elles.

(A)—Nous avons pesé environ 100 grammes d'étoiles de mer en décomposition; nous les avons désséchées à l'étuve à 110°C pendant 36 heures jusqu'à poids constant et nous avons constaté qu'elles avaient perdu 56·15 pour cent de leur premier poids. Ce qui est disparu à l'étuve, c'est l'eau surtout et les gaz résultant de la décomposition de la partie organique de l'étoile.

Les étoiles desséchées sont pulvérisées et passées au tamis de 100 mailles au pouce. Un échantillon est prelevé et l'on incinère au four. La poudre grise résultant de l'incinération est traitée par de l'acide chlorhydrique dilué et la solution évaporée à sec au bain de sable. Le résidu est de nouveau traité par l'acide dilué et évaporé à siccité. On reprend encore le résidu par 10 c.c. d'acide chlorhydrique concentré qu'on laisse agir pendant quinze minutes, puis par 30 c.c. d'eau; on chauffe et on filtre. Le papier-filtre est lavé avec de l'eau chaude et le volume de la solution est porté à 250 c.c.

Silice.—Par l'incinération du papier-filtre nous avons trouvé 3·34 pour cent de silice calculée sur le produit sec et 1·46 pour cent par rapport aux étoiles non desséchées.

Phosphates: On prend 50 c.c. des 250 c.c. de la solution chlorhydrique: on les traite par l'ammoniaque pour précipiter les phosphates, puis par l'acide acétique pour dissoudre les phosphates alcalino-terreux, laissant le phosphate de fer (*a*) non dissous sur le filtre qu'on lave à plusieurs reprises. Les phosphates solubles se trouveraient dans le liquide filtré (*b*).

Après avoir été lavé et séché, le filtre et le précipité (*a*) sont calcinés séparément, puis réunis, chauffés au rouge dans un creuset de platine et pesés.

La solution filtrée (*b*) pouvant contenir aussi des phosphates solubles est évaporée à siccité avec de l'acide nitrique: cette opération, répétée plusieurs fois en reprenant par de l'eau et de l'acide nitrique, donne un résidu qu'on dissout encore dans l'eau et qu'on traite par le molybdate d'ammonium. Après un long repos, le précipité formé est lavé par décantation et sur le filtre avec une solution d'azotate d'ammonium (150 grs. au litre), acidulée par de l'acide nitrique et contenant quelques centièmes de la solution molybdique. Le précipité lavé est redissous sur le filtre avec de l'ammoniaque et le filtre est lavé avec le même alcali (1 dans 3). On ajoute au liquide obtenu 10 c.c. de mixture magnésienne, puis, après quelque temps, un volume d'ammoniaque égal au quart du liquide: le phosphate ammoniaco-magnésien précipite lentenemt et on laisse reposer pendant 24 heures. Le mixture magnésienne se prépare en dissolvant 150 grammes de chlorure de magnésium et 150 grammes de chlorure d'ammonium dans l'eau nécessaire pour former un litre de solution. Ce repos prolongé à pour but de permettre à la précipitation d'être complète; après ce repos, le précipité est lavé avec de l'eau ammoniacale jusqu'à ce que les eaux de lavage, acidulées par l'acide nitrique, ne donnent plus de louche avec l'azotate d'argent. Le filtre est desséché à l'étuve, le précipité séparé du filtre, ce dernier est inciné séparément et les cendres sont réunies au précipité pour la calcination finale. En unissant le poids de ce dernier résidu avec le poids du phosphore dans le phosphate de fer obtenu auparavant, nous avons trouvé qu'il y avait dans notre échantillon d'étoiles décomposées et desséchées 0·684 pour cent. d'anhydride phosphorique P_2O_5; ce qui donne une proportion de 0·30 pour cent. de P_2O_5 dans la matière non desséchée.

Dosage de la Chaux. Nous prenons 25 c.c. de la solution chlorhydrique des étoiles à laquelle nous ajoutons de l'ammoniaque jusqu'à ce qu'un précipité commence à se former; ce précipité est de nouveau dissous dans la quantité strictement nécessaire d'acide chlorhydrique. Nous y ajoutons ensuite un peu d'acétate de soude, qui empêchera les phosphates de devenir insolubles, et de l'oxalate d'ammonium jusqu'à précipitation complète. Après un repos de plusieurs heures, on filtre, on lave le précipité, on dessèche et on calcine. Nous avons trouvé 39·06 pour cent de CaO, calculé sur le poids des étoiles desséchées et 17·11 pour cent sur le produit humide. En considérant que cet oxyde de calcium doit se trouver dans les Astéries sous forme de carbonate, nous concluons que dans ces animaux il y a 30·55 pour cent de carbonate de calcium et qu'il se trouve 69·75 pour cent de ce même carbonate dans la poudre d'étoiles calcinées.

Recherche de la Magnésie. La solution obtenue en filtrant l'oxalate de calcium est traitée par du phosphate acide de sodium; le mélange est laissé au repos pendant douze heures et filtré. Le magnésium reste sur le filtre sous forme de phosphate-ammoniaco-magnésien que l'on dessèche et que l'on calcine d'abord à basse température pour que le phosphore réduit par le carbone du filtre ne détériore pas le creuset de platine. Quand tout le charbon est disparu on élève la température jusqu'à ce que le résidu, devenu bien blanc, soit à poids constant. En pesant, nous trouvons que nos étoiles de mer desséchées contiennent 3·25 pour cent de MgO, et que la proportion de cet oxyde par comparaison avec les Astéries décomposées avant d'être mises à l'étuve est de 1·42 pour cent.

Recherche des Sulfates. Vingt-cinq centimètres cubes de la solution chlorhydrique des étoiles sont traités par une solution de chlorure de baryum; il se forme un précipité que l'on sépare par filtration, que l'on dessèche et que l'on pèse. Tout le sulfate des étoiles est à l'état de sulfate de baryum et nous trouvons par calcul que lorsqu'elles sont desséchées elles renferment 0·73 pour cent du radical SO4″, et 0·32 pour cent avant d'être mises à l'étuve.

Recherche du Potassium et du Sodium. La solution obtenue en filtrant le précipité de sulfate de baryum ainsi que les eaux de lavage, évaporées jusqu'à 150 c.c. environ, puis rendues alcalines par un peu d'ammoniaque, sont ensuite traitées par une solution saturée de carbonate d'ammonium. On filtre et on lave à plusieurs reprises le précipité sur le filtre. Le filtrat et les eaux de lavage sont évaporées au bain de sable dans une capsule de porcelaine. On calcine le résidu au rouge sombre, on le reprend par l'eau et cette opération est répétée plusieurs fois. Le résidu final est traité par de l'acide oxalique anhydre, et le mélange est calciné. On reprend encore par l'eau, on filtre et on calcine le résidu au rouge sombre dans une capsule de platine jusqu'à ce qu'il n'y ait plus rien d'insoluble dans l'eau. La solution, contenant les carbonates de sodium et de potassium, est évaporée à sec dans une capsule de platine tarée, et le résidu dissous dans l'acide chlorhydrique: ce dernier transforme les carbonates en chlorures de sodium et de potassium qu'on dessèche et pèse. Ces chlorures sont traités par une solution de chlorure de platine et le mélange est chauffé jusqu'à consistance sirupeuse. Le potassium, rendu insoluble sous forme de chlorure double de platine et de potassium, existe dans les étoiles desséchées, dans la proportion de 0·168 pour cent, et dans les étoiles non desséchées, dans la proportion de 0·074 pour cent. En retranchant du poids des chlorures alcalins, trouvés auparavant, le poids du potassium considéré sous forme de chlorure, on constate que les Astéries contiennent 1·03 pour cent de sodium lorsqu'elles ont été desséchées et 0·66 pour cent de ce même élément avant d'avoir été mises à l'étuve.

Dosage de l'Azote Total. Nous avons suivi pour ce dosage le procédé de Kjeldahl qui est basé sur l'oxydation du carbone et la transformation de l'azote organique en sulfate d'ammonium au moyen de l'acide sulfurique bouillant en présence du mercure, lequel agit comme porteur d'oxygène et se transforme lui-même en sulfate mercurique. La précipitation du mercure se fait au moyen du sulfure de sodium afin d'empêcher la formation de composés ammoniaco-mercuriques quand la solution est rendue alcaline. On neutralise ensuite avec la potasse caustique qui met le gaz ammoniac en liberté; par la distillation, ce gaz est reçu dans un volume déterminé d'acide chlorhydrique décinormal et l'excès d'acide est enfin dosé avec de la soude décinormale. La différence entre la quantité d'acide qui a été mesurée et la quantité, trouvée ensuite au moyen de la soude, donne la quantité d'ammoniaque. Ces opérations multipliées sur divers échantillons d'étoiles décomposées et non desséchées ont indiqué que les Astéries contenaient 0·77 pour cent d'azote total.

Nous avons fait ensuite l'analyse d'Astéries ramassées à St-Andrews, N.B., débarrassées de toute matière étrangère et bien lavées dans l'eau pure pour enlever l'eau de mer qui les imbibait. Nous avons suivi, pour le dosage des différents éléments et radicaux, les procédés déjà décrits excepté pour le sodium et le potassium où nous n'avons pas employé de chlorure de platine. Pour le dosage de ces deux métaux alcalins, nous les avons transformés en chlorures d'après la marche indiquée précédément dans l'analyse des étoiles qui n'étaient pas séparées des substances diverses qui y sont attachées.

Après avoir pesé ces chlorures, nous avons dosé le chlore au moyen d'une solution décinormale d'azotate d'argent. Nous avons fait aussi le dosage de ces deux éléments par le procédé de Gabrola et Braun tel qu'indiqué dans les "Annales des falsifications" de novembre-décembre, 1917. On a eu recours à ce procédé à cause de la majoration extraordinaire du prix du platine depuis le début de la guerre.

Dans ce procédé on se sert comme réactif du cobalti-nitrite de sodium, qui se prépare avec le nitrate de cobalt et le nitrite de sodium en mélangeant les deux solutions suivantes:

SOLUTION I

Nitrate de cobalt	28 gr. 60
Acide acétique cristallisable	50 c.c.
Eau, q. s. pour faire	500 c.c.

SOLUTION II

Nitrite de sodium	180 gr.
Eau, q. s. pour faire	500 c.c.

Ces solutions, conservées séparément, sont mélangées à volumes égaux deux heures avant de s'en servir. Quand il se fait un dépôt, on filtre.

Ce nouveau procédé commence au point où les métaux alcalins ont été transformés en chlorures et le mélange de chlorure de potassium et de chlorure de sodium a été pesé. On dissout ces chlorures dans environ 25 c.c. d'eau; on acidifie avec l'acide acétique et on y verse entre 5 et 10 c.c. du réactif cobalti-nitrite de sodium.

Après que le réactif a été ajouté on bouche le vase dans lequel s'est fait le précipitation de la potasse. Au bout de douze heures au moins, le potassium est complètement précipité et on filtre à la trompe dans un creuset à amiante taré. Le précipité est lavé à l'eau acidulée avec 10 pour cent d'acide acétique jusqu'à ce que le liquide passe incolore, puis avec l'alcool à 95°. L'eau est ainsi enlevée et la dessication à l'étuve jusqu'à poids constant se fait plus facilement. Le poids du précipité, multiplié par 0·2074 donne le poids de l'oxyde de potasse, K_2O.

Nous avons analysé plusieurs échantillons des deux sortes d'Astéries et nous avons trouvé en moyenne les résultats suivants:

Par l'analyse d'un premier échantillon d'étoiles de mer, telles qu'elles sont ramassées, sans avoir été débarrassées de terre, de mollusques, d'herbes marines, d'eau de mer, etc.

Perte par dessication à 110°C	56·15%
Calculs sur produit humide:	
Silice (Si O_2)	1·52%
Chaux (CaO)	17·11%
Magnésie (MgO)	1·42%
Sulfates (SO_4'')	0·32%
Sodium (Na)	0·66%
Potassium (K)	0·074%
Acide phosphorique (P_2O_5)	0·30%
Azote total	0·77%

Si on considère la chaux sous forme de carbonate, on trouve:

Carbonate de calcium ($CaCO_3$)	30·55%
Calculs sur produit sec:	
Silice (SiO_2)	3·46%
Chaux (CaO)	39·06%
Magnésie (MgO)	3·25%
Sulfates (SO_4'')	0·73%
Sodium (Na)	1·03%
Potassium (K)	0·168%
Acide phosphorique	0·684%
Azote total	1·38%

La chaux doit exister sous forme de carbonate et on aura:

Carbonate de calcium	69·75%

En analysant plusieurs fois les étoiles de mer lavées et séparées de toute substance étrangère, nous trouvons:

Perte par dessication	73·27%
Perte par incinération, calculée sur produit sec	38·06%

Calcul sur produit humide

Silice (SiO_2)	0·15%
Sulfates (SO_4'')	0·42%
Sodium (Na)	0·28%
Potassium (K)	0·54%
Acide phosphorique (P_2O_5)	0·35%
Azote total	2·39%

Calcul sur produit sec

Silice (SiO_2)	0·57%
Sulfates (SO_4'')	1·65%
Sodium (Na)	1·05%
Potassium (K)	2·01%
Acide phosphorique (P_2O_5)	1·32%
Azote total	8·91%

Nous n'avons pas dosé la chaux dans les dernières étoiles.

Il appert donc d'après ces analyses que les Astéries contiennent tous les éléments qui entrent dans la composition d'un engrais, c'est-à-dire, l'azote, le potassium et le phosphore, cependant il est évident aussi que le potassium s'y trouve en trop petite quantité—un peu plus que ½ pour cent dans les étoiles non desséchées—pour songer à l'extraire avec profit de cet animal.

Les étoiles de mer pourraient être employées pour engraisser les terres situées près des fonds marins où ces échinodermes existent en grande abondance. Elles seraient surtout utiles pour amender les terrains acides à cause de la grande quantité de carbonate de calcium qu'elles renferment. Mélangées à de l'apatite pulvérisée et à un sel de potassium, elles feraient sans doute un excellent engrais complet, qui ne serait pas économique toutefois.

Vestigial Centripetal Xylem and Transfusion Tissue in the Leaf of Pinus Strobus

By LILIAN V. BAKER

Presented by R. B. THOMSON, B.A., F.R.S.C.

