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DE

LA SOCIÉTÉ ROYALE

DU

CANADA

TROISIÈME SÉRIE—TOME XII.

SÉANCE DE MAI 1918

EN VENTE CHEZ
JAS. HOPE ET FILS, OTTAWA; LA CIE COPP-CLARK (LIMITÉE), TORONTO
BERNARD QUARITCH, LONDRES, ANGLETERRE
1919

PROCEEDINGS

AND

TRANSACTIONS

OF

THE ROYAL SOCIETY

OF

CANADA

THIRD SERIES—VOLUME XII.

MEETING OF MAY, 1918

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1919

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THE ROYAL SOCIETY OF CANADA

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LIST OF FELLOWS, 1918-1919

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

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1917—Chouinard, H.-J.-B., LL.B., C.M.G., *Québec.*

1890—David L.-O., chevalier de la Légion d'honneur, sénateur, *Montréal.*

1885—DeCelles, A.-D., C.M.G., LL.D., Litt.D., chevalier de la Légion d'honneur, *Ottawa.*

1918—Després, L'abbé Azarie Couillard, *Sorel, Qué.*

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1908—Lemieux, Rodolphe, LL.D., membre du Conseil privé du Canada, officier de la Légion d'honneur, *Ottawa.*

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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.*

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1918—DeLury, Alfred T., M.A., University of Toronto, *Toronto.*

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1909—Fields, John Charles, Ph.D., F.R.S., University of Toronto, *Toronto.*

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1891—Goodwin, W.L., D.Sc., Queen's University, *Kingston.*

1908—Harkness, James, M.A. (Cantab. & Lond.), McGill University, *Montreal.*

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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).

1918—Patterson, John, M.A., Physicist with Meteorological Service of Canada, *Toronto.*

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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.*

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1911—Brock, Reginald, W., M.A., F.G.S., F.G.S.A., University of British Columbia, *Vancouver, B.C.*
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1888—Mackay, A. H., LL.D., B.Sc., Superintendent of Education, *Halifax.* (Life member).

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1918—Wesbrook, Frank F., M.A., M.D., C.M., LL.D., President of the University of British Columbia, *Vancouver, B.C.*
1912—Willey, Arthur, D.Sc., F.R.S., McGill University, *Montreal.*

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Salone, Émile, professeur d'histoire au Lycée Condorcet, 68 rue Jouffray, *Paris.*
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Lamy, Étienne, secrétaire perpétuel de l'Académie française, 3 place d'Iéna, *Paris.*
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1895—Callendar, Hugh L., M.A., (Cantab.,) F.R.S., *London, England.*
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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.*
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1889—Mair, Charles, *Prince Albert, Sask.*
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1902—Owens, R. B., M.Sc., Franklin Institute, *Philadelphia, U.S.A.*
1898—Parkin, G. R., C.M.G., LL.D., *London, England.*
1900—Poole, H. S., M.A., F.G.S., *Spreyton, Stoke, Guildford, England.*
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1890—Roberts, C. G. D., M.A., *London, England.*
1900—Rutherford, E., B.A. (Cantab.), A.M., F.R.S., *Manchester, England.*
1910—Thomson, E. W., F.R.S.L., *Ottawa.*
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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.

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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 Instite.
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 Alumnae.
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'Economie 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, 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 1918.

THIRTY-SEVENTH GENERAL MEETING

SESSION I.—(Tuesday, May 21).

The Royal Society of Canada held its thirty-seventh annual meeting in the Chateau Laurier on May 21, 22 and 23.

The President, Mr. W. D. Lighthall, took the chair at 10 a.m., and, having called the meeting to order, requested the Honorary Secretary to call the roll.

The following members answered to their names or arrived later during the session:—

OFFICERS OF THE SOCIETY

Honorary President, Hon. Mr. Justice Longley.

President, Mr. W. D. Lighthall.

Honorary Secretary, Mr. Duncan C. Scott.

Honorary Treasurer, Dr. C. Gordon Hewitt.

Honorary Librarian, Mr. D. B. Dowling.

SECTION I.—Barbeau, C.-M.; Chapais, Thomas; Chartier, Emile; Chouinard, H.-J.-J.-B.; David, Hon. L.-O.; Després, A.-C.; DeCelles, A.-D.; Fauteux, A.; Groulx, Lionel; Gérin, Léon; Lemieux, Hon. Rodolphe; Morin, Victor; Myrand, Ernest; Perrault, Antonio; Poirier, Pascal; Rouillard, Eugène; Sulte, Benjamin.

SECTION II.—Bryce, George; Cappon, James; Coyne, J. H.; Doughty, A. G.; Edgar, Pelham; Falconer, Sir Robert; Grant, W. L.; King, W. L. MacKenzie; Longley, J. W.; Lighthall, W. D.; Macnaughton, John; Mavor, James; McLachlan, R. W.; Peterson, Sir William; Raymond, Ven. Archdeacon W. O.; Riddell, W. R.; Scott, D. C., Shortt, Adam; Wood, William; Wrong, George M.

SECTION III.—Allan, F. B.; Bain, J. Watson; Burton, E. F.; Clark, A. L.; Dawson, W. Bell; Deville, E.; Ellis, W. H.; Fields, J. C.; Glashan, J. C.; Goodwin, W. L.; Harkness, James; Johnson, F. M. G.; King, L. V.; Klotz, Otto; MacKenzie, A. Stanley; McGill, Anthony; McIntosh, Douglas; Miller, W. Lash; Ruttan, R. F.; Satterly, John; Shutt, F. T.; Stansfield, Alfred; Stupart, Sir Frederic.

SECTION IV.—Adams, F. D.; Bailey, L. W.; Bensley, B. A.; Buller, A. H. R.; Camsell, Charles; Coleman, A. P.; Dowling, D. B.; Dresser, John A.; Faribault, E. R.; Grant, Sir James; Harrison, F. C.; Hewitt, C. Gordon; Huard, Victor A.; Huntsman, A. G.; Lambe, L. M.; Lewis, F. J.; Lloyd, F. E.; Macallum, A. B.; MacKay, A. H.; McKenzie, J. J.; McConnell, R. G.; McInnes, William; McMurrich, J. P.; Prince, E. E.; Wesbrook, F. F.; White, James.

Letters of regret for absence were received from the following:—

Cruikshank, E. A.; Chouinard, H. J. J. B.; Archibald, E. H.; Mignault, P. B.; Miller, W. G.; Bégin, Cardinal H. E.; Fraser, C. McLean; Burgess, T. J. W.; Robertson, J. Ross; Bethune, C. J. S.; Gosselin, A. E.; Tory, H. M.; Gosselin, A. H.; Harris, D. Fraser; Roy, Camille; Ami, H. M.; Tyrrell, J. B.; Scott, H. A.; Bruchési, Archbishop Paul; McPhedran, Alex.

The following Fellows are reported as being on military service:—
Cruikshank, E. A.; Doughty, A. G.; Edgar, Pelham; Grant, W. L.; Macphail, Sir Andrew; Scott, F. G.; Wood, William; Lang, W. R.; Eve, A. S.; Kenrick, F. B.; McLennan, J. C.; Tory, H. M.; Brock, R. W.

It was moved by Dr. F. T. Shutt, seconded by Dr. J. J. MacKenzie, 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 1917-1918.

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 in the Chateau Laurier on May 22, 23 and 24. The meeting was most successful, and the accommodation which was given the Society by the management of the Chateau was, as in former years, excellent. We have been able to make like arrangements for this year's meeting.

I.—PROCEEDINGS AND TRANSACTIONS OF THE SOCIETY.

Owing to the diminution in the Society's income, it was found necessary to practise economy, and the officers of the Society accordingly carried out the direction of Council in reducing the size of the annual volume to 640 pages, exclusive of the proceedings. The papers presented last year were voluminous and to meet the necessity of the case many excellent and important papers had to be sacrificed to the restricted limits of the volume. The Fellows cheerfully submitted to the abnormal conditions and the volume appears the smallest issued for some years. It is believed, however, that the selection of papers has been judicious, and that the volume is worthy of the series. It will be noted that this Report of Council does not deal with as many subjects as usual. The effect of the war has been to limit the activities of the Society, as all are absorbed in the commanding interest of the struggle in Europe.

The number of papers in the agenda this year, which is about the same as last, shows the continued interest of the Fellows in the work of the Society.

II.—Election of New Fellows.

This year there were vacancies in all the Sections. Voting was closed on the 1st of April. 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.

L'abbé Azarie Couillard Després.
M. Aegidius Fauteux.
L'abbé Lionel Groulx, M.A.

Section II.

Walter Charles Murray, M.A., LL.D.

Section III.

Ebenezer Henry Archibald, M.A., Ph.D., F.R.S.E.

Section IV.

Charles Camsell, B.A.
Francis John Lewis, D.Sc., F.R.S.E.
Frank Fairchild Wesbrook, M.A., M.D., C.M., LL.D.

In Section III five candidates received a majority of votes, but four received the same number of votes. As there were but four vacancies the Council can only submit for confirmation the election of Mr. Archibald. The Section may make a selection from those whose votes were equal to fill the other three vacancies and recommend them to the Society for election.

III.—Deceased Members.

It is with deep regret that we record six vacancies in the ranks of the Fellows, which have occurred by death: Dr. W. D. LeSueur, Dr. W. W. Campbell, Dr. G. P. Girdwood, Dr. Robert Bell, Professor C. H. McLeod, and Rev. Father Jones.

The biographical sketches were written respectively by Dr. John Reade, Mr. W. D. Lighthall, Dr. R. F. Ruttan, Mr. Charles Camsell, Mr. Fraser Keith and Rev. Father Devine.

WILLIAM DAWSON LESUEUR

Dr. William Dawson Le Sueur, a son of Mr. Peter LeSueur, for many years chief of the Post Office money order system of Canada, and subsequently Secretary of the Dominion Board of Civil Service Examiners, and of Barbara (Dawson), his wife, was born at Quebec on the 19th February, 1840. He was educated at the Montreal High School, the Ontario Law School and Toronto University. In 1856 he entered the Canadian Civil Service, during the entire period of his connection with which he was attached to the Post Office Department. Of that Department he was Secretary from 1888 until 1902 when he retired from the Service. While the conscientious assiduity and the intelligence that he brought to the discharge of his duties won the acknowledgment of his superiors, his official work was really but a fragment of the labours that engaged his ever active mind. Intellectually, he was gifted greatly above the average of mankind and so diverse and comprehensive were his endowments that one may well hesitate to say where he most excelled. His devotion to the classics of Greece and Rome may be said to date from his boyhood. He was Dux of the Montreal High School at a time when Latin and Greek were deemed more essential in education than they are to-day. When in 1863 he graduated in the University of Toronto, he took honours in Classics. One of his very latest literary achievements was a Latin metrical version of Dr. John Mason Neale's beautiful hymn, "Art thou weary? Art thou languid?" Yet his unceasing cultivation of the old classics never prevented Dr. LeSueur from appreciating what he considered praiseworthy in modern literature, especially in that of the motherlands with which the twofold culture of which this Society is the guardian is filially allied. His essays on Sainte Beuve and other eminent French writers which

William Dawson Lesueur

appeared in a great English quarterly, when he was still quite a young man, drew attention to his taste and judgment. The *Canadian Monthly*, *The Week*, *The Canadian Magazine*, *Queen's Quarterly*, *The Commonwealth*, *The University Magazine*, *The Montreal Gaz tte*, *The Montreal Star* and *The Ottawa Citizen*, were enriched by contributions from his pen, either on subjects purely literary or on matters of current interest. In later years he gave much attention to the study of history, which was the subject of his thoughtful address as President of this Society.