(Read May Meeting, 1920)

Transfusion elements, in the form of variously sculptured parenchyma shaped tracheids,[1] constitute an intrastelar tissue of wide occurrence in the leaves of the Gymnosperms. From the year 1847 since its first recorded observation by Karsten (8) the problem of the origin, development and significance of transfusion tissue has greatly interested a number of botanists. Of the earlier writers, Frank (5) was, perhaps, the first to suggest its origin (1864). He considered the connection of transfusion tissue with the centrifugal xylem of the fibrovascular bundle a definite indication of its derivation from secondary

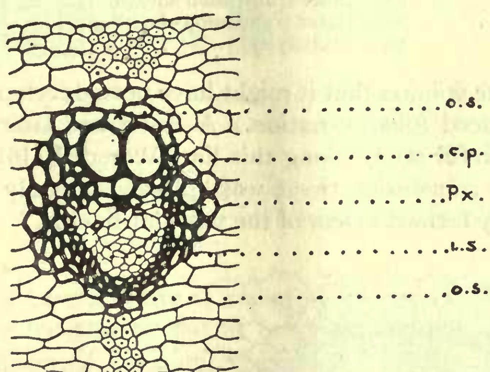


Fig. 1.—*Cordaites principalis.*
[Transverse section of leaf bundle—Stopes after Jeffrey (7).]
cp.—Centripetal xylem.
i.s.—Inner transfusion sheath.
o.s.—Outer transfusion sheath.
px.—Protoxylem.

[1] Coulter (3) divides the entire foliar pericycle into "two kinds of parenchymatous cells; (1) those without protoplasm and pitted and (2) those with protoplasm and not pitted," and terms both groups of elements collectively, transfusion tissue. All other authors, however, except, perhaps, Jeffrey (7), restrict their use of this term to the former group of elements only, that is to the tracheary components of the pericycle.

wood. However, in 1865, Thomas (13) and later, in 1871, Von Mohl (10) expressed the view that it was a derivative of parenchymatous tissue. Moreover, in 1890, Daguillon, after an extensive study of the foliar conditions of the Abietineæ came to substantially the same conclusion, in that he evidently considered transfusion tissue of pericyclic origin. DeBary (1) in 1877, and Lignier (9) as late as

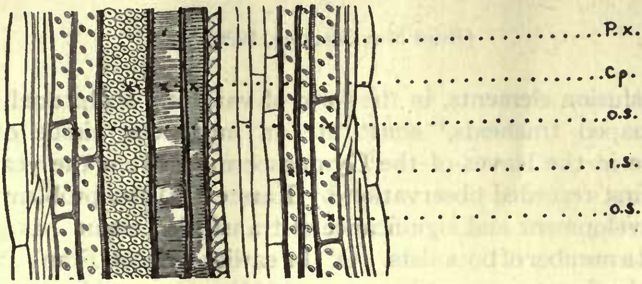


Fig. 2.—*Cordaites principalis.*
[Long. radial section of leaf bundle—Stopes after Jeffrey (7.).]
cp.—Centripetal xylem.
i.s.—Inner transfusion sheath.
o.s.—Outer transfusion sheath.
px.—Protoxylem.

1892, formed the opinion that it might have been developed in replacement of a reduced foliar venation. A few years later (1879) after considerable careful study along this line, Worsdell (16) came to the conclusion that transfusion tissue was "phylogenetically derived from the centripetally formed xylem of the vascular bundle." Bernard's (2)

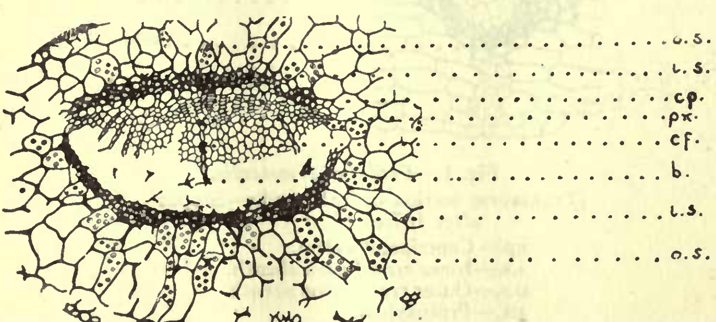


Fig. 3.—*Prepinus statenensis.*
Transverse section of leaf bundle—Jeffrey 7.
b—Bast.
cp.—Centripetal xylem.
cf.—Centrifugal xylem.
i.s.—Inner, o.s.—outer, transfusion sheath.
px.—Protoxylem.

observations in 1904 brought him a step further than Worsdell and led him to conclude "le tissue de transfusion n'est autre chose que le bois centripete." Stopes (12) in her interpretation of the Cordaitean leaf bundle (1903) Figs. 1 and 2, combined Worsdell's view with that of some of his predecessors. She thought the cells of the fossil inner sheath might "represent but little modified elements of it (centripetal xylem)"—but the outer transfusion zone, she considered "phylogenetically a parenchyma sheath which had acquired bordered pits." Jeffrey (7), however, appears to have associated both these sheaths in the ancestral fossil forms (Cordaites, Figs. 1 and 2, and Prepinus, Figs. 3 and 4) with the "cryptogamic wood."

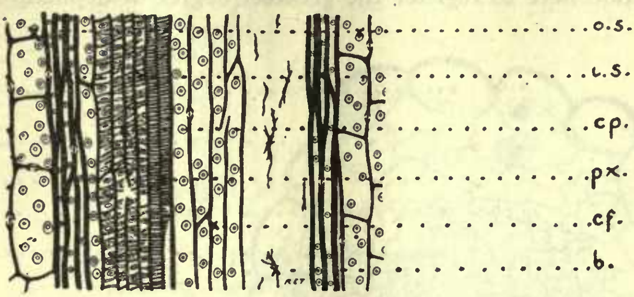


Fig. 4.—*Prepinus statenensis.*
(Long. radial section leaf bundle—Jeffrey 7.)
b.—bast.
cp.—Centripetal xylem.
cf.—Centrifugal xylem.
i.s.—Inner, o.s.,—outer, transfusion sheath.
px.—Protoxylem.

Obviously a careful study of a single present day Abietinean form in all stages of development should bring important evidence to bear on this much disputed question. Selection from the genus *Pinus* in particular was considered advisable, inasmuch as the peculiar disposition of transfusion tissue within the pericycle of this group has led some authors to consider the pine a most primitive type, while others believe it a much modified form. The species *strobus* was chosen in view of the fact that it afforded such a great variety of easily accessible material. The writer, moreover, was particularly fortunate in having also available polyphyllous brachyblasts produced by the seedling in response to wounding. These were described by Thomson (15) in his work on the "Spur Shoot of the Pines" in 1914, and he suggested that they might yield internal structural evidence of considerable significance from a phylogenetic standpoint. It was possible, therefore, to make sections of cotyledonary, primordial, normal, and polyphyllous adult leaves. These were studied both in transverse and longitudinal series. All drawings were made with the camera lucida. Longitudinal figures have been so oriented that the upper surface of the leaf bundle appears to the left, the lower to the right of the page, respectively, while cross sections have been shown in each instance with the xylem portion of the bundle towards the top.

The Adult Leaf. It was considered advisable to begin a study of the adult leaf of Pinus strobus in order first to become acquainted with the ultimate state of development to which the present day form had attained. Whatever the morphological or anatomical structures which characterized the ancestor of the group, it is natural to expect the condition here to register the greatest degree of departure therefrom.

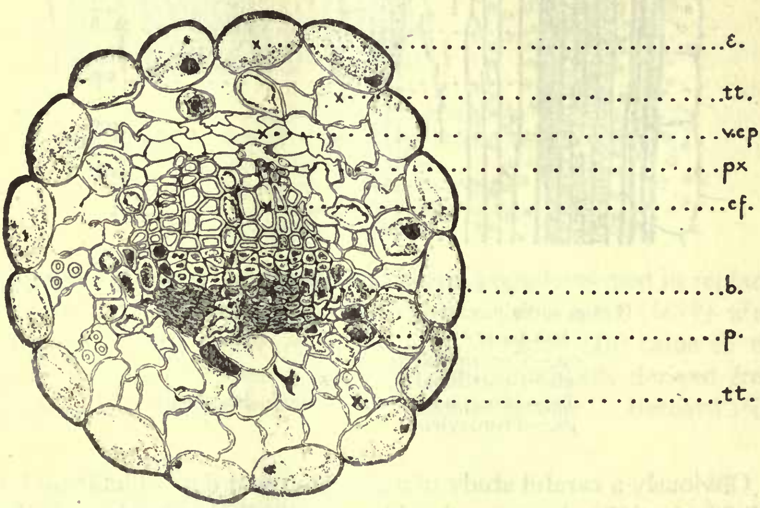


Fig. 5.—*Pinus strobus.*
Transverse section of adult leaf bundle at centre—x 300.)
b.—Bast; cf.—Centrifugal xylem; e.—Endodermis; p.—Parenchyma; px.—Protoxylem; tt.—transfusion tissue; v.cp.—Vestigial centripetal xylem.

Turning first to a consideration of the adult stele, in transverse section (Fig. 5) one finds a general tendency on the part of the transfusion tissue to resolve itself, above and below the bundle, into two irregular layers, interpersed with parenchyma while laterally by additional transfusion elements it comes into direct continuity with the secondary wood. Radial longitudinal sections prove the outer layer of tracheary tissue immediately below the bundle to be composed of short and comparatively broad elements, while the inner row is observed to consist of longer and relatively narrower cells (Fig. 6). The same feature in regard to the respectively greater length of the inner transfusion elements is shown by Figs. 7, 8 and 9. Fig. 7 represents a portion of a section cut longitudinally in the tangential plane at the flanks of the secondary wood. Here the suggestion of continuity of the tissues in transverse section is strengthened by the presence of a defi-

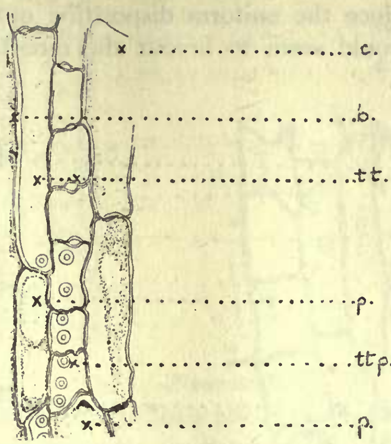


Fig. 6.—*Pinus strobus.*
(Adult, long., radial, lateral and below bundle—x 300.)
b.—Bast; e.—Endodermis; p.—Parenchyma;
tt.—Transfusion tissue; tt.p.—Pitting.

nite gradation of elements both in length and calibre, from the cells of the centrifugal xylem to those of the transfusion tissue immediately within the endodermis. The inner transfusion tracheids extending around and above the bundle from this region also are of greater length than the outer tracheary cells. The latter, however, are longer at this point than below the bast. Obviously the greatest length of transfusion elements is attained at the flanks of the centrifugal xylem and especially in those elements in direct contact with it, the elements becoming shorter the farther they are from this region, and attaining their minimum length immediately above and below the bundle. They are shorter, however, below the bast than above the wood.

This lack of uniformity in length among the transfusion elements of the modern leaf presents a curious anomaly in view of Stopes' (12) interpretation of the origin of transfusion tissue. The elongate character of the elements of the inner transfusion sheath of the fossils, which encircled the entire bundle in Prepinus (Figs. 3 and 4) and when present, enveloped the bast in Cordaites (Figs. 1 and 2), may be seen from the figures. If transfusion tissue be a derivative of this inner sheath there is every reason to expect the elements below the bundle, in the modern form, to equal in length those at its flanks, or those above it. However, this is not the case, and consequently this interpretation of the origin of transfusion tissue can hardly be accepted, without, at least, some reasonable explanation for the non-conformity of cell length in the modern type. A physiological explanation seems scarcely possible, since the uniform disposition of the chlorenchyma around the stele would seem to favour the retention of a uniform surrounding sheath.

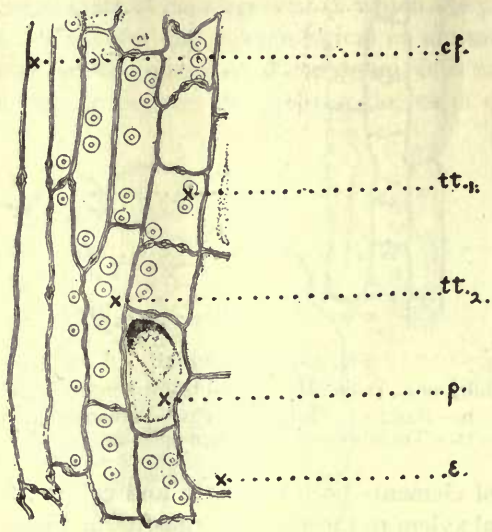


Fig. 7.—*Pinus strobus.*
Adult long. tang. at flank of centrifugal xylem—x 350.
cf.—Centrifugal xylem; e.—Endodermis; tt_1 and tt_2.—Inner and outer layers of transfusion tissue; p.—Parenchyma.

The longitudinal radial section, (Fig. 8) shows the disposition of tissues in the upper portion of the bundle. The presence of a large parenchymatous cell interrupts the continuity of the two layers of transfusion elements just within the endodermis. Immediately below these, to the left, a much elongated parenchymatous cell is found, followed abruptly by three rows of extremely thin walled elements just above, *i.e.*, to the right of the protoxylem. Four very small pits in face view are discernible on the radial walls of these elements, while on the square end wall shown, there was a structure suggestive of a bordered pit. To the left, in Fig. 9, a tangential section, cut across the pericycle just above the protoxylem, the nature of this tissue is more clearly shown. The elements are much elongated and have variously

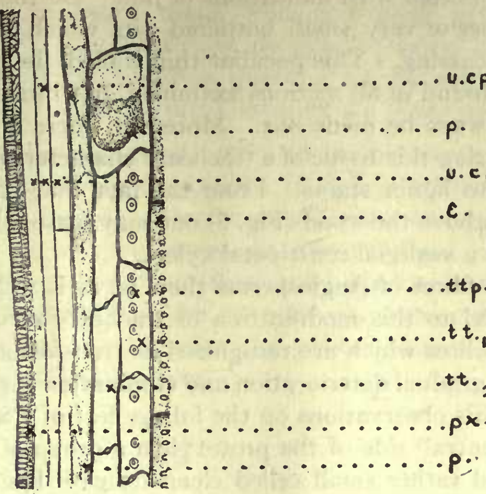


Fig. 8.—*Pinus strobus.*

Adult long. radial above protoxylem—× 300.

e.—Endodermis; p.—Parenchyma; px.—Protoxylem; tt_1, tt_2 and ttp., inner, outer, and pitting of, transfusion tissue; v.cp.—Vestigial centripetal xylem; v.cp.p.—Pitting on v.cp.