It is noteworthy that, although Dr. LeSueur's literary and historical studies covered a large range and were elaborated with characteristic care, they did not cause him to stint his interest in scientific progress. There have been some animated controversies in recent years between those who would retain the ancient classics on their traditional footing as a branch of education, and those who would give a virtually exclusive preference to science as more rational and more practical. But, while Dr. LeSueur was devoting so much time and thought to ancient letters, while he was gauging the great modern products of inspiration and criticism that had done so much to advance the cause of civilization, he had been all along a fruitful devotee of science. He was among the rare students of Canada who recognized at once the significance of the new science and its destined ultimate effects on religious and philosophic thought. He was for years on the staff of the *Popular Science Monthly*, and when a leader of the new movement was to be honoured in New York by a dinner to which the foremost scientific men of the Union were invited, Dr. LeSueur was chosen to represent Canada. His study on "The Data of Ethics" was included in the preface of a special edition of that work. Among his essays that were published separately were those entitled, "A Defence of Modern Thought," and "Evolution and the Positive Aspects of Modern Thought."

Dr. LeSueur contributed to the "Makers of Canada" Series, a volume dealing with the most illustrious of the Governors of the Old Regime after the great explorer and founder Champlain. In dealing with the character, policies and acts of Count Frontenac, Dr. Le Sueur is original and independent and at the same time fair and unprejudiced to both his champions and his critics.

Among his other writings may be mentioned "Notes on the Study of Language," "Partizan Politics," and "The Development of Responsible Government in Canada."

Besides The Royal Society, of which he was successively Honorary Secretary, Vice-President and President, Dr. LeSueur was a member of the Ottawa Literary and Scientific Society to which he presented his "Notes on the Study of Language" and other Essays, and of which he became President; of the Peace and Arbitration Society, of which he was a Vice-President; and of the Canadian Society of Authors in which he held the same position. He also attained the presidency of the Toronto University Club of Ottawa. His advice and counsel were highly valued by his colleagues of The Royal Society and he did constant labour in forwarding the purposes for which the Society was founded. Of the very many instances in which he gave signal help, the recasting of the Diploma of the Society and the choice of a new motto might be mentioned. The motto adopted by the Society was suggested by him and was essentially founded on a passage from Claudian. In every capacity in which he served his fellow-men, he was recognized as one whom it was a privilege to know not only for his commanding abilities but for qualities that appealed to the heart. His attachments were strong and he was conscientiously faithful in his friendships. For years he bore much pain with exemplary patience, rarely complaining, sometimes seeking relief in a favorite book or in the use of his pen, sometimes in intercourse with congenial minds. But notwithstanding his long illness, it was a shock as well as a cause of very real sorrow to those who knew and esteemed him when word reached them that, on the 28th of September, 1917, the summons of death had come to him.

WILLIAM WILFRED CAMPBELL

William Wilfred Campbell was born at Berlin, Ontario, in 1861. He died of pneumonia at his country residence near Ottawa on the 1st January, 1918. He was one of that small band of true poets who rose soon after Confederation and first gave idealistic voice to the Dominion. Dr. Campbell was always intensely in earnest, hated whatever he thought was trifling with the poetic art and was noted for his bardic fire and feeling. His best passages on poetic and patriotic subjects were strong and satisfying. Like all real seers his sense of beauty and of mystery sometimes carried him very near perfection. He was at his best in his great poem "The Mother."

Son of an Anglican clergyman, the Reverend Thomas S. Campbell, related to the Argyle family, he was thoroughly Highland in his devotion to the history of his clan; but he was proud also of descent through his mother from the artist Wright, who like Hoppner was one of the four leading successors of Sir Joshua Reynolds. Educated at Toronto University , he took Anglican orders in 1885 and was Rector of St. Stephen, N.B., but resigned in 1891 for certain intellectual reasons. Soon afterwards he entered the Civil Service at Ottawa,

WILLIAM WILFRED CAMPBELL

and during the Great War filled a good post under the Imperial Munitions Board. Financially he always had a hard struggle, in which he fought bravely for those dependent on him, and which constantly hampered his genius.

In 1889 he produced his first volume, "Lake Lyrics," inspired by the scenery of the Great Lakes, which at once marked him as a skilful master of versification and possessor of a keen insight into the beautiful. In 1893 appeared a volume of poems entitled "The Dread Voyage." He now became a frequent contributor to the principal American and other magazines. In 1895, he published the verse tragedies "Mordred " and "Hildebrand;" in 1908 "Political Tragedies;" in 1899 another volume of poems, "Beyond the Hills of Dream;" in 1905 "The Collected Poems;" and in 1914 "Sagas of Vaster Britain," expressing his stirring passion for the British Empire. Some prose works and fugitive poems complete the list.