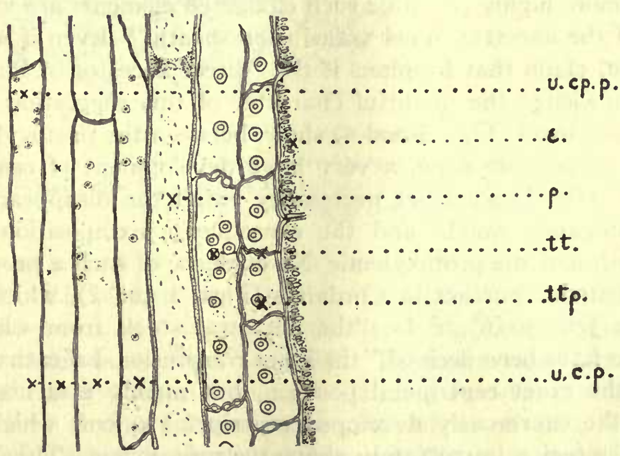


Fig. 9.—*Pinus strobus.*

Adult, long. tang. above protoxylem—× 320.

e.—Endodermis; p.—Parenchyma; tt.—transfusion tissue; tt.p.—Pitting on tt; v.cp.—Vestigial centripetal xylem; v.cp.p.—Pitting on v.cp.

shaped end walls, often with indications of pits. On the walls in face view are a number of very small bordered pits which show distinct cross pores on focussing. This peculiar thin walled tissue above the protoxylem was found in all sections examined, but its small bordered pits could not always be made out. Moreover, there is further evidence for considering this tissue of a tracheary character, since its walls readily respond to lignin stains. From the fact that it occurs in a position directly above the wood (Fig. 5) one may reasonably conclude that it represents a vestigial centripetal xylem.

In the wood fibres of Angiosperms there is, as is well known, an interesting parallel to this modification of tracheary elements in the pine. Here, on fibres which are recognized as transformed tracheids, one meets with a gradual deterioration and elimination of pits.

Worsdell in his observations on the foliage leaf of *Pinus Pinaster* found "on the ventral[1] side of the protoxylem a group of thin walled irregularly shaped rather small celled elements with lignified walls," and "very small, but distinct bordered pits." The latter, in some instances, he further records, were "almost obliterated" and, he adds, "in a great many cases were entirely gone." He says, "it seems to me that these tracheids represent the last lingering remnant of centripetal xylem which is gradually becoming resolved into parenchymatous elements."

Jeffrey (6), however, doubts Worsdell's interpretation and considers it "more highly probable such elongated elements are in reality vestiges of the ancestral inner transfusion sheath." Even if we allow Jeffrey's (6) claim that Prepinus is the "direct ancestor of Pinus" we must acknowledge the doubtful character of this suggestion, for his figures of the fossil (Figs. 3 and 4) show, between the protoxylem and the inner transfusion zone, a very large development of centripetal tracheids. His theory must necessarily entail the disappearance of this "cryptogamic wood," and the consequent juxtaposition of the inner sheath and the protoxylem. No evidence of such a process has been presented. Further in Cordaites (Figs. 1 and 2), which is admitted by Jeffrey (6) to be "the ancestral stock from which the Coniferales have been derived," the inner transfusional sheath does not occur in the exact centripetal position, but merely attaches to the flanks of the enormously developed centripetal xylem, which alone occupies the region immediately above the protoxylem. Thus, in this generally recognized ancestor of the group, one can find no elements of the structure from which Jeffrey suggests that the thin walled tissue has been derived. In consequence, the writer does not see any ground

[1] Ventral, in the old sense, means directly above the protoxylem.

for accepting Jeffrey's view, and believes herself justified in considering this vestigial tracheary tissue true centripetal xylem. This is in agreement with Worsdell's view, though the writer disagrees with his interpretation of the tissue in question as the source of transfusion elements, believing rather that the latter is a tissue sui generis.

The Polyphyllous Adult Leaf. Ordinarily, as is well known, the spur shoot of *Pinus strobus* bears a fascicle consisting of five needles. Thomson (15), however, has recorded several instances of the occurrence of supernumerary leaves, in acknowledged primitive regions. Moreover, he has shown that these can be induced traumatically, and that morphologically they are more primitive than the ordinary adult leaves, suggesting further that the polyphyllous leaf would possess primitive anatomical features.

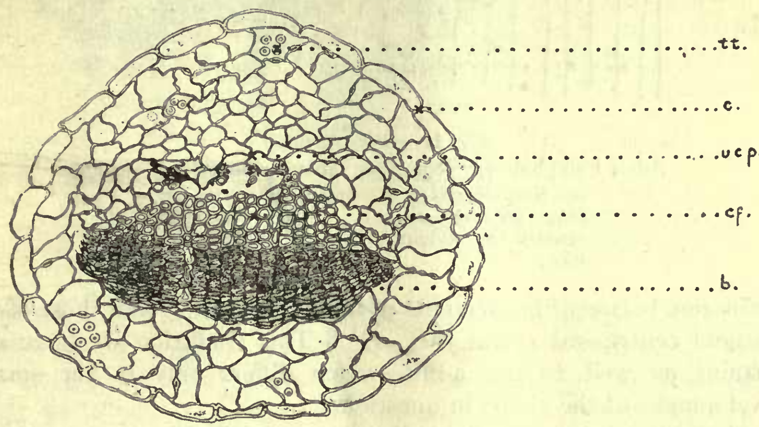


Fig. 10.—*Pinus strobus.*
Adult Polyphyllous—transverse centre.
b.—Bast; cf.—Centrifugal xylem; e.—Endodermis; tt.—transfusion tissue; v.cp.—Vestigial centripetal xylem.

A cross section at about the centre of a leaf taken from a fifteen needled fascicle is shown in Fig. 10. Transfusion elements here form an irregular zone about the entire bundle, and are more abundant than in the normal leaf (*cf.* Figs. 5 and 10). The inner transfusion cells like those of the normal form are longer than the elements just within the endodermis. A direct lateral connection of transfusion tissue with centrifugal wood is clearly discernible as in the ordinary leaf. Above the protoxylem a large proportion of the pericycle consists of thin walled cells comparable to those found in the corresponding region of the normal adult. When observed in longitudinal section (Fig. 11) their similarity is even more apparent, although in the material examined, only a few pits were discovered. These proved to be, in all instances, of the same type as the "vestigial centripetal xylem" of the ordinary form. The longitudinal walls of the elements composing this tissue are, moreover, very thin and the slightly tapered or horizontal end walls often show pit-like thickenings. There is a sharp

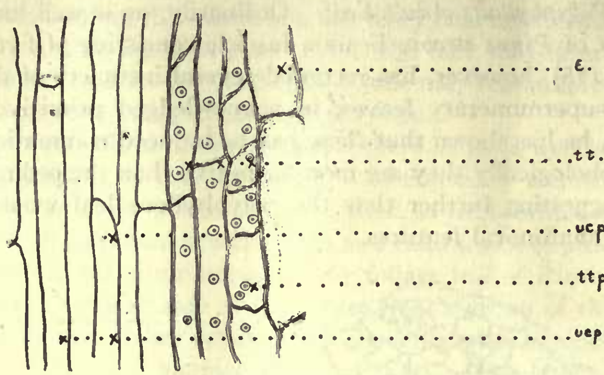


Fig. 11.—*Pinus strobus.*
Adult Polyphyllous—long. tang. above protoxylem—x 200.
e.—Endodermis; tt.—transfusion tissue; tt.p.—Pitting on tt; v.cp.—Vestigial centripetal xylem; v.p.cp.—Pitting on v.cp.

distinction between the elements of transfusion tissue and those of this vestigial centripetal xylem (Fig. 11). This condition we have seen pertains as well to the adult, which differs only in the smaller development of the tissue in question.

Unfortunately, all polyphyllous material had been preserved for an indefinite period in strong formaldehyde solution, which had so greatly distorted the tissues it was found necessary to treat the material with "eau de javelle." This subsequently interfered with the ready absorption of staining reagents and consequently increased the difficulty of interpretation. For instance, it cannot be concluded that the vestigial pitting found represents the maximum of development for the form, nor yet can it be compared with any certainty in this respect with that of the ordinary type.

The Primordial Leaf. The primordial leaf, which occurs normally on the seedling, in advance of the fascicled condition, and occasionally on the adult, as a traumatic response, is conceded by morphologists to be more primitive than the adult leaf.

Fig. 12 is from a transverse section at about the centre of a primordial needle. The pericycle consists of numerous tracheary elements intermingled with parenchyma, the former particularly abundant at the flanks of the secondary phloëm and at the region of the primary bast. A definite linkage with the cells of the centrifugal wood, just above the cambial region, can be seen, while in Fig. 13 the actual transition between the elements of the two tissues may be

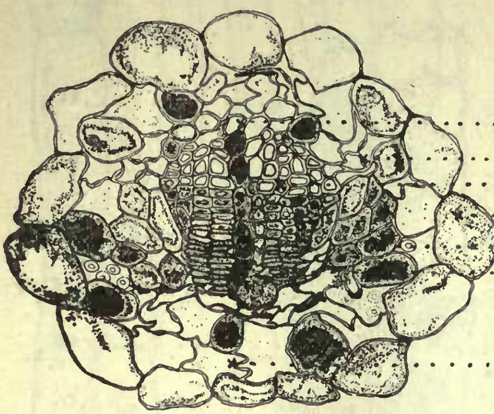


Fig. 12.—*Pinus strobus.*
Primordial, transverse at centre—x 300.
b.—Bast; cf.—Centrifugal or secondary wood; e.—Endodermis; p.—Parenchyma; tt.—transfusion tissue; v.cp.—Vestigial centripetal xylem.

observed in the longitudinal tangential plane. Fig. 14 is a tangential section cut through the region between the transfusion elements and the protoxylem, the lateral transfusion cells and the endodermis being shown at the sides of the figure. The thin walled cells in the centre are quite distinct from the transfusion elements, nor could any continuity be found between them. In the two superposed layers of this tissue the end walls are blunt or oblique as the case may be, and the few pits small and faint. Vestigial centripetal xylem is thus present in the primordial leaf and is quite distinct from the surrounding tracheary elements of the transfusion zone.

There is thus unmistakable evidence in the three types of leaves of *Pinus strobus* studied of the presence of centripetal xylem, notwithstanding Jeffrey's (7) statement to the contrary. Further the elements of centripetal xylem are separated by a distinct line of demarcation from those of the transfusion tissue. There is moreover no indication of transition in pitting between the transfusion cells and the immediately adjacent centripetal tracheids. Thomson (14) in his observation on the attachment of transfusion tissue throughout the Gymnosperms has noted, however, that where there is much primary wood present the transfusion tissue is connected with it. He has observed, further, that in the higher forms where the centripetal xylem has been replaced by secondary wood the attachment takes place at the flanks of the latter. The degree of development to which the wood has attained seems thus to be the deciding factor in

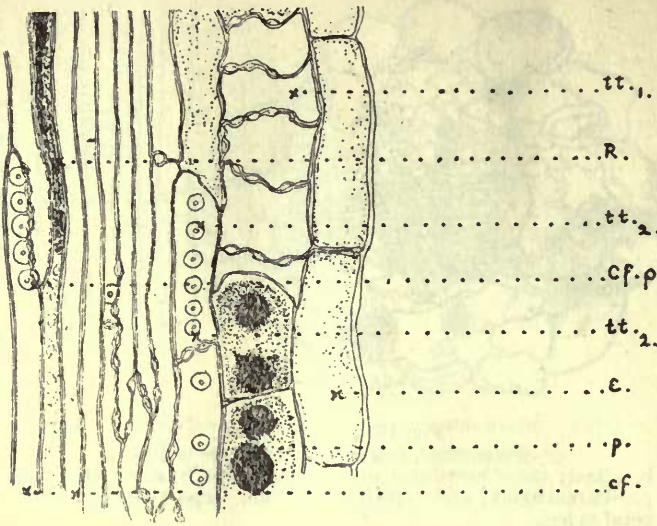


Fig. 13.—*Pinus strobus.*
Primordial, long., tang. at flanks of cf.—x 320.
cf.—Centrifugal wood; cf.p.—Radial pitting on cf; e.—Endodermis; p.—Parenchyma; R.—Medullary ray; tt_1 and tt_2—Inner and outer transfusion tissue.

determining where we shall find the attachment of transfusion tissue. Worsdell and Bernard, however, laid especial emphasis on its origin from and connection with primary wood and considered its attachment with centrifugal xylem "a purely secondary result." Worsdell states that the linkage with the primary wood is a definite indication of "an extension" of centripetal xylem "towards the sides of the bundle." Physiologically this may be possible, but all evidence from the pine proves it none the less possible that transfusion tissue may be as well a physiological extension of secondary wood. Moreover, the term "extension," as used by Worsdell, postulates an active transmigration of cells, an idea which may have arisen as a result of observations on the transformations in animal tissues. However, in plant cells transmigration is not known to take place. Again Bernard (2), who goes a step further than Worsdell and claims the complete identity of centripetal xylem with transfusion tissue, has failed to appreciate the fact that "*true centripetal xylem is opposite the protoxylem.*" (Thomson 14.) Thus his homology can only apply to those elements immediately above the protoxylem.

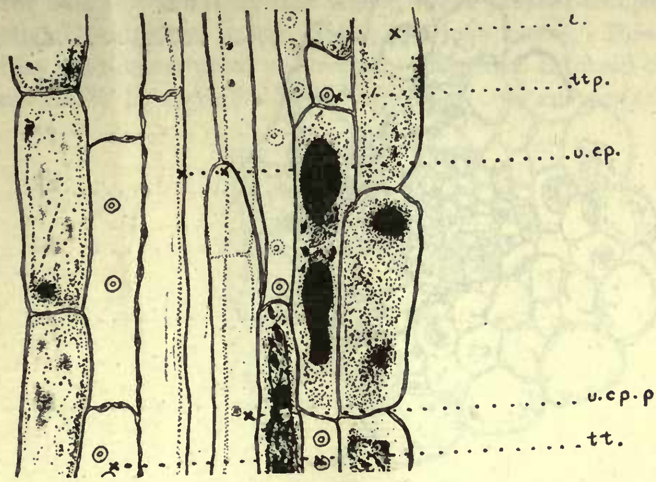


Fig. 14.—*Pinus strobus.*
Primordial long. tang. above protoxylem—x 320.
e.—Endodermis; tt.—transfusion tissue; ttp.—Pitting on tt; v.cp.—Vestigial centripetal xylem, v.cp.p.—Pitting on v.cp.

The Cotyledonary Leaf. The cotyledon is regarded as one of the most primitive types of leaf. A section cut transversely at about the centre (Fig. 15) shows within the irregular endodermis (bounding the figure) a pericycle of, for the most part, two largely parenchymatous layers. There is at the left an obvious connection of transfusion tissue with the secondary wood. This is not so manifest at the right owing to the considerable admixture of parenchyma at this point. The tendency of the transfusion tissue to dispose itself in the arc of a circle just within the endodermis above the xylem portion of the bundle is also demonstrated by the figure. No tracheary elements are found on the phloëm side of the bundle. Fig. 16 is a drawing of a radial section cut in the longitudinal median plane. Fig. 17 shows at a lower magnification one of the very long centripetal xylem elements. In both figures, as usual, the lower surface of the leaf is towards the right. Immediately at the left of the protoxylem a single row of elongated parenchyma cells occurs, followed by a long narrow tracheary element. To the left of this again, and between it and the endodermis, there is found a row of elements suggestive of elongated transfusion tracheids. A tangential longitudinal section above the protoxylem is partly represented by Fig. 18. Here within the endodermis there is a tier of cells consisting of one complete tracheary element, a portion of a second and a parenchyma cell. Adjacent to this row (at the left of the figure) a narrow and apparently much longer element with bordered

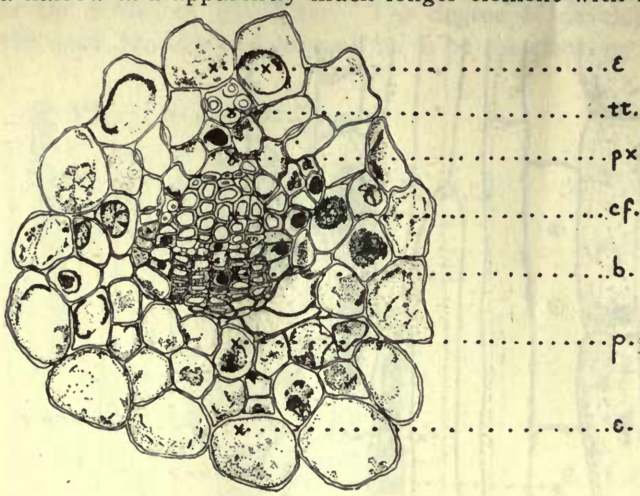


Fig. 15.—*Pinus strobus.*
Cotyledon—transverse at centre—x 500.
b.—Bast; cf.—Centrifugal xylem; cp.—Centripetal xylem; e.—Endodermis; p.—Parenchyma; px.—Protoxylem; tt.—Transfusion tissue.

pits is found. At the flanks of the secondary wood (Fig. 19) are tracheid-like elements which, even including those situated immediately within the endodermis, are of considerable length.

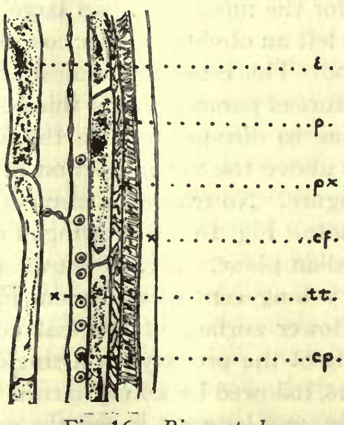


Fig. 16.—*Pinus strobus.*
Cotyledon—long. radial median sect.—x 500.
cf.—Centrifugal; cp.—Centripetal xylem;
e.—Endodermis; p.—Parenchyma;
px.—Protoxylem; tt.—Transfusion tissue.

The structure of the cotyledonary leaf varies considerably, as will have been observed, from the other forms. Probably the most marked difference consists in the total absence of transfusion elements below the bast. There is no thin walled tissue present comparable to the vestigial centripetal xylem of the previous leaves. However, in view of its exact centripetal position, the elongated tracheid of Fig. 20 may reasonably be considered an element of true centripetal xylem.

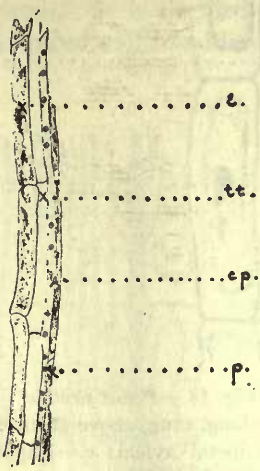


Fig. 17.—*Pinus strobus.*
Cotyledon—long. radial median—x 150.
cp.—Centripetal xylem; e.—Endodermis;
p.—Parenchyma; tt.—Transfusion tissue.

The smallness of the amount of this tissue is probably associated with the lack of development of the whole stele. (If a comparison of figures of the steles of the adult and cotyledonary leaves is made (*cf.* Figs. 5 and 15) it will be seen that the former has fully twice as much stelar tissue as the latter.) Moreover, transfusion elements, while continuous with the secondary wood at its flanks, do not show as marked a diminution in length towards the endodermis as in the other types.

While theoretically a primitive organ some have considered the cotyledon, in view of its peculiar functions, in reality a specialized structure. Consequently the value of any phylogenetic interpretation suggested by the cotyledonary condition might meet with some disparagement. However, the position of the cotyledon within the seed is such that the lower portion is turned towards the outside and consequently the bast is in contact with the endosperm. In consequence of the absorptive activity of the lower surface one ought to find a well-developed transfusion tissue on the bast side of the bundle. Certainly if ever of ancestral occurrence here its physiological function would necessitate its retention at this position of most need. However, as previously noted, it is never found below the phloëm. This condition in the cotyledon is at distinct variance with Jeffrey's view that trans-

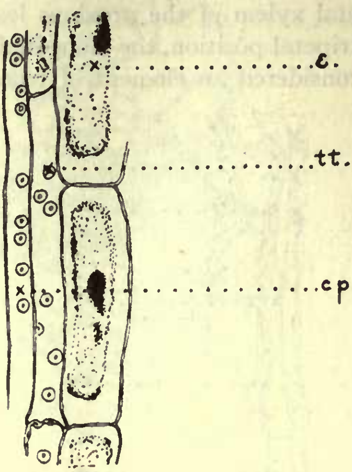


Fig. 18.—*Pinus strobus.*
Cotyledon—long. tang, above protoxylem—x 550.
cp.—Centripetal xylem; e.—Endodermis;
tt.—Transfusion tissue.

fusion tissue in the pines and modern conifers represents a deterioration of the outer transfusional sheath which surrounded the entire bundle in Cordaites and Prepinus (Figs. 1 and 3). In whatever way the fossil transfusion tissue may have arisen the structure shown in the vegetative leaves of modern pines obviously cannot be considered to represent a deteriorated remnant of it.

General. Several authors, as stated previously, have spoken of the possible origin of transfusion tissue from the parenchymatous cells of the pericycle. Worsdell (16) himself admits that "tracheids such as those of the transfusion tissue may be formed anywhere, at any time and from any tissue of the plant," and as an illustration refers to the transfusion tissue found in the stem of Casuarina. This is a tracheary tissue evidently developed from parenchyma and certainly absolutely independent of centripetal xylem, since such a tissue is not existent in the form. He might equally well have referred to the velamen of orchids—a well-known example of a tracheary tissue derived from cortical and therefore parenchymatous cells.

The derivation therefore of transfusion tracheids from the pericycle of the foliar vascular bundle is undoubtedly a possibility. Such an interpretation of their origin would explain the parenchymatous shape of the transfusion elements and account for their irregular distribution. It moreover requires no explanation for the lack of transitional elements between centripetal xylem and transfusion tissue. Connection with the secondary wood and the absence of radial arrangement both become normal features requiring no especial morphological explanation. Further the theory does not depend for justification on any doubtful hypothesis. It is decidedly less open to objection than the other views advanced and in addition explains the condition found in the pine.

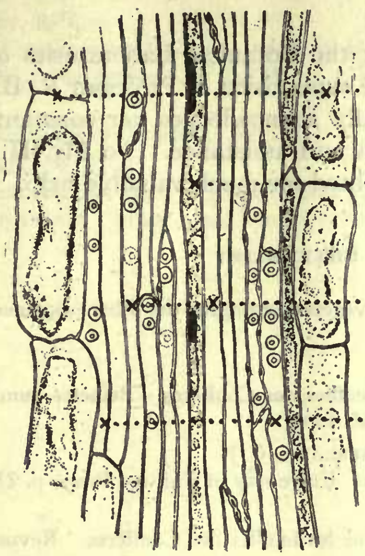


Fig. 19.—*Pinus strobus.*
Cotyledon—long. tang. across cf.,—x 450.
cf.—Secondary wood; e.—Endodermis;
R.—Medullary ray; tt.—Transfusion tissue.

Conclusions

A. The evidence from *Pinus strobus* invalidates the evidence of the origin of transfusion tissue from:

1. *The Fossil Sheaths.*

   Owing to the fact that the cotyledonary transfusion tissue does not envelope the entire bundle as in the fossils.

2. *The Secondary Wood.*

   In view of the lack of radial arrangement of the transfusion tissue and its varied pericyclic disposition.

3. *The centripetal xylem.*
   Because of the lack of transition between it and the transfusion tissue, and the impossibility of explaining the pericyclic distribution of the latter.

B. The evidence from *Pinus strobus* permits an interpretation of the origin of transfusion tissue from parenchyma since it admits of:

1. The variable pericyclic arrangement of elements in cotyledon, primordial or adult leaf without necessarily demanding any explanation for the lack of correlation with the fossil forms.
2. The parenchymatous shape of the cells.
3. The complete demarcation both in form and character of transfusion elements from the cells of the centripetal xylem.
4. The absence of radial arrangement at the connection with the secondary wood.

This work was done at the Botanical Laboratories of the University of Toronto under the supervision of Professor R. B. Thomson, to whom the writer gratefully acknowledges her constant indebtedness for invaluable criticism and assistance. To Mr. H. B. Sifton, M.A., the writer is also indebted for much valuable help.

Bibliography

1. De Bary—
   Vergleichende Anatomis der Vegetationsorgane der Phanerogamen und Farne, Leipzig, 1877.
2. Bernard—
   Le Bois centripete dans les feuilles des Conifères. Beihefte zum Botanischen Centralblatt, p. 241, Bd. XVII, 1904.
3. Coulter, J. M., and Chamberlain., C J.
   Morphology of Gymnosperms. University of Chicago Press, p. 237, 1910.
4. Daguillon—
   Reserches morphologiques dans les feuilles des Conifères. Revue générale de Botanique II (1890).
5. Frank—
   Beitr zur Kenntn. d. Gefaszbundel (Bot. Zeit. Jhrg. XXII, p. 149, Leipzig, 1864).
6. Jeffrey—
   On the structure of the Leaf in Cretaceous Pines. Annals of Botany. Vol. 22, pp. 207–220, 1908.
7. —
   The Anatomy of Woody Plants. University of Chicago Press. pp. 119–213, 1917.
8. Karsten—
   Die Vegetationsorgane d. Palmen. (Abh. d. k. Adad. d. Wiss. zu Berlin, Séances de 1847, Berlin, 1849.)
9. Lignier—
   La nervation des Cycadées est dichotomique (Ass. fr. pour l'avancement des Sc. Congrés de Caen, 1894).

10. VON MOHL—
Uber den Bau des Cycadeenstammes und sein Verhaltiness zu dem Stamme d. Coniferen und Baumfarne (Denkschr d. k. bayer. Akad. d. Wiss. Vol. X, p. 400. Munchen, 1832).

11. —
Morphol, Betrachtung d. Blatter in Sciadopitya (Bot. Zeit. XXIX, p. 1. Leipzig, 1871).

12. STOPES, DR. M. C.—
On the Leaf-structure of Cordaites. New Phytologist, Vol. II, Nos. 4 and 5, 1903.

13. THOMAS—
Zur vergl. Anat. d. Coniferen-Laubblatter. (Pringsheim's Jahrb. IV, Heft 1, Leipzig, 1864).

14. THOMSON, R. B.—
On the Comparative Anatomy and Affinities of the Araucarineæ. Phil. Trans. Roy. Soc. Long. Series B., Vol. 204, pp. 1–50, 1912.

15. —
The Spur Shoot of the Pines. Bot. Gaz. 57, pp. 362–385. 1914.

16. WORSDELL, W. C.—
On "Transfusion-tissue," its Origin and Function in the Leaves of Gymnospermous Plants. Trans. Linn. Soc., Ser. 2, Bot., Vol. V, pp. 301–319. 1897.

Elevator Screenings; Their Source and Composition and Certain Problems Connected with their Disposal and Use

By JOHN R. DYMOND, M.A.

Presented by R. B. THOMSON, B.A., F.R.S.C.

(Read May Meeting, 1920)

INTRODUCTORY

Weed growth in farm crops constitutes an economic loss due to the injury sustained by the growing crop on account of the competition of the weeds for the light, moisture and plant food.

As a result of estimates made in 1908 Pammel concluded that an increase of twenty million bushels in the corn crop of Iowa should be possible by better methods of cultivation. These conclusions were based on the observation that good clean fields yield fifty to sixty bushels per acre while the weedy fields only between twenty-five and thirty. It is said that the farmers could easily increase their wealth by eight million dollars, allowing a little expense for labour.

In this connection it must be borne in mind that increased production by means of more thorough tillage is not always economically advantageous. Carver states that,

"the aim of rational industrial management and statesmanship is, or always should be, to secure as large a product per man as possible, and not necessarily as large a product per acre as possible. In fact a large product per acre is desirable *only* when it means a large product per man, and never otherwise."

"Even assuming it to be possible to make one acre produce a hundred bushels of wheat, it by no means follows that it would be economical to try to do so. In fact, it most certainly would not be economical, for the reason that it would require such a quantity of labor and care in the preparation of the soil, in the selection of the seed, and in the nurture of the plants, as to amount to a great waste of time and energy—a waste so great as to overbalance the economy of land. It would require much less labor to produce a hundred bushels on two acres than on one, probably less on three acres than on one, and quite possibly less on four than on one."

In Western Canada, the area of cultivated land per man is very large. This, together with the fact that a large proportion of the land is sown continuously to cereals year after year, has allowed a great variety of annual weeds to become widely established. Weed growth in Western grain fields is therefore largely an economic question which it is not proposed to deal with here.

It was the object of the investigation reported herein to inquire into (1) the extent to which Western grain is contaminated with weed seeds, (2) the relative prevalence of the seeds of different species,

(3) the disposal and use of the screenings accumulating where the grain is cleaned, and (4) certain results arising from the various uses made of the screenings.

The extent to which grain is sometimes contaminated by weed seeds is shown by the result of an analysis of a sample representing a car of western-grown flax. The weed seeds made up 16 per cent of the total weight of the car. One ounce contained the following weed seeds: Wild mustard (Brassica arvensis (L.) Ktze. and other Brassica species) 1,051, Tumbling mustard (Sisymbrium altissimum (L.) 1,009, Western false flax (Camelina sativa (L.) Crantz) 429, Flat-seeded false flax (Camelina dentata Pers.) 170, Lamb's quarters (Chenopodium album L.) 152, Stinkweed (Thlaspi arvense L.) 106, Hare's-ear mustard (Conringia orientalis (L.) Dumort) 73, Wild Buckwheat (Polygonum Convolvulus L.) 14, Cinquefoil (Potentilla monspeliensis L.) 10.

A sample representing over 25,000 bushels of wheat contained only 92·6 per cent by weight of pure wheat, the remainder being made up largely of weed seeds, chiefly wild oats (Avena fatua L.) Wild buckwheat and lamb's quarters. These do not represent average conditions, but samples as badly contaminated as the above are by no means rare.