His genuineness, intense patriotism, strong, interesting personality and warm heart, endeared him greatly to his family and friends. His work was devoted to art in a high and reverent sense, the glory and history of the Empire deeply moved him, and he was a faithful clansman to all causes in which he believed. He was elected to The Royal Society of Canada in 1893; was President of the English Literature Section in 1900; rendered long services as Secretary to the Section; in 1906 was a delegate of the Society to attend the quatercentenary of Aberdeen University, where he received the degree of LL.D.; was a member of the Literary Committee appointed to attend the Quebec Tercentenary in 1908; and was long one of the best known Fellows of the Society. Both in and out of it he had a large circle of literary and personal friends, whom he entertained with an overflowing fund of historical and literary knowledge, recollections of travel, and many original theories. His numberless contributions to the press on such subjects were read with interest by a large circle in Canada and Great Britain. Wilfred Campbell was one of those outstanding literary figures who brought credit to the Canadian people as being a nation not without ideals, and he permanently enriched our life with many an inspiring thought and line, helping to feed the fire which has blazed out so brightly in the Great War and promises to melt and remould our future.

GILBERT PROUT GIRDWOOD

Dr. G. P. Girdwood, one of the original Fellows of the Society, passed away at his residence in Montreal on the second of October, 1917.

He was in his eighty-fifth year and although practically confined to his house for six years before his death, he was up to within a few weeks of the end intellectually active and keenly interested in the progress of science. He was quite blind for his last five years of life, but with the assistance of his devoted wife and daughter he collected evidence regarding the toxic effect of carbonic oxide in coal gas from over one hundred sources in England, United States and Canada. The result of this extensive investigation was reported to this Society in 1916 and 1917.

Born in London in 1832, he received his early education at a private school and subsequently entered University College and St. George's School of Medicine. He was admitted a member of the Royal College of Surgeons of England in 1854, and for a short time served as house surgeon in the Liverpool Infirmary. In the same year he was gazetted assistant surgeon of Her Majesty's Grenadier Guards.

Dr. Girdwood accompanied the 1st battalion of the Grenadier Guards to Canada at the time of the famous Trent affair in 1862, and on its return to England in 1864 retired from the army and entered upon the practice of medicine in Montreal. In 1865 he took the degree of M.D., C.M., at McGill University. He was for some years surgeon of the Third Victoria Rifles, and served with that regiment at the front during the Fenian Raids, later receiving the medal. Not long after he was promoted to be a medical staff officer of the Militia of Canada.

For twelve years he was surgeon to the Montreal Dispensary and to the Montreal General Hospital, and following this service was appointed consulting surgeon to both institutions. He also became consulting surgeon to the Children's Memorial Hospital and Consultant in the X-ray Department of the Royal Victoria Hospital.

He was appointed surgeon to the Canadian Pacific Railroad during its construction and had charge of the Eastern Division. He afterwards became Chief Medical Officer of that railroad.

Dr. Girdwood was a former president of the Roentgen Society of America; vice-president of the Canadian Branch of the Society of Chemical Industry; a Fellow of the Chemical Society and also of the Institute of Chemistry of Great Britain.

He was a member of the College of Physicians and Surgeons of the Provinces of Quebec, Ontario and British Columbia. He also was an active member of both the British and the American Associations for the Advancement of Science, of the Montreal Natural History Society, and of the Montreal Microscopical Society; of the last he was elected President in 1892.

Gilbert Prout Girdwood

The late Dr. Girdwood was an interesting and conspicuous figure among the scientific men of Canada, especially during the last quarter of the nineteenth century. He was a type which our modern methods of education will not reproduce, the type of the all round scientist, cultured, enthusiastic and interested in many fields of science.

Breadth of scientific knowledge and versatility of accomplishments were his outstanding characteristics as a scientific man. He was very much more than dilettante in almost every field of natural and experimental science. He had a sound knowledge of medicine, surgery, medical jurisprudence, botany, physics, hygiene, microscopical technique, including photomicrography, besides being fundamentally a chemist. These varied accomplishments were all the more astonishing when we remember that he began life as an assistant surgeon in a fashionable British regiment, namely, the Grenadier Guards, where he was conspicuous as an athlete and a genial companion.

Before entering the army medical service, and while still a young man, he studied chemistry in London and Liverpool. With Mr. Rodgers, a London chemist, he devised the method which is known as the Rodgers and Girdwood method for the detection of strychnine, by which it is possible to detect less than one hundredth thousandth part of a grain of this poison.

During his career as a scientific man, and while engaged in general practice, he was connected with many important legal cases, where his knowledge of medical jurisprudence was of great value to the country. He was not only a good toxicologist, but was the first to use enlarged photographs and the application of reagents for the detection of forgeries, counterfeits, and the identification of handwriting. In this field he was one of the best experts in America.

He was associated with the late Dr. Sterry Hunt in many of his chemical studies, among which was the production of Hunt's Chronium Oxide Green, which is still used as an ink in the printing of bank notes. In the field of microscopy he was an expert in the identification of starch granules and was a pioneer in the stereoscopic photography of crystals under the microscope and also in the application of the stereograph to the study of the photographs produced by the Roentgen rays. He was the first to demonstrate that the position of a foreign object in relation to a bone could be shown perfectly by the application of stereoscopic principles in taking Roentgen ray photographs.

In his busy life he found time to contribute many valuable scientific articles to the London Lancet, the Montreal Medical Journal, the

Transactions of The Royal Society of Canada, and various chemical journals.

He was actively engaged in medical education from the time of his resignation from the Guards and was an interesting teacher both of clinical surgery in the hospital and of chemistry in the university. His name will always be associated with the development of chemical teaching in McGill University. The introduction of practical chemistry as an integral part of a medical student's education in Canada was first carried out by Dr. Girdwood in some classes which he gave to the medical students of McGill University about 1870. The classes were held in his own home in Lagauchetiere Street. In 1872 he became Professor of Practical Chemistry and for ten years he gave all of the instruction in Practical Chemistry in McGill University. He subsequently succeeded Dr. Craik to the Chair of Chemistry in the Medical Faculty in 1879, which chair he held up to 1902, when his failing health and the pressure of work from his other activities compelled his resignation. He retained his connection with university education as Emeritus Professor of Chemistry up to the last.

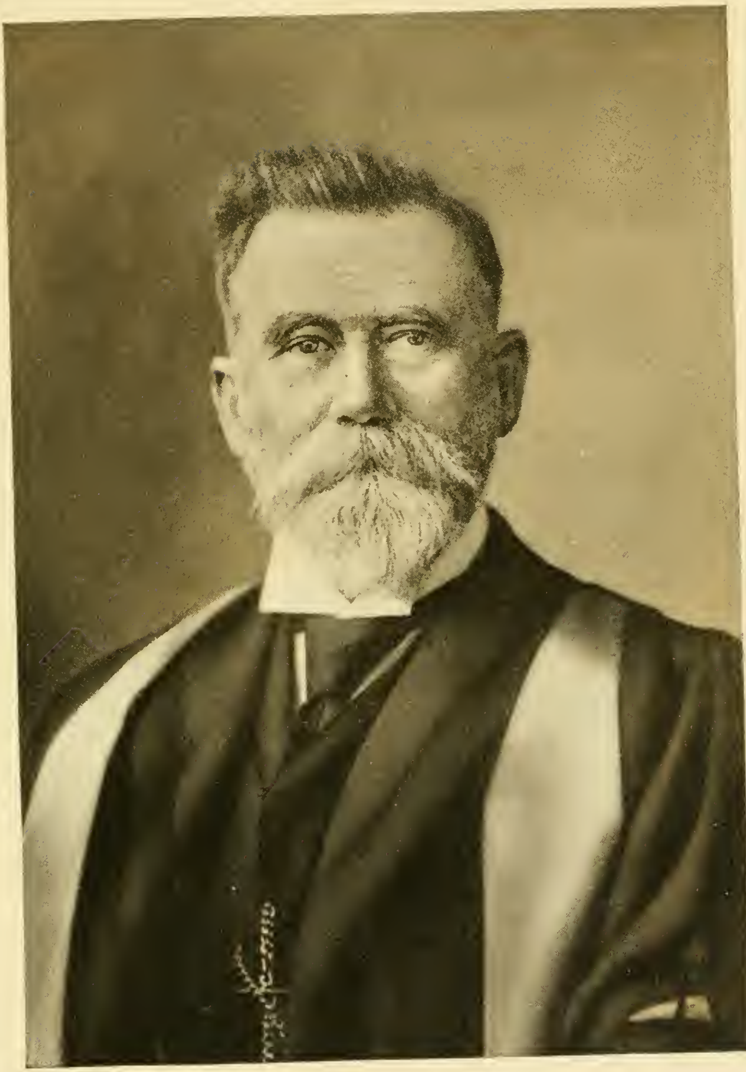
He was widely known both in Canada and the United States. He was a man of high ideals, who took pride in his profession as a chemist, and one of his great ambitions during his last illness was to obtain legislation to give the profession of chemistry the same legal status as the professions of law and medicine.

His genial, kindly and humorous character won him a host of personal friends in all walks of life. He enjoyed apparently above all else the pleasure of adding, as he had opportunity, to the happiness of those about him.

ROBERT BELL.

Robert Bell, I.S.O., F.R.S., M.D., C.M., D.Sc. (Cantab.), LL.D., F.G.S., F.G.S.A., who was formerly Assistant Director and Chief Geologist of the Geological Survey of Canada and for several years acted as Director of the Survey, was one of the charter members of The Royal Society of Canada. He was born in Toronto on the 3rd of June, 1841, and was thus in his 77th year when he died at Portage la Prairie, Manitoba, on June 19, 1917.

Both his grandfather, Rev. Wm. Bell, and his father, Rev. Andrew Bell, were ministers of the Church of Scotland. His father was one of the pioneers of Canadian geology, and when Sir William Logan was called by the government of the United Provinces of Upper and Lower Canada to establish a Geological Survey, one of the first Canadians with whom he conferred on this subject was Dr. Bell's father, Rev.



Robert Bell

Andrew Bell. Dr. Bell therefore came justly by his predilection for geological and natural history studies.

Dr. Bell obtained his early education at the grammar school of the county of Prescott and afterwards studied at McGill University, under the distinguished scientists Dr. T. Sterry Hunt and Dr. Sutherland, receiving his degree in Applied Science in 1861 and the Governor's gold medal. He afterwards pursued his studies in Edinburgh, taking chemistry under Lords Playfair and Lister and Professors Dittmar and Crum Brown, and botany under Professor J. H. Balfour. At the age of 21 years he became professor of Chemistry and Natural Science at Queen's University, a chair which he held for five years from 1863 to 1867.

Previous to accepting the professorship at Queen's, Dr. Bell in 1857, at the early age of 16 years, had joined the staff of the Geological Survey of Canada under Sir W. E. Logan, and for over 50 years he was connected with that branch of the Government service. He had the privilege in his early history on the Survey under Logan of being associated with Murray, Hunt, Billings and Richardson, all men of high ideals and attainments with whom it was an inspiration to work and from whom he imbibed an enthusiasm for geological exploration and research which he retained throughout his life.

During his 50 years of active connection with the Geological Survey, Dr. Bell accomplished an enormous amount of geological work, but he was pre-eminent as an explorer, and it is in that branch of work that his name will be remembered by succeeding generations. He had practical training as a surveyor at McGill University, and to further equip himself to meet emergencies that might arise in the course of his exploratory journeys he completed a course in medicine and surgery at the same University in 1878. His geographical and geological surveys covered a great part of northern Quebec and Ontario and the region about Hudson Bay, as well as northern Manitoba, Alberta and the North West Territories, and he traversed at one time or other most of the larger streams and lakes of these regions, many of them being surveyed by him for the first time. The Bell river, the western branch of the Nottaway river, is officially named after him.