Occurrence of Weed Seeds in Statutory Grades of Western Grain

In December, 1916, representative samples of the various grades of oats were obtained from the Grain Inspector at Fort William. The following table indicates the weed seed content per pound of each grade:

Weed Seeds Per Pound in Statutory Grades of Western Oats

	Canada Western			Feed			Rejected
	No. 1	No. 2	No. 3	Ex. No. 1	No. 1	No. 2	
Avena fatua L.	14	39	208	80	376	976	3456
Polygonum Convolvulus L.	136	312	432	392	360	256	632
Chenopodium album L.	82	48	1272	896	96	264	1496
Neslia paniculata (L.) Desv.	7	36	165	56	80	144	98
Brassica species	2	35	59	2	16	..	27
Thlaspi arvense L.	..	4	158	32	16	72	50
Conringia orientalis (L.) Dumort	5	15	59	2	40	64	176
Camelina sativa (L.) Crantz	..	4	62	7	5	80	10
Lappula echinata Gilibert	..	2	23	9	4	48	318
Sisymbrium altissimum L.	..	..	..	2	3	..	..
Other sorts	5	11	37	47	29	168	26
	251	506	2475	1525	1025	2072	6289

The results given below were obtained from the analysis of another series of samples representing the lower and feed grades of wheat, oats and barley. These samples were also secured from the Grain Inspector at Fort William. The analyses were made after the separation of the smaller or so-called "black seeds" by means of the one-fourteenth inch perforated zinc screen. The percentage of these smaller seeds by weight occurring in each grade is also indicated in the table.

WEED SEEDS PER POUND IN LOWER GRADES OF WESTERN GRAIN

	3 C. W. Oats	2 Feed Oats	Rejected Oats	Rejected Barley	No. 4 Barley	Feed Wheat
Avena fatua L.	376	2576	3492	1992	392	56
Neslia paniculata (L.) Desv.	168	904	376	72	16	24
Polygonum Convolvulus L.	496	392	352	152	808	72
Other sorts	48	24	8	64	168	96
Total	1088	3896	4228	2280	1384	248
Percentage of "black seeds"	0·2	1·6	1·0	0·3	3	0·5

DOCKAGE

Most of the Western grain entering commerce is shipped eastward. At Winnipeg it is graded,[1] and on its arrival at Fort William or Port Arthur is taken into the terminal elevators and stored according to grade. That is, grain of the same grade is binned together. It often happens that a carload of grain contains too high a proportion of weed seeds or other impurities to be binned with the grade to which its quality entitles it. In such cases the grain is graded according to its quality and a dockage set representing the percentage by weight of impurities which must be removed by the cleaners before it is binned.

The material removed in bringing the grain up to the standard of cleanliness for the grade to which it has been assigned constitutes the screenings.

The total dockage set by the Inspection Department, Board of Grain Commissioners, Department of Trade and Commerce, on the wheat, oats, barley, and flax received by terminal elevators for the year ending August 31st, for each of the past few years was as follows:

[1]See "Grain Inspection in Canada," by R. Magill.

Dockage on Cars Received at Terminal Elevators

Year [1]	Cars	Dockage (tons)	Average per car (pounds)	Cars	Dockage (tons)	Average per car (pounds)
	Wheat			Oats		
1912-13	95,110	58,144–380[2]	1,223	17,824	593–657	67
1913-14	111,342–½	83,638–68	1,502	20,057	840–667	84
1914-15	66,734	41,390–270	1,240	9,022–¼	97–969	21
1915-16	217,944–½	116,389–76	1,068	35,899–½	125–668	7
1916-17	102,818–½	48,548–640	942	28,284–½	24–572	3
1917-18	79,820	64,140–897	1,608	12,890	1,639–035	255
	Barley			Flax		
1912-13	7,500	2,099–184	560	16,572	40,463–068	4,883
1913-14	7,585–½	2,350–454	617	10,675–½	31,503–011	5,102
1914-15	2,029–½	3,304–804	384	3,011–½	10,038–216	6,664
1915-16	6,817–½	1,452–879	428	4,327–½	14,187–080	6,558
1916-17	5,443	484–020	178	5,046–½	8,652–002	3,427
1917-18	4,611–½	1,122–459	487	3,590–½	10,304–42	5,742

[1] Crop year Sept. 1st–Aug. 31st.

[2] Total dockage is expressed in tons and pounds. The number after the dash represents pounds.

Variations in Composition of Screenings

The weed seed content of screenings varies considerably, depending on the kind of grain cleaned, place of growth and season or climatic conditions. Most of the screenings accumulating in the elevators at the head of the lakes are obtained from the cleaning of wheat. Dockage is set on only occasional cars of oats and barley, while the total quantity of flax handled is comparatively small.

The seeds of false flax (Camelina sativa (L) Crantz and C. dentata Pers) which are the commonest impurities in flaxseed are rarely found in other grain. Flaxseed screenings also contain a high percentage of broken pieces of flax. These screenings are kept separate from other grain screenings in some elevators and command a higher price on account of their oil content. An elevator handling much flax and mixing all its screenings together will have screenings widely different from one where flax is not handled.

Seasonal or local climatic conditions have a profound effect on the amount of weed seed impurities occurring in grain and also on the relative prevalence of the seeds of different species.

Screenings from the 1915 crop contained a considerable proportion of broken wheat and a relatively low percentage of weed seeds. The smaller percentage of weed seeds was due to the excellent crop condition prevailing that season. The fall was dry, causing the wheat to crack in threshing, which accounts for the high proportion of cracked wheat.

The 1916 crop was poor, much of the wheat belonging to the lower grades. As a consequence the screenings from that crop contained a much higher percentage of weed seeds. Many of the grain inspectors at Fort William made the observation that hare's-ear mustard (Conringia orientalis (L) Dumort) was unusually prevalent in the 1917 crop, No efforts have been made to study this phase of the subject systematically.

In connection with the distribution of different weeds in Western Canada, the following information was collected, at the suggestion of the writer, by Mr. W. Wilson, a deputy grain inspector of the Board of Grain Commissioners at Fort William.

A record was kept by Mr. Wilson of the weed seed impurities and point of shipment of 793 cars of grain arriving at the Western elevator in the fall and winter of 1915. Nearly all of the grain covered by these records was wheat; only a few cars of oats and barley are included.

The following table indicates the number of cars of grain from different electoral districts which contained the more common impurities. Districts from which fewer than ten cars were received are not included in the table.

	Lisgar, Man.	Macdonald, Man.	Provencher, Man.	Souris, Man.	Assiniboia, Sask.	Battleford, Sask.	Humboldt, Sask.	Moose Jaw, Sask.	Regina, Sask.	Saskatoon, Sask.
Total cars examined	24	71	50	13	27	13	60	151	112	176
Polygonum Convolvulus L.	23	49	44	12	24	12	60	150	98	175
Chenopodium album L.	22	55	37	13	27	13	58	144	100	176
Avena fatua L.	21	51	40	13	16	4	23	46	65	81
Neslia paniculata (L) Desv.	17	42	18	7	6	1	6	15	23	17
Saponaria Vaccaria L.	14	22	21	11	15	1	5	59	41	14
Brassica species	9	28	22	3	8	1	5	29	35	8
Conringia orientalis (L) Dumort.	12	8	17	8	19	1	20	91	86	69
Thlaspi arvense L.	16	38	27	6	7	4	8	63	55	44
Sisymbrium altissimum L.	2	5	5	2	11	2	18	61	34	47
Lappula echinata Gilibert	3	13	4	8	16	5	7	35	34	64
Agrostemma Githago L.	7	19	15	1	5	1	..	3	5	..
Ambrosia trifida L.	..	19	18	..	..	..	..	..	1	..
Amaranthus retroflexus L.	6	17	11	2	15	1	18	47	30	54
Lepidium apetalum Willd.	5	7	2	2	5	..	7	13	16	24
Axyris amarantoides L.	..	1	5	2	..	5	6	7	11	30
Dracocephalum parviflorum Nutt	10	6	8	2	1	..	..	3	1	2
Cirsium arvense (L) Scop.	1	10	1	..	..	..	..	2	1	..
Sonchus arvensis L.	..	2	2	..	..	..	..	..	..	..
Lolium temulentum L.	..	3	1	..	..	..	..	..	..	..

It will be noticed that some kinds of weed seeds, notably wild oats, lamb's quarters and wild buckwheat, seem to be of general distribution, while others are more prevalent in some localities than others. For example, ball mustard (Neslia paniculata (L.) Desv.) occurred in forty-two cars out of seventy-one from Macdonald, Man., while hare's-ear mustard (Conringia orientalis (L.) Dumort) was found in only eight. In contrast to this only fifteen cars out of 151 from Moose Jaw, Sask., contained ball mustard, while hare's-ear mustard occurred in ninety-one. Great ragweed (Ambrosia trifida L.), Canada thistle (Cirsium arvense (L.) Scop.), Sow thistle (Sonchus arvensis L.) and darnel (Lolium temulentum L.) appear to be of only local distribution as yet.

As the distribution of weeds is determined by a number of factors —accidental introduction, soil and climatic conditions, rotation and system of cropping, etc.—no effort is made to interpret the data here presented.

Composition of Elevator Screenings

Following is the analysis of a sample taken from a carload of screenings made up to represent the average run of screenings as cleaned from grain at Fort William and Port Arthur and before any separation or cleaning had been done. This is the same carlot as that referred to on page 84.

Wheat		32 %
Oats		2·6%
Flax (including broken pieces)		6·1%
Wild oats (Avena fatua L.)		2·8%
Wild buckwheat (Polygonum Convolvulus L.)		11·7%
Lamb's quarters (Chenopodium album L.)		20·2%
Wild mustard (Brassica species†)	(91)[1]	1·8%
Other Cruciferæ seeds*		2·5%
Conringia orientalis (L.) Dumort	(53)[1]	
Sisymbrium altissimum L.	(341)	
Erysimum cheiranthoides L.	(28)	
Neslia paniculata (L.) Desv.	(13)	
Thlaspi arvense L.	(14)	
Lepidium apetalum Willd	(11)	
Camelina sativa (L.) Crantz	(8)	
Camelina dentata Pers.	(1)	
Other sorts		2·2%
Chaff		18·1%

†The identification of the seeds of the various species of Brassica is not possible except by microscopic examination of sections of the seed coats.

Besides Brassica arvensis (L.) Ktze., Brassica nigra (L.) Koch. and Brassica campestris L. are reported by Clark and Fletcher to be common in the West.

*The following are also occasionally found in screenings:—

Capsella Bursa-pastoris (L.) Medic.
Sisymbrium incisum Engelm. and varieties.
Erysimum parviflorum Nutt.
" asperum DC.
Arabis gladra (L.) Bernh.

[1]The numbers in brackets indicate the relative prevalence by number of the different sorts. The numbers employed are the actual numbers of the various kinds of seeds found in the portion examined in making the analyses.

The seeds which would be classed as "other sorts" in such an analysis as is reported above include a wide variety of which the following are more or less prevalent.

Panicum capillare L.
Setaria viridis (L.) Beauv.
Phleum pratense L.
Lolium temulentum L.
Agropyron tenerum Vasey

Hordeum jubatum L.
Rumex sp.
Axyris amarantoides L.
Amaranthus retroflexus L.
" graecizans L.
Agrostemma Githago L.
Silene noctiflora L.
Saponaria Vaccaria L.
Cleome serrulata Pursh.
Rosa pratincola Greene.
Trifolium hybridum L.
Astragalus caryocarpus Ker.
Hedysarum boreale Nutt.
Oenothera biennis L.
Gaura coccinea Pursh.
Gilia linearis (Nutt.) Gray.
Lappula echinata Gilibert.
Agastache Foeniculum (Pursh) Ktze.
Dracocephalum parviflorum Nutt.
Stachys palustris L.
Plantago major L.
" Rugelii Dcne.
Symphoricarpos occidentalis Hook.
Grindelia squarrosa (Pursh) Dunal.
Iva axillaris Pursh.
Iva xanthifolia Nutt.
Ambrosia trifida L.
Rudbeckia laciniata L.
Helianthus scaberrimus Ell.
" Maximiliani Schrad.
Coreopsis tinctoria Nutt.
Achillea Millefolium L.
Artemisia biennis Willd.
Cirsium undulatum (Nutt.) Spreng.
Cirsium arvense (L.) Scop.
Sonchus arvensis L.
Lactuca pulchella (Pursh) DC.

Sclerotia of Claviceps purpurea (Fr.) Tul. are also commonly found in Western grain and sometimes occur in elevator screenings.

Commercial Separations of Screenings

The material removed by the elevator cleaners in bringing the grain up to the standard for the grade to which its quality entitles it, may be divided roughly into two portions.

(1) The smaller weed seeds removed by means of a zinc sieve containing perforations 1/14 inch in diameter.

(2) Material too large to pass through the 1/14 inch sieve.

The latter material is usually further separated in practice by the removal of *Scalpings* (the larger seeds) consisting of shrunken kernels and the larger pieces of wheat and oats, wild oats and some wild buckwheat. The material left is known as *Buckwheat Screenings* and is made up of wild buckwheat, cracked wheat, and a few of the larger weed seeds. The material passing through the 1/14 inch sieve is called *Black Seeds* on account of the preponderance in it of lamb's quarters. The average run of elevator screenings consists of approximately 40 per cent black seeds. A representative sample of black seeds gave the following analysis:

COMPOSITION OF BLACK SEEDS

Small pieces of wheat, oats, barley and flax		17·4%
Wild buckwheat		4·2%
Lamb's quarters		45·4%
Brassica sp. (140)		2·8%
Seeds of other species of Cruciferæ		5·6%
Sisymbrium altissimum L.	(544)	
Conringia orientalis (L.) Dumort	(180)	
Thlaspi arvense L.	(44)	
Camelina sativa (L.) Crantz	(28)	
Neslia paniculata (L.) Desv.	(28)	
Erysimum cheiranthoides L.	(20)	
Lepidium apetalum Willd.	(8)	
Capsella Bursa-pastoris L.	(8)	
Other sorts		4·6%
Chaff		20· %

The material left after the removal of the black seeds from screenings is usually separated into *Scalpings* and *Buckwheat Screenings* as explained above. Together these make up about 60 per cent of the average elevator screenings. These materials vary a great deal in composition but when properly recleaned should contain comparatively few seeds as small as lamb's quarters.

Following is the average of the analyses of samples of buckwheat screenings purchased from different elevator companies by the Experimental Farms Branch during the summer of 1919.

COMPOSITION OF BUCKWHEAT SCREENINGS

Cracked, broken and small wheat	35 %
Oats and Barley	1·6%
Flax	2·5%
Wild oats	6·2%
Wild Buckwheat	41·0%
Seeds of Cruciferæ species	2·8%
Lamb's quarters	0·4%
Other seeds	1·4%
Chaff	9·1%

The different Cruciferous seeds were present in the following proportion by numbers:—Brassica species, 41; Neslia paniculata (L.) Desv., 78; Conringia orientalis (L.) Dumort, 66; Thlaspi arvense (L.), 12; Sisymbrium altissimum (L.), 3.

Scalpings

Scalpings consist of the larger grains and weed seeds in the screenings. An average sample contains about 65 per cent wheat; 25 per cent wild oats, oats, flax and barley; 3 per cent weed seeds (wild buckwheat, lamb's quarters, stickseed, ball mustard, prairie rose, wolfberry, great ragweed, cow cockle); 7 per cent straw, chaff, etc.