His reports contain a fund of information on the geological and physical features of that northern country which was of great value to the government and the locating engineers at the time that the building of the National Transcontinental railway was under discussion, and is appreciated at the present time as different portions of that region become opened up.

He was attached to several expeditions into Hudson Bay, and was able through his knowledge of conditions in Hudson straits to furnish the government with a great deal of valuable information when the question arose of a railway to Hudson Bay and the navigation of the straits. He was medical officer and geologist to the "Neptune" expedition in 1884 and the "Alert" expedition of 1885. Again when on the "Diana" expedition in 1897, he surveyed the south shore of Baffinland and penetrated that island to the great lakes of its interior.

During his numerous explorations he naturally came in contact with many tribes of Indians and was deeply interested in their customs, folk lore and archæology. This was one of his chief recreations, and his collection of native legends numbers several hundreds. He thoroughly understood the mind of the Indians, and by his intelligent treatment of them was able to gain their confidence so that at Grand Lake, Quebec, he was made an honorary chief of the Algonquin Indians of that district.

Dr. Bell was deeply interested in forestry, and during his long journeys had an excellent opportunity to study the geographical distribution of Canadian forest trees. As early as 1873, he prepared a large map showing the northern limits of the principal trees in the four original provinces of the Dominion. Later he published a map to accompany the report of the Geological Survey for 1879-80 which showed the northern range of the trees east of the Rocky Mountains. This was supplemented in 1897 by another map, giving much additional information compiled from observations of his own and data furnished by his colleagues and other travellers.

In recognition of his contributions to our knowledge of the geography of Canada Dr. Bell was awarded the King's or "Patron's Gold Medal" of the Royal Geographical Society in 1906. In the same year he was the recipient of the "Cullum Gold Medal" from the American Geographical Society and was the first Canadian to receive that honour. He was the Canadian correspondent to the "Royal Scottish Geographical Society" and to "la Société de Géographie" of France.

Besides the degrees received in course at McGill University, B.A.Sc., 1861; M.D., C.M., 1878; D.Sc., 1901; Dr. Bell was the recipient of many honorary degrees from other universities. Queen's University bestowed on him her LL.D. degree in 1883, and Cambridge University honoured him with the degree of D.Sc. in 1903.

The scientific societies with which he was associated included the Chemical Society, 1865; American Institute of Mining Engineers, 1881; Royal Society of Canada, 1882; Geological Society of America, 1889; Royal Society, London, 1897; Geological Society, London; American Association for the Advancement of Science, Royal Astronomical Society, Canadian and American Forestry Associations, and the Canadian Mining Institute. He was also one of the Royal Commissioners appointed in 1888 to enquire into the Mineral Resources of the province of Ontario, a delegate representing the Canadian Government and the Royal Society of Canada at the International Geological Congress at Vienna in 1903, president of the International Congress of Americanists in 1906, president of Section IV of the Royal Society in 1893 and of the Ottawa Field Naturalists' Club 1900 to 1902.

The bibliography of Dr. Bell's writings includes over 200 reports and pamphlets, most of which are contained in the volumes of the Geological Survey, while some appear in other scientific publications. These deal mainly with the results of his explorations and cover geology, geography, forestry, biology and folk-lore. His first report addressed to Sir W. E. Logan was published in 1857 in the Report of Progress of the Geological Survey for that year and dealt with the Fauna of the Lower St. Lawrence, the Saguenay and Lake St. John. His last report was published 50 years later in the Summary Report of the Geological Survey for 1906 and referred to the important mining district of Cobalt, Ontario.

In 1877 Dr. Bell was appointed Assistant Director of the Geological and Natural History Survey of Canada and when a separate department was created out of the Geological Survey in 1890 under the Minister of the Interior, he retained the title of Assistant Director, but to this was added the title of Chief Geologist. In January, 1901, Dr. Bell took over the administration of the department and directed the operations of the staff until April, 1906. He was superannuated in December, 1908, after almost 52 years of devotion to the interests of his country. His long service rewarded in 1903 by companionship in the Imperial Service Order, a distinction instituted by King Edward VII to more fully recognize the faithful and meritorious services rendered by the Civil Services of the Empire.

Dr. Bell's later years were spent partly at his home in Ottawa and partly on his farm in Manitoba, where he died in June, 1917.

In his religious views he was very broad-minded, and though a Presbyterian by birth and persuasion he took a keen interest in the missionary activities among the northern Indians of other denominations, and the Church of England missions on Hudson Bay are indebted to him for material assistance in carrying on their work.

The numerous honours conferred on Dr. Bell during his lifetime are an index of his ability as a scholar, while his long list of accomplishments both in the field and the study give evidence of his great industry. This was one of his outstanding characteristics, and he found his recreation in studies which to others would have been considered a labour. The performance of his duties as an explorer involved numerous risks and much hardship from fatigue, cold and hunger, yet his perseverance, patience and courage were always sufficient to carry him through to success in all his explorations.

He was a man of strong personality and he held decided opinions on all subjects. At the same time his kindly disposition caused him to be considerate of the opinions of others. In his own home he made a charming host and his hospitality was of the open-handed kind which left nothing to be desired. He was a staunch friend and was always at the service of those to whom his friendship was given.

CLEMENT HENRY McLEOD.

Professor Clement Henry McLeod, M. Can. Soc. C.E., Ma.E., F.R.S.C., F.R.A.I., occupied a unique position in engineering, scientific and educational circles in Canada, his work covering a range of activity, the required mental and physical capacity for which is rarely found. In his death, which occurred at his desk in the Engineering Building of McGill University, McGill lost one of its able and energetic professors, the public a scientist, and the engineering profession a devoted leader, who gave freely of his time and services in its interests. As Vice-Dean of the Faculty of Applied Science he occupied a high professorial position. As superintendent of McGill Observatory, he was the official time-keeper for Canada. In the engineering world no man was better known. For twenty-five years as secretary and member of Council of the Canadian Society of Civil Engineers, he was the one who more than any other, was responsible for the development of that organization. A bronze tablet has been erected to his memory in the hall of the Society's headquarters.

The late Professor McLeod was born at Strathlorn, Cape Breton, N.S., descended from sturdy Scotch Presbyterian stock, and was educated at high school and McGill University, from which he graduated in 1873. Following his graduation he went to Newfoundland in connection with railway work, which he followed up in various parts of the Maritime Provinces. In 1888 he joined the staff of McGill University as Professor of Geodesy and Surveying, becoming Vice-Dean of the Faculty of Applied Science in 1908. During his long services as professor he was connected with various University societies and took a prominent part in athletic affairs. He was the author of a standard text book on descriptive geometry. His was the

CLEMENT HENRY McLEOD

distinction of being the only Fellow in Canada of the Royal Astronomical Institute.

ARTHUR EDWARD JONES.

The Rev. Arthur Edward Jones, S.J., came from United Empire Loyalist stock and was born in Brockville, Ont., November 17th, 1838. After a brilliant course of classics at St. Mary's College, Montreal, he entered the Jesuit Order in France in 1857, studied philosophy and theology both in Europe and America and was ordained in 1873. During a number of years he taught classics and mathematics in Fordham University and in Montreal.

In 1882, when the care of the Archives of St. Mary's College, Montreal, was given to him, this mass of precious documents, dating from the seventeenth and eighteenth centuries, many of them unpublished, were awaiting some one to identify and classify them. So thoroughly did he master them that he became a recognised authority on the Canadian Missions between 1611 and 1800.

When there was question of bringing out the Cleveland edition of the *Jesuit Relations and Allied Documents*, Father Jones was one of the first consulted and his co-operation sought. Dr. Reuben Gold Thwaites, the editor, wrote in his General Preface, "The archivist of St. Mary's College, Montreal, opened his heart to the enterprise and has not only given us *carte blanche* to ransack his priceless treasures, but has contributed invaluable suggestions and data almost without number."

The period which always possessed the greatest interest for Father Jones extended from 1626 to 1650, the heroic age of the Huron missions on Georgian Bay. The sites of the ancient Huron villages, the arrival and departures of the Fathers, their names, their labors, the civilizing effect of their ministry on the savages, were all details that he worked out with great patience and constancy. The result, after fifteen years' labor, was "*8endake Ehen*, or Old Huronia," a learned volume of five hundred pages, which was published later by the Ontario Bureau of Archives. It tells the reader all that will ever be known on the work of the Jesuits among the Hurons.

The publication of a collection of letters, discovered in the Vendée, in France, in 1889, relating to the massacre by the Sioux of La Verendrye's expedition in the Lake of the Woods in 1736, aroused interest in that ill-fated expedition and resulted in the discovery, in 1908, of the site of Fort St. Charles (built in 1742), with the remains of the victims.

Father Jones published various pamphlets of historic interest. In recent years a great part of his time was taken up in answering appeals for historic information from all over the continent. Besides his membership in the Royal Society of Canada, he was Member of the International Congress of Americanists and addressed that learned body at Quebec, in 1906, on Huron topography. He was also Corresponding Member of various historical societies of America.

During his sixty years in the Jesuit Order, this delver into the by-paths of Canadian history was remarkable for the simplicity of his life, his courtesy, and his kindly feeling towards all men.

IV.—The Honorary Advisory Council for Scientific and Industrial Research

The Honorary Advisory Council for Scientific and Industrial Research reports a year of activity in organization to meet the requirements for the promotion of research in Canada, and in the formulation of measures to assist in the development of the industries and the utilization of our natural resources along expert lines.

Associate Committees on Chemistry and on Mining and Metallurgy, consisting of specialists in these lines from all over Canada, have been appointed, and an Advisory Committee for British Columbia has been created to assist the Council in dealing with industrial problems affecting that province. A considerable number of Special Committees, composed of experts not members of the Council, have been constituted to report to the Council on industrial questions.

The Council has had under consideration the question of the method and organization which will best promote research in Canada, especially on problems concerned in the development of the industries of the country, and, as a result, it recommends the foundation at Ottawa of a National Research Institute, associated with laboratories which can be placed at the disposal, under conditions, of industries in particular lines, for research on their own problems. The Research Institute would have the functions of the Washington Bureau of Standards or of the National Physical Laboratory of Great Britain.

An effort has been made to ascertain the man-power and equipment for research in Canada, by the issue of questionnaires to the industries, to the technical societies and the heads of the Laboratories of the Government Departments and of the Universities. A great majority of these have been returned and the information they furnish has been, in great part, now summarized. The situation thus far revealed indicates that radical measures involving the direct encouragement of scientific research in pure and in applied science must be undertaken.

Arthur Edward Jones

To increase the number of those who are training for a career in Scientific research, twenty studentships of $700 each and five fellowships of $1,000 have been instituted. Owing to the depletion of the student ranks in the Universities and Technical Colleges, primarily through voluntary enlistment for the last three years, but also through the operations of the Military Service Act, there has been a very great decrease in the number of graduates qualified for these studentships and fellowships, and, in consequence, only seven of these were awarded, the holders of which are now engaged in research, three in McGill University, two in the University of Saskatchewan, and one each in the Universities of Toronto and Alberta.