Disposal of Screenings

Prior to 1915 from 80 to 90 per cent of the screenings accumulating at the head of the lakes went to the United States. The balance, chiefly scalpings, were shipped to Ontario and Quebec. There has been an increasing proportion of our screenings used at home since the publication of the "Grain Screenings" bulletin in 1915.

Uses of Screenings in the United States

Sheep Feeding.—Considerable quantities of screenings are fed every winter to sheep. The sheep are fed in large sheds operated in connection with railway companies on whose lines the sheep are carried from the ranges. The following sheep-feeding stations in the vicinity of Chicago are typical: On the Chicago, Milwaukee and St. Paul Railway at Kirkland, Ill.; on the Chicago, Burlington and Quincy Railway at Montgomery, Ill.; and on the Rock Island Railway at Stockdale, Ill. Besides these, other railways entering Chicago maintain similar stations. They are also provided at Osseso, New Brighton, and Anoka, in the vicinity of Minneapolis.

At the Kirkland station, which is typical of such places, there is accommodation for 50,000 sheep at one time. The sheep are fed here from one to sixty days, depending on their condition, and often, too, on the markets. Shearing sheds are provided and used as required.

Sheep taken from the ranges are usually fed about thirty days. At first they are given only hay. Then a small quantity (half a pound per day) of light chaffy screenings is added. Gradually this is increased until in about a week or ten days the sheep have access to the "self-feeders," from which they eat all the screenings they want (about 2 pounds per day). At the same time the proportion of chaff is decreased and the proportion of seeds increased. The sheep are kept on a diet of pure screenings for only a day or two, and then a little cracked corn is added. The proportion of corn is increased gradually until the ration consists of half or slightly more than half corn, the sheep being given all they will eat of this mixture, as well as hay.

The aim of the feeder is to get the sheep on a diet of corn as soon as possible, but pure corn is too heavy a feed for the sheep, and so the screenings are used as a sort of "filler." Formerly, elevator screenings contained much shrunken and broken wheat, oats, and barley, but with improved methods of recleaning the screenings, practically all this material is removed, and only the smaller weed seeds and chaff are available as screenings. When corn sold at $20 per ton, such screenings cost at the feeding stations $10 to $12 per ton. On such feed the sheep usually gain from 12 to 15 pounds during the first thirty days. After that they gain less rapidly. Fifty thousand sheep will eat about two cars of screenings and a car of corn per day. Seed-house screenings and screenings containing a large proportion of broken flax are avoided. At Kirkland much of the manure accumulating in the sheds is hauled away by farmers during the summer, and put into piles until fall. The manure, when so piled, "heats" and the vitality of many of the weed seeds which have become mixed with the manure is destroyed. Farmers who have used this manure admit that large numbers of weeds make their appearance after its application. Its use, however, has not resulted in any serious spread of noxious weeds. This is explained by the two following circumstances:—

1. In that district, as in other parts of Illinois and neighbouring states, large quantities of corn are grown. This sheep manure is put on corn ground, and by constant cultivation of the corn the weeds are destroyed before they can mature seeds.

2. Practically all of the farms around Kirkland are worked by tenants, and as rents are high and land valuable, the careless and slovenly farmer is crowded out.

It must be admitted that the farms are all practically free from noxious weeds, although one meadow was seen to be badly contaminated with tumbling mustard, very probably introduced through screenings. Although the use of this manure has resulted in no very serious spread of weeds, its use undoubtedly involves considerable risk of introducing some of the worst weeds the farmer has to fight. At Montgomery and Stockdale, the American Guano Company has put up factories where the sheep manure is dried and pulverized, and from it is made a fertilizer used largely on golf links, country estates, market gardens, etc.

The Manufacture of Mixed Feeds. Another use that is made of elevator screenings is in the manufacture of mixed feeds, chiefly molasses feeds. Usually it is only the finest weed seeds and smaller pieces of broken wheat and flax that are used in these feeds. Mills that make a specialty of handling screenings are equipped with cleaning machinery which separates all the whole kernels of wheat, barley, oats, or flax that the elevators have failed to remove. Straw and chaff are taken out of the screenings at the same time as this separation is made. The material left after these grains are removed is separated into two grades by means of one-fourteenth inch perforated zinc sieve. The material passing over this screen consists largely of wild buckwheat and broken wheat, but there is often a considerable sprinkling of broken flax and of the larger weed seeds, such as purple cockle, ball mustard, etc. Most of the buckwheat screenings so separated are used with cracked corn, Kaffir corn, barley, wheat, sunflower seed, etc., as chicken feed, although some of it is used in other ways. The seeds of wild mustard and other species of Brassica are separated from the other weed seeds by taking advantage of the fact that they are spherical and will roll if placed on an inclined surface. Before the remaining fine seeds are ready for grinding they have to be put through a reel to remove the fine sand which would otherwise injure the rolls.

The exact method and the thoroughness with which these seeds are ground varies in the different mills. The grinding is usually done by a combination of one or more rolls such as are used in flour mills, or by an attrition mill. After each "break" (*i.e.*, passage through the roll or attrition mill) the material passes to a reel, which removes the fine material and sends the coarse material on to the next "break" to be still further pulverized. To reduce to a minimum the possibility of the final product containing vital weed seeds, the mesh of the wire gauze used in these reels should be sufficiently fine to prevent the passage through it of the smallest weed seeds found in screenings.

These ground and bolted screenings are used in the manufacture of molasses feeds, mixed with various other ingredients, such as cottonseed meal, linseed meal, gluten feed, and molasses. Other mills which handle screenings make only the above separations and grind the fine black seeds to sell for use in molasses feeds, in medicinal stock foods, and occasionally for feeding in its natural condition. In its natural condition it does not make a palatable feed because of the presence of certain seeds having a pungent or otherwise disagreeable taste. The mixture of molasses with the feed tends to overcome this difficulty, besides increasing greatly the carbohydrate content of the ration.

Uses of Screenings in Flour Mills

Eastern Canada. Most of the Western wheat milled in Eastern Canada has passed through the elevators at the head of the lakes. The standard grades coming out of the elevators carry only a small percentage of weed seeds fine enough to be removed by elevator cleaners; the lower the grade the greater the proportion of impurities tolerated.

Before the wheat is ground to make flour, all dirt and impurities are removed from it. It is the practice of nearly all flour mills in this country and in the United States to mix with the bran and shorts the screenings taken from the wheat. Formerly the material was unground but at the present time regulations in both countries require the complete pulverization of all weed seeds included in the feeds.

The mill screenings differ from elevator screenings in that they contain a lower percentage of the smaller weed seeds and a higher percentage of small and broken wheat. To remove the impurities as completely as is necessary in milling, a good deal of the smaller and lighter wheat is removed with the weed seeds. The most prevalent weed seeds are wild buckwheat, wild oats, wild mustard, hare's-ear mustard, ball mustard, stinkweed and lamb's quarters. Mill screenings, however, vary as widely in composition as elevator screenings.

The smaller flour mills usually buy the higher grades of wheat because they have not such highly efficient cleaning machinery as that possessed by the larger mills. The latter can and do handle more of the lower grades which carry a relatively high percentage of weed seeds.

Many of the smaller mills in Eastern Canada use a proportion of local wheat in the manufacture of their flour. This local wheat is usually bought directly from farmers and much of it is uncleaned. The screenings mixed with the bran and shorts of such mills will vary considerably with the locality and the season.

Western Canada. Very little of the wheat purchased by Western Canada mills has had any previous cleaning; it is just as it came from the threshing machine. It is first given a cleaning similar to that given wheat passing through the terminal elevators on its way East and therefore the screenings resulting from this first cleaning resemble those accumulating in the elevators.

The screenings are disposed of in various ways depending on the location of the mill and the composition of the screenings.

The fine seeds are usually separated from the rest of the screenings and disposed of: (1) by shipping them to the United States where they are used in the manufacture of mixed dairy feeds; on account of heavy freight rates this is seldom possible west of Moose Jaw. (2) By burning them; on account of the high oil content of the black seeds (Lamb's quarters and mustards) they burn readily and have considerable value as fuel. (3) By feeding to cattle and sheep in stock yards where it is not intended to keep animals longer than a day or two. (4) In a few places they have been fed to sheep kept in enclosures over a period of six weeks or two months.

All through the West chop-feed made from recleaned screenings sells readily and usually gives excellent results. Buckwheat screenings make an especially satisfactory hog feed.

The screenings removed in further preparation of the wheat for grinding are pulverized and mixed with the bran and shorts, as in the East.

Results of Feeding Experiments with Screenings

During the winter of 1914–15 the Animal Husbandry Division of the Central Experimental Farm, Ottawa, conducted experiments in the feeding of elevator screenings and their commercial separations, with milch cows, swine, and lambs.

THE MATERIAL

In securing material for the experiments, pains were taken to get screenings representing as nearly as possible the average cleanings taken from western grain. The following statement from Mr. F. Symes, Grain Inspector, Fort William, explains how the material used for these experiments was secured:—

Fort William, Ont., Feb. 6, 1915.

J. R. Dymond, Esq., Seed Analyst,

Department of Agriculture, Ottawa.

Dear Sir,

I beg to advise you the carload of screenings which I obtained for the department was taken from the Port Arthur elevator, Empire, Grand Trunk Pacific, and the Dominion Government elevators at Port Arthur and Fort William. This would represent screenings from each road, namely, the Canadian Northern, Canadian Pacific, and Grand Trunk Pacific railways, and would be as representative a sample of the natural screenings from western points as it would be possible to obtain.

These screenings were not recleaned in any way, but came straight from the cleaning machinery. It would be impossible to get a more representative sample than that which I obtained for you.

Yours truly,

(Signed) F. SYMES,

Inspector.

These screenings were from the 1913 crop. The separations were made at the elevator of the Ogilvie Flour Mills Co., Ltd., at Fort William, by a screening separator of the type commonly used in terminal elevators. They, therefore, represent as accurately as possible the average run of the different materials, viz., "Entire screening," "Entire screenings, black seeds removed," "Black seeds," and "Buckwheat screenings." These were all finely ground in the feed mill of the Ogilvie Company. The material, after passing through an attrition mill, was separated into two portions, coarse and fine, by a reel. The coarser portion was further reduced by a "Perplex" grinder.

RESULTS[1]

As a result of these experiments it was shown that the black seeds are useless as feed and expensive as adulterants. Their admixture in any considerable quantity to other feed makes it unpalatable for all kinds of stock. The addition of molasses to ground screenings containing the black seeds makes the feed palatable, but not economical. The most economical way of making screenings palatable is to remove the black seeds.

Screenings without the black seeds may be fed freely to horses, cattle, sheep or swine, but it is more profitable to have such screenings compose not more than 50 to 60 per cent of the total grain ration. Buckwheat screenings are especially valuable as poultry feed.

These conclusions are confirmed by the success met with in handling elevator screenings on a commercial basis in accordance with the experimental results.

Use of Screenings as Feed Since 1915

Following the publication of the results in 1915, the Board of Grain Commissioners began recleaning the screenings accumulating in their elevators at Port Arthur, Moose Jaw, and Saskatoon. On February 2, 1916, they reported "the demand for recleaned screenings at the moment is considerably larger than the supply."

On account of the shortage of feed in autumn of 1917, the Live Stock Branch of the Federal Department of Agriculture arranged with the elevators at Fort William and Port Arthur for the purchase of recleaned screenings and distributed them at cost to those requiring feed. This material proved to be so satisfactory that the same

[1] See "Grain Screenings" Bulletin Dept. of Agr., Ottawa

arrangement was made in 1918 and there is now (December, 1919), a large demand for recleaned screenings on the part of Eastern Canada live stock men.

Occasional carlots of these recleaned screenings have been unsatisfactory but investigation has usually shown that this is due to the fact that the screenings have not been thoroughly recleaned.

In addition to the evidence of the feeding experiments reported above, there is a considerable mass of data supporting the belief that it is the presence of the smaller seeds chiefly mustards in elevator screenings that render this material unpalatable to stock and that by cleaning thoroughly enough to remove all seeds as large as hare's-ear mustard, wild mustard, and stinkweed, the average run of screenings makes a valuable food material.

Deleterious Effects of Certain Weed Seeds

Sifton lists six varieties of weed seeds commonly found in elevator screenings which are authoritatively stated to be poisonous and five more that are otherwise objectionable. The poisonous seeds include Brassica arvensis, Brassica nigra, Erysimum cheiranthoides, Thlaspi arvense, Sisymbrium altissimum, Camelina sativa. The objectionable ones are Agrostemma Githago, Lolium temulentum, Saponaria Vaccaria, Lappula echinata, and ergotized grains.

The various branches of the Federal Department of Agriculture receive an ever-increasing number of feed samples of various kinds that the senders claim have caused the death or serious injury to the health of animals. Analysis of such samples usually reveals the presence of weed seeds of various kinds. As a result of such examinations and the experimental work already referred to, it is believed that the difficulty in most cases could have been avoided had the weed seeds entering into the manufacture of such feeds been thoroughly cleaned so as to remove all seeds as large as hare's-ear mustard, wild mustard and stinkweed.

Considerable harm appears to have resulted during the past few years from the adulteration of mill feeds, including bran and shorts with screenings.

Poisonous Properties of Flaxseed Screenings

Difficulties have been encountered in feeding flaxseed screenings unmixed with other grain products. A letter received from a Saskatchewan farmer under date May 14, 1915, is quoted in part:

"I am sending you a sample of cleanings from flaxseed which is deadly poison. It contains principally frozen blossom buds, which must contain the poison. I had never heard of its being poison before using it with fatal results. Since I have learned my lesson I have heard that a neighbour lost several cattle by its use a few years ago. A few weeks ago, I fed about three gallons to a cow and two gallons to a heifer. Both were in convulsions in less than twenty minutes. The heifer died in about two hours, the cow in about eight hours."

An analysis of the sample gave the following: Immature flax bolls and chaff, 75 per cent; flaxseed, 18 per cent; wheat, 4 per cent; weed seeds, 3 per cent. The weed seeds were chiefly lamb's quarters and wild buckwheat, with traces of tumbling mustard. Dr. A. McGill, Chief Analyst, Laboratory of the Inland Revenue Department (now of the Department of Public Health), reported on this sample of flaxseed screenings: "We find considerable quantities of prussic (hydrocyanic) acid, quite sufficient to explain the toxicity of the article."

Similar results from feeding flaxseed screenings are reported from North Dakota (Special Bulletins Nos. 31 and 35, N.D. Exp. Station):

"In one herd of nineteen, all died; while in a second of ten, five died. Analyses made of several samples of flaxseed screenings showed clearly the presence of hydrocyanic acid. This poison was also found in immature seed bolls of flax analysed separately. A healthy, well-fed, 2-year-old heifer which refused to eat flaxseed screenings was fed by force from a bottle with an extraction obtained from 4½ pounds of screenings. Toxic symptoms developed, from which she recovered, as was the case with a second feeding obtained from 4 pounds. An extraction from 12 pounds resulted in the death of the animal in ninety-two minutes. Quantitative determinations showed that 0·9583, 1·0736 and 4·892 gms. of hydrocyanic acid, respectively, were fed."

Thus it is clearly evident that flaxseed screenings may contain hydrocyanic acid in sufficient quantities to cause the death of animals, even when the screenings are fed in moderate quantity.

Pammel records the opinion of Dr. Schaffner that the cause of death to cattle is probably due to the prussic (hydrocyanic) acid evolved from the plant when wilting.

Danger of Spreading Weeds Through Seeds in Feeding Stuffs

Apart from the deleterious effects of certain seeds on the health of animals, the presence of vital seeds in feeding stuffs is a menace to agriculture on account of the fact that many seeds retain their vitality after they have passed through the digestive tract of domestic animals.

In an experiment at the Maryland Experimental Station twenty-two kinds of seeds were fed to animals and the manure spread over sterile soil. It was found that only one kind of seed, Spanish needles (Bidens bipinnata L.), failed to germinate. Docks, ragweed, purple cockle, tumbling mustard and peppergrass, were all capable of germination.

In another experiment a cow and horse were each fed two pounds of the unground grain screenings with middlings, bran, and wheat straw, each morning and night for seven days. On the evening of the seventh day the animals were bedded with sawdust and the dung of one night collected. The sawdust and dung were thoroughly mixed and put in boxes and set on a bench in the greenhouse. The dung was collected on May 24. On June 21, the following weeds had grown:

Cow Dung	Horse Dung
149 Lamb's quarters	1213 Lamb's quarters
12 Pigweed	28 Foxtail
14 Bindweed	11 Pigweed
4 Foxtail	12 Bindweed
2 Timothy	6 Timothy
	3 Clover
	2 Morning glory
	5 Mustard.

Grinding Screenings

The impossibility of pulverizing all of the seeds when the entire screenings are ground up together by an ordinary chopper is well illustrated by the analysis of a sample that had been ground with the idea of putting it on the market as a feed. One-eight ounce contained the following weed seeds:

Chenopodium album L.	460
Sisymbrium altissimum L.	215
Camelina sativa (L) Crantz	8
Potentilla monspeliensis L.	7
Setaria viridis (L) Beauv.	6
Brassica sp.	2
Conringia orientalis (L) Dumort.	2
Thlaspi arvense L.	2
Other sorts	15

This is equivalent to more than 90,000 weed seeds per pound.

The complete reduction of screenings containing the black seeds is a difficult and expensive process. It requires specially constructed machines which are difficult to drive, and thus expensive to operate. Often a combination of two or more machines is employed, one of which is usually an attrition mill. The "Perplex" or "Simplex" grinder is also in common use.

The difficulty of grinding the screenings containing all of the weed seeds is due to the hard flinty seed-coat of some, such as lamb's quarters, and the very small size of others, as tumbling mustard. These two seeds, it will be noticed, make up over 95 per cent of the unground seeds in the feed cited above. Screenings carefully re-cleaned over a screen with perforations one-fourteenth of an inch in diameter to remove the black seeds may be satisfactorily ground by an ordinary chopper.

Uses for Black Seeds

Many of the seeds making up the material known as "black seeds" have a comparatively high content of oil and it has been suggested that they might be used profitably in making oil.

Brassica. The seeds of a number of varieties of Brassica campestris are used in the manufacture of an oil to which the names rape or colza are commonly applied.[1] Rape oil is a semi-drying oil and is characterized by a high viscosity and a saponification value lower than that of any of the common oils of commerce. Rape oil was formerly used in Europe and elsewhere to a very large extent as a burning oil. The principal use of the oil at the present time is as a lubricant; its high viscoscity, which can be increased by blowing hot air through it, rendering it particularly suitable for this purpose. Smaller quantities of rape oil are used for soft soap manufacture. In India the oil is largely used as an edible oil, in fact, it is said to be the chief oil for cooking purposes. In Europe refined rape oil is said to be used as a "bread oil," *i.e.* for greasing the ends of loaves before baking. Large quantities of rape oil are also used in steel-plate manufacture, the heated steel plates being dipped in the oil in order to harden them. Most of the varieties of Brassica campestris resemble Brassica nigra in that they yield ethereal mustard oil to which the pungency of mus-ard is due, but in much smaller quantities.

The residues remaining after the expression or extraction of oil from rape seed have a fairly high nutritive value. Rape-seed cake is now used as a feeding stuff to a less extent than formerly. This is due partly to disrepute owing to adulteration, especially to the fact that rape cake is liable to contain mustard seed which produces injurious effects when fed to animals, owing to the presence of ethereal mustard oil. The principal use of rape-seed cake is as a manure, generally in the form of a meal from which almost all the oil has been extracted by means of solvents. Rape-seed meal contains about 4·9 per cent of nitrogen, 2·5 per cent of phosphoric acid, and 1·5 per cent of potash.

[1]Bull. Imp. Institute, 1915.

The seeds of several plants belonging to the Cruciferæ family yield oils similar in character to rape oil and some of these enter into commerce in competition with true rape oil.

In the United States the brassica seeds are separated from screenings and sold to firms who make a specialty of handling oil seeds. One of the largest of such firms is the Gorgas Pierie Co., of Philadelphia. In the summer of 1914 the writer saw a mustard machine in the Robin Hood Mills, Moose Jaw, and was told that two carloads of mustard seed per year were shipped to Philadelphia from that mill alone.

Camelina. Brenchley says that oil obtained from the seed of Camelina sativa was famous in the days of the old herbalists. Rich people are said to have burnt it in their lamps, while the poorer people used it for culinary purposes at festivals. The oil has hardly any smell, and is supposed to give a brighter flame and less smoke than oil of rape or mustard, but it is probably more useful to soapmakers than as fuel.

Chenopodium. American wormseed oil, official in the United States Pharmacopœia as *Oleum chenopodii*, is distilled from *Chenopodium ambrosioides, var Anthelmintica.* Nelson states that it is used as a remedy for worms, particularly for Ascarides, which it seems to narcotize so that they can be eliminated by means of a laxative. The larger part of this oil produced in the United States is distilled from an herb grown in a section of Carroll County, Md., and is known in the trade as "Baltimore" wormseed oil.

A sample of "blackseeds" of the same composition as that whose analysis is given on page 79 was supplied to W. J. Jones, Jr., Chemist, Purdue University, Lafayette, Indiana, at his request. His analysis was as follows:

Moisture	8·12%
Crude fat	10·63%
Crude protein	15·53%
Crude fibre	13·17%
Crude ash	6·07%
N. F. Extract	46·48%

By the removal of chaff and dirt, a material of fairly high oil content would result.

The fat content of some of the weed seeds most commonly found in elevator screenings is reported by Shutt as follows:

	Per cent
Camelina sativa (L.) Crantz	34·19
Brassica arvensis (L.) Ktze	23·78
Conringia orientalis (L.) Dumort	29·95
Sisymbrium altissimum (L.)	24·14
Thlaspi arvense L	20·61
Neslia paniculata (L.) Desv	16·26
Chenopodium album L	6·60
Agrostemma Githago L	6·53
Saponaria Vaccaria L	3·54
Avena fatua L	3·89
Polygonum Convolvulus L	1·75

Conclusions

In 1914 the writer drew attention to the loss sustained by Western farmers in connection with the shipment of their grain uncleaned.

The Saskatchewan Grain Markets Commission in that year placed the cost of hauling wheat from the farm to the railway station at 5 cents per bushel, local and terminal elevator charges at 2½ cents, and average freight rates from Saskatchewan points to Fort William at 12 cents per bushel, making total charges of 19½ cents per bushel, or $6.50 per ton. Taking Saskatchewan points as average location for the Prairie Provinces, the charges on 100,000 tons of screenings at $6.50 per ton amount to $650,000. These charges must be met by the grain sold, and therefore represent a loss to the growers.

At that time the owner of the grain was allowed to claim his screenings if the dockage was over 5 per cent after 1½ per cent was deducted for invisible waste. It was rare then for farmers to claim their screenings and there was point to the argument that the farmers bore the expense of getting this material to the terminal elevators and then made a present of it to the elevator owners. At the present time (December, 1919) the elevator tariff in reference to screenings is as follows:

"On wheat carrying a dockage of three per cent (3 p. c.) or more, after deducting one per cent (1 p. c.) of the gross dockage for waste, a return will be made for the balance of the screenings.

"On oats, barley, and flax carrying a dockage of five per cent (5 p. c.) or more, after deducting one per cent (1 p. c.) of the gross dockage for waste, a return may be demanded for the balance of the screenings.

"If disposition of screenings covered by outstanding returns is not received within thirty (30) days from date of unloading they may be disposed of for account of whom it may concern.

"The holder of warehouse receipts or shutouts covering dockage is entitled to the same quality of screenings as taken from the car, as shown by the grain inspector's test."

It is common now for owners of grain to get pay for the screenings contained and it is more difficult to persuade them that it would be to their financial advantage to leave the screenings on their own farms. However, from the national point of view, the proper solution of this problem is believed to be to keep the screenings on the farm where they are produced. The portion possessing good feeding value should be worth more to the Western livestock industry than to feeders over a thousand miles away. This, being the least valuable product of the grain grower, costs relatively the most for transportation. If in 1914 it cost $650,000 to get the screenings from the farm to the elevators, it must now cost considerably more than $1,000,000 to take this material from the point where it is produced to where it is fed in Eastern Canada and the United States.

The question of cleaning the grain before shipment has not been studied exhaustively. It was learned, however, that relatively few of the interior elevators, except those operated by farmers' co-operative organizations, have cleaning machinery, and even where such facilities are available the cleaning of grain hauled direct from the machine is impossible during the rush season owing to the necessity of changing sieves for each different kind and lot of grain received. Where wheat, oats, barley, and flax are being hauled to an eleavtor at the same time by several different farmers it is quite impracticable to change the sieves in the cleaner for each load. Farmers who can store their grain until after the busy season can usually arrange to have a cleaner fitted up specially for their grain and then haul all they have and clean and load it before it is necessary to change or rearrange the sieves.

That threshing machines as at present operated do not clean grain satisfactorily is shown by the fact that nearly every carload received at the terminals must be cleaned. If the grain could be cleaned by the thresher it would effect an enormous saving to the growers of the West. See Appendix.

It is believed that a cleaner of simple design and of comparatively small cost of construction and operation could and should be used on every threshing machine to remove the screenings which, otherwise, are not removed until the grain is taken into the terminal elevator. Such a cleaner could be placed on top of the machine and the grain passed through it after being weighed and elevated.

The thresherman is entitled to payment for every bushel he threshes whether it is grain or weed seeds, and by the above arrangement he would get credit for every pound of material threshed. Cleaning the grain in this way would of course increase the cost of threshing, but even then an enormous benefit would result to the farmer, not only by a great reduction in the expense of handling and transportation, but also through its value as a feed for livestock.

The idea of operating an efficient cleaner as an attachment to a grain thresher is not new. Cleaners are employed on threshers in the Argentine Republic and Chili, which receive machines from the same American and Canadian firms as supply the prairie provinces. But the manufacturers of these machines seem to have the impression that the Canadian grain grower believes there is no advantage in having his grain cleaned in threshing, and consequently does not want even the ordinary cleaning screens supplied with the machines to be used for this purpose. In the opinion of the manufacturers, threshing machines as at present constructed might be operated to remove much of the screenings now left in the grain.

Literature Cited

Brenchley, W. E., "The uses of Weeds and Wild Plants" in Science Progress, Vol. XIV, pp. 121-133, 1919.

Bulletin of the Imperial Institute XIII (1915) pp. 452-460. "Production and Utilization of Rape Seed."

Carver, T. N., "The Principles of Rural Economics." Boston, 1911.

Clark, G. H., & Fletcher, Jas. "Farm Weeds of Canada." Second Edition, Ottawa, 1909.

Dymond, J. R. "The Screenings Problem" in The Agricultural Gazette of Canada, Vol. I, pp. 694-696, 1914.

. . . . Archibald, E. S. & Elford, F. C. "Grain Screenings." Dept. of Agriculture, Ottawa, 1915.

Magill, R. "Grain Inspection in Canada," Dept. of Trade and Commerce, Ottawa, 1914.

Nelson, E. K. "A Chemical Investigation of the Oil of Chenopodium," U. S., Dept. Agr., Bureau of Chemistry, Circ. No. 73–1911.

Oswald, E. I., "The Effect of Animal Digestion and Fermentation of Manures on the Vitality of Seeds." Maryland Agric. Exp. Station, Bull. 128–1908.

Pammel, L. H., "The Problems of Weeds in the West" in Proc. Iowa Academy of Science. Vol. XV, p. 34-46, 1910.

. . . . "A Manual of Poisonous Plants." Cedar Rapids, Iowa, 1911.

Patterson, H. J., & White, H. J. "By-Product Feeds." Maryland Agric. Exp. Station, Bull. 168, 1912.

Shutt, F. T., "Farm Feeds," Dept. of Agric. Experimental Farms Branch, Bull. No. 36, Ottawa, 1919.

Sifton, H. B., "Injurious Weed Seeds in Feeding Stuffs" in Agric. Gaz. of Canada, Vol. V, pp. 951-957, Ottawa, 1918.

For statistics

Prior to 1916, Grain Statistics and the Report of the Board of Grain Commissioners comprised Part V of the reports of the Department of Trade and Commerce.

Since 1916 the Report of the Board of Grain Commissioners for Canada has been published as a separate report.

Report of the Grain Markets Commissioner of the Province of Saskatchewan, Regina, 1914.

Appendix

In connection with the suggestion that it would be to the financial advantage of farmers to have their grain cleaned at time of threshing and use the screenings on their own farms the following statement by Robert B. Sangster, agent for the Duke of Sutherland's Canadian Lands is interesting:

"Brooks, Alta., *Feb. 1, 1916.*

"The loss of feeding material and the loss on freight of same due to shipping out uncleaned grain had appeared to me capable of being eliminated either by cleaning the grain as it was threshed, or by getting it cleaned as it was passed through the local elevator on to rail. After some discussion, the local elevator company agreed to install a cleaner, and deliver back the screenings at a charge of 1¾ cents per bushel, but they expected that, even after their cleaning, the Government Inspector would still put on a small percentage of dockage. Their proposed charge of 1¾ cents per bushel seemed too large, as I believed the cleaning could be done cheaper on the farm. I was assured by more than one that cleaning direct from the Separator had never been done in Alberta, and was impracticable.

"However, in 1913, our average dockage on grain shipped out was about 1½ per cent, when there was not a weed on the place, and I figured that, with an 80,000 bushel crop, 1½ per cent of broken and small grains would go a good way in paying for a first-class cleaning outfit to work in conjunction with the Separator in the field. I, therefore, bought a Monitor Grain Cleaner with all the latest improvements, viz:—double blower, double opposed screens, with automatic brushes for keeping both screens clean, and self-oiling bearings, and capable of handling up to 400 bushels per hour of wheat, at a cost here of $378. The power required for driving this was 2½ H.P., but I got a 5 H.P. engine suitable also for other work, and mounted both it and the Cleaner on an extra strong wagon gear, with a 15-ft. ordinary separator grain elevator attached to the cleaner spout. The cleaner and engine were covered as in a van, and the cost of the outfit was:

Cleaner	$378
Engine	200
Elevator	110
Wagon Gear	125
For labour of assembling and boarding in the apparatus	100
Total	$913

"In operation the cleaner was drawn up so that the Separator spout sent the grain directly into the Cleaner hopper. Then, the elevator attached to the cleaner delivered the cleaned grain into the wagon, or into the field bins, as required. There was no trouble when shifting the separator, as the cleaner was attached by a chain to, and trailed by the separator. An ordinary box wagon stood beside the cleaner, the light and broken grain from which fell by gravity into this wagon. The latter was emptied midday and evening, so that there was no hindrance to the other work. In the Cleaner, the weed seeds were arranged to be taken out by the lower screen, and to fall into a large receptacle underneath the screen and attached to the framing supporting the cleaner and engine. Originally this lower screen was a perforated sheet of zinc, adapted for dealing with mustard seed, and measuring some 5 ft. in length, in halves of 2½ ft. each. I, however, got one of these halves changed to a regulation dockage screen mesh, viz:—ten wires per inch each way, and as all of the market grain had to pass over this, I reckoned there could not be anything left to go through the Government Inspector's screen. As a matter of fact, we had very little weed seed, and what fell through the bottom screen into the said receptacle was mainly small bits of broken grain of the appearance of medium crushed wheat. This was fed directly to the hogs without further crushing, and they did well on it, and I reckoned we could take care of any weed seeds germinating after digestion by the hogs, as these were enclosed in a small pasture. Of course, if weed seed was to form any material part of what fell through the lower screen, the idea was to burn it. It will be understood that the adjacent wagon received the great bulk of the screenings.

"A lad attended the cleaner and cleaner engine, and his wages, together with the cost of fuel and oil, worked out at $3.35 per day. The cleaning capacity being 400 bushels per hour, the operating cost per bushel would thus be (neglecting interest on capital) less than 1/10 cent per bushel. But the normal day's threshing, with this year's long straw, was rather under 2,000 bushels wheat, say 1,500 bushels, which thus cost under ¼ cent per bushel to clean.

"Well, as to the results, we had no dockage in the returns of grain that went through the cleaner—about 80,000 bushels wheat. But we had one neighbour thresh a field of about 10,000 bushels for us, without, of course, any cleaning attachment, and the returns here showed an average Government dockage of 2·6 per cent, although there was scarcely a weed on the whole field. Another neighbour threshed a straight car load of 1,500 bushels wheat off a small field that had not a weed noticeable on it, using a 1915 Separator, and the Government return was 3 per cent dockage. I think I am safe, therefore, in saying the cleaning eliminated 2 per cent dockage on 80,000 bushels, or 1,600 bushels of good feed wheat, which would be worth 60 cents a bushel for feed purposes, making $960. There is also the saving of freight of 23 cent per 100, making another $220, besides the hauling of it from farm to rail at the local rate of one cent per bushel per mile, or $64 for the 4-mile haul.

"The account, therefore, stands for 1915:

Capital Expenditure	$ 913	1,600 bus. at 60c	$ 960
Operating	200	Freight on ditto at 23c. per cwt.	220
Repairs, Cleaner and Engine	28	Haulage	64
Interest on capital	54		
Balance	49		
	$1,244		$1,244

"It would thus appear that the outfit paid for itself in the one season, and the cleaner, owing to its substantial construction, seems as good as when it was started.

"I think one could argue from the above that cleaning the grain on a large farm is practicable where one has their own threshing outfit. On a medium sized farm, where the threshing is hired out, it could not be done in the case of grain hauled directly to market. When the grain is stored on the farm before hauling, cleaning is practicable and advisable. It will be apparent that, on the same basis of screenings, the proposed elevator charge of 1¾ cents per bushel would have caused a loss of $220 besides the expense of hauling both ways, but I imagine the proposed charge might very well be a good deal less. The really practicable way for the whole country generally would be that the threshing outfits should include a grain cleaning attachment, as many of them now do a sheaf loading machine."

Nouvelle Méthode D'Homogénéisation pour la recherche du Bacille Tuberculeux dans les Crachats[1]

Par ARTHUR VALLÉE, M.D.

Présenté par A. B. MACALLUM, M.S. . .

(Lu à la réunion de mai 1920)

Dès la découverte du B. tuberculeux, l'importance de sa recherche dans les crachats pour dépister au plus tôt la maladie, fut nécessairement le fait capital dans la pratique bactériologique courante.

Il fut cependant constaté que le bacille pouvait souvent passer inaperçu dans l'expectoration de malades dont les lésions ouvertes ne laissaient aucun doute. Aussitôt l'attention des bactériologistes se porta sur l'étude des méthodes qui pouvaient réaliser les résultats les plus nettement positifs. Dans ce but Bieder, un des premiers dès 1886, préconisa une technique d'*homogénéisation*, qui en permettant une fluidification des liquides expectorés et des matières qu'ils contenaient, distribuait en somme le B. de Koch uniformément dans toute la masse des crachats à examiner.

Par la suite, ces méthodes se multiplièrent tout en restant à peu près semblables quant au principe. Successivement on eut recours à différents agents chimiques, dont les propriétés fluidifiantes semblaient les meilleures.

D'après Bezançon et de Jong[2], ces différents procédés relèvent de l'emploi d'alcalins dilués, de sucs digestifs, ou de substances classées comme diverses, telles que: acide phénique, formaline alcoolisée, ou alcool à 90°.

Voilà où en est encore à l'heure actuelle la question de l'homogénéisation, qui ne manque pas d'une portée pratique assez importante pour le dépistage du bacille dans les cas où précisément il importe le plus de pouvoir le reconnaître, tant pour confirmer un diagnostic clinique que pour prendre avant la lettre les précautions prophylactiques immédiates.

Principe de la Méthode: Le principe de tous les procédés préconisés consiste à transformer les crachats plus ou moins purulents,

---

[1] Ce travail expérimental de technique a été fait dans les laboratoires de la Faculté de l'Université Laval à l'hôpital et à l'école de Médecine. La partie technique a été exécutée par notre assistant à l'époque, M. le docteur H. Laliberté, en avril et mai 1919.

[2] Bezançon et de Jong: Traité de l'examen des crachats.

visqueux ou conglomérés en une substance homogène aussi fluide que possible. Cette partie de l'opération libère les bacilles emprisonnés dans les substances grasses de l'expectoration et il est ensuite facile par centrifugation de les réunir tous, quelque peu nombreux qu'ils soient, dans le culot.

Voyons brièvement quelques-unes des principales méthodes employées jusqu'ici.

Méthodes d'Homogénéisation: 1° *Par les Alcalis:* Ces méthodes semblent de beaucoup les plus populaires, parceque les alcalis exercent une action fluidifiante connue sur la fibrine et la mucine.

La méthode de Bieder, la première en date, consiste à faire bouillir les crachats avec de la lessive de Soude à 2/10%, dans une capsule, et ajouter de l'eau jusqu'à fluidification, laisser sédimenter, décanter et examiner le culot.

Courtade et Arnaude préconisent à leur tour le procédé assez complèxe qui suit: Mélanger: 1°, Crachats, 10 cc.; Eau, 100 cc.; lessive de Soude, 10 gts., porter à ébullition en agitant jusqu'à homogénéisation.

2° Dans un tube à essai traiter 20 cc. du mélange par Acide Acétique, 4 gts.; Ether, 4 cc. Emulsionner le tout. Il se forme un précipité qui surnage.

3° Dissoudre le précipité par la lessive de Soude, ajouter un excès d'éther et agiter fortement.

4° Il suffit alors d'évaporer l'éther et il se forme une pellicule qui contient presque tous les bacilles. C'est sur cette pellicule qu'on effectue ensuite la recherche.

Dilg se sert d'Ammoniaque et d'une solution de Chlorure de Sodium.

De Lannoise et Girard utilisent l'Eau de Javelle au tiers plus la Soude en action sur le culot.

D'autres emploient l'Antiformine ou l'Hypochlorite de Soude ou de Potasse qu'ils désignent ainsi. D'autres la liqueur de Labarraque.

Bezançon et Philibert se servent également de la Soude, mais en modifiant la méthode de la façon suivante:

Mesurer la quantité de crachats dont on dispose, mesurer une quantité d'eau 10 fois supérieure. Les crachats et moitié de cette eau additionnés d'autant de gouttes de lessive de Soude qu'il y a de cc. de crachats, sont portés dans une capsule. Chauffer doucement en agitant. Le reste de l'eau est ajouté graduellement. On laisse refroidir le liquide homogénéisé, puis on prend la densité. En effet le bacille tuberculeux aurait une densité variant de 1010 à 1080, et un liquide trop dense ne permettrait pas le dépôt du bacille dans le culot au moment de la centrifugation. Aussi si la densité dépasse 1004. Bezançon conseille-t-il l'addition d'un peu d'alcool à 50°, jusqu'à ce que la densité tombe au moins à 1000. Le liquide est alors centrifugé pendant trois-quarts d'heure à une heure. Le culot est ensuite examiné en colorant par le procédé ordinaire appliqué avec précision.

Ces auteurs prétendent au moins décupler ainsi le nombre de bacilles trouvés.

2° *Par les Sucs Digestifs:* Nous n'insisterons pas sur les procédés utilisant les sucs digestifs, et qui ne semblent pas, vu le temps exigé pour les résultats, avoir une portée pratique.

Spengler préconise dans ce but la Pancréatine après avoir utilisé la Soude. Jousset le suc gastrique et le fluorure de sodium. Tous en somme font intervenir quand même dans leurs méthodes spéciales des alcalins.

3° *Substances diverses:* Ces substances pour la plupart donnent de mauvais résultats parceque presque toutes précipitent une quantité de matières albuminoides.

Ce qui frappe surtout à première vue dans ces diverses méthodes d'homogénéisation, c'est que toujours le crachat à examiner est tout d'abord traité par l'eau. C'est secondairement que l'on fait intervenir les alcalis ou les sucs digestifs pour fluidifier la mucine ou la fibrine.

Or est-ce bien dans la mucine ou la fibrine qu'il importe de rechercher le bacille de Koch? Toutes les méthodes d'examen direct préconisent au contraire d'aller puiser la parcelle à examiner, au plus profond des portions *purulentes* de l'expectoration. Ces amas purulents conglomérés, il n'est pas nécessaire pour les désagréger d'utiliser un alcali ou autre produit. Un chauffage modéré avec de l'eau distillée semble devoir suffir pour les dissocier complètement. C'est en partant de ce principe que nous en sommes arrivés à établir une technique de la plus grande simplicité qui permet l'emploi journalier du procédé.

Méthode D'Homogénéisation par l'eau distillée: Le crachat à examiner est dilué dans environ 10 fois sa quantité d'eau distillée. Le tout est porté dans une capsule de porcelaine et chauffé légèrement en agitant jusqu'à émission de vapeur, sans pousser jusqu'à l'ébullition, pendant 2 ou 3 minutes. Le crachat est alors parfaitement fluide, toutes les particules solides étant dissociées.

Comme aucune substance n'est intervenue qui puisse précipiter ou coaguler les matières en suspension, et comme aucun produit n'a pu élever la densité du liquide, l'eau distillée étant à 1000, la centrifugation nous donnera un culot contenant tout au moins la majorité des bacilles.

Le liquide ainsi obtenu est alors centrifugé pendant 5 à 10 minutes. Le culot porté sur lame s'étale de lui-même sans grumeaux, sans précipité important et peut alors être fixé et coloré par la méthode de Ziehl ordinaire. Les cellules ont conservé leur aspect normal et les bacilles nombreux n'ont pas été altérés ni dans leurs dimensions, comme ils le sont par la soude qui les gonfle facilement, ni dans leur forme, ni dans leur pouvoir de coloration.

Voici quelques statistiques comparatives de crachats examinés par la recherche directe, par le procédé d'homogénéisation à la Soude et par notre méthode d'homogénéisation à *l'Eau distillée.* Dans tous les rapports qui suivent, les données ont été établies sur dix champs microscopiques et les chiffres indiquent la moyenne de bacilles par champ.

Obs. I.	Recherche directe	1·9
	Homogénéisation à l'eau	4·1
Obs. II.	Recherche directe	0·4
	Homogénéisation à l'eau	4·9
Obs. III.	Recherche directe	2·8
	Homogénéisation à l'eau	9·0
Obs. IV.	Recherche directe	6·0
	Homogénéisation à l'eau	33·2
Obs. V.	Recherche directe	0·0
	Homogénéisation à l'eau	6·8
Obs. VI.	Recherche directe	3·5
	Homogénéisation à l'eau	5·3
Obs. VII.	Recherche directe	0·5
	Homogénéisation à l'eau	1·6
Obs. VIII.	Recherche directe	3·6
	Homogénéisation à l'eau	9.3
Obs. IX.	Recherche directe	5·0
	Homogénéisation à la Soude	4·0
Obs. X.	Recherche directe	0·0
	Homogénéisation à l'eau	0·0
Obs. XI.	Recherche directe	0·0
	Homogénéisation à la Soude	0·0
Obs. XII.	Recherche directe	0·0
	Homogénéisation à la Soude	0·0
	Homogénéisation à l'eau	2·7
Obs. XIII.	Recherche directe	0·0
	Homogénéisation à l'eau	0·4
Obs. XIV.	Recherche directe	0·0
	Homogénéisation à l'eau	3·3
Obs. XV.	Recherche directe	0·5
	Homogénéisation à l'eau	8·9

Inutile de multiplier encore ces observations concordantes. Si l'on prend les moyennes par champ microscopique pour les examens directs et pour les examens des mêmes spécimens après homogénéisation à l'eau distillée, on constatera que le nombre des microbes se trouve au moins quintuplé par ce procédé.

Il semble assez clairement démontré par ces quelques observations que ce procédé suffit à donner des résultats largement augmentés.

Son exécution facile, tant au point de vue de la technique que du temps qu'il faut y consacrer, en rend l'application courante des plus simples et journellement applicable.

La méthode d'homogénéisation, dont les techniques quelquefois complexes et en tout cas l'emploi de substances chimiques diverses, limitaient l'utilisation et en faisaient un procédé d'exception, semble pouvoir devenir un moyen de routine pour la recherche minutieuse du B. de Koch, dans les crachats.

La simplification constituant au laboratoire comme dans l'industrie le gage le plus sûr de vulgarisation, il est de toute évidence que cette technique facile soit appelée à rendre, nous l'espérons, d'importants services à la clinique.