Assistance in the form of grants has been given to a number of researches on problems which are of possible industrial importance, among which are the following:

The improvement of signalling in fog,

The electrical condensation of tar and other constituents in the vapours from the destructive distillation of coal, wood and oils,

The improvement of the flotation methods in the separation of Canadian ores,

The utilization of the waste straw to provide gas for heating and lighting on the farms of the Prairie Provinces,

The production of a variety of wheat that will resist the rust which now causes annually enormous losses in the wheat crop of those three Provinces,

The utilization of the sulphite liquor of the pulp mills to produce industrial alcohol, and

The reduction of low grade iron ores.

Amongst the questions of special interest dealt with by the Council were Forestry Studies and the Carbonizing-Briquetting of the Lignites of Saskatchewan. A grant was given through the Council to the Forestry Branch of the Department of the Interior to inaugurate investigations on the growth and rate of reproduction of our more valuable species of forest trees, to be carried out on the Petawawa Military Reserve. The preliminary steps in these investigations were taken last summer and the work will be carried on during the coming season. It is expected that the results of these investigations will lead to systematic work for the preservation of our forest wealth.

The briquetting of the Lignites of Saskatchewan for domestic fuel has been carried out on a super-laboratory scale, under the auspices of the Saskatchewan Government, and the Council proposed that it be attempted on a commercial basis to demonstrate that it is possible to prepare from this fuel an equivalent substitute for anthracite, of which annually half a million tons have been imported from Pennsylvania into Manitoba and Saskatchewan. It was recommended that the Government undertake this demonstration, erecting and operating a plant equipped to turn out 30,000 tons of briquettes a year. This proposal has been accepted by the Government, and the Governments of Manitoba and Saskatchewan are co-operating with the Dominion in this matter. It is expected that within a year the plant will be in operation and that the result will encourage further efforts with the object of utilizing the vast deposits of lignites in the west as domestic fuel.

V.—Sir John Murray Memorial Lecture.

On the 14th February, 1918, Mr. C. A. E. Blanchet, Barrister, Ottawa, advised the Honorary Secretary that he had received the sum of $250.00 as a gift to The Royal Society from a Scottish scientific man, a friend of the late Sir John Murray, one of our late Honorary Presidents, who was accidentally killed in a motor accident in Scotland in 1914. The gift is an anonymous one, and is to be devoted to the following purpose, namely:—

The delivery at a session of The Royal Society of Canada of a "Sir John Murray Memorial Lecture" on Marine Scientific Research or on Life in the Sea, with Special Reference to Fishery Researches, the donor to nominate the lecturer. One of our Fellows, Professor E. E. Prince, LL.D., was chosen to deliver such an address.

At a meeting of Council held on February 15th, it was unanimously decided to accept the generous offer on the conditions stipulated. Professor Prince was at once communicated with, and, after consideration, it was decided that the delivery of the lecture should be postponed until next year, and that it should constitute the popular lecture on that occasion.

VI.—Report of Honorary Librarian.

The Honorary Librarian begs to report that the binding of the publications of the associated Royal Societies was completed on August 1st, 1917. Four hundred volumes were contracted for and finished in buckram.

The following list of volumes of Transactions and Proceedings of the Royal Societies shows the selection made by the special committee: London, 95 volumes; Edinburgh, 46 volumes; Glasgow, 30 volumes;

Dublin, 30 volumes; South Australia, 23 volumes; Queensland, 11 volumes; Victoria, 30 volumes; Tasmania, 10 volumes; New South Wales, 29 volumes; and South Africa, 2 volumes.

Ninety-four volumes of publications of the Carnegie Institute were added to fill the contract.

To the authors' sets have been added volumes received from L. J. Burpee, J. Mavor, R. W. McLachlan, R. W. Riddell, D. C. Scott and J. H. Coyne.

A contribution has also been received from the estate of the late Dr. W. D. LeSueur, consisting of about 80 volumes of Revue des Deux Mondes.

A box of publications has also been received from the Massachusetts Historical Society. These and a number of later contributions have been stored in the Library pending the absence since December of the Librarian, whose services have been acquired by the Office of the Food Controller.

VII.—The following is the financial statement of the Honorary Treasurer for the year ending April 30th, 1918. The statement includes the Government Grant Account and the General Account and it has been audited by two members of the Society:—Dr. Adam Shortt and Dr. J. C. Glashan—who were appointed for that purpose:

FINANCIAL STATEMENT OF THE ROYAL SOCIETY OF CANADA FOR THE YEAR ENDING 30TH APRIL, 1918

GOVERNMENT GRANT ACCOUNT

RECEIPTS

By Balance in Bank of Montreal, May 1st, 1917	$ 3,874.62
" Grant from Dominion Government	4,000.00
" Bank Interest on Account	114.40
	$ 7,989.02

EXPENDITURE

To Printing and Publication of *Transactions*	$ 4,005.49
" Maintenance of Library and Librarian's salary	441.81
" Clerical assistance	365.00
" Insurance	66.00
" Miscellaneous expenditures	10.92
" Balance in Bank of Montreal, April 30, 1918	3,159.80
	$ 8,049.02
Less outstanding cheques	60.00
	$ 7,989.02

GENERAL ACCOUNT

Receipts

By Balance in Merchants Bank of Canada, May 1, 1917	$ 1,764.47
" Annual and Life Subscriptions	755.00
" Sale of Transactions	13.35
" Interest on Investments: Standard Trusts Co	206.65
Lampman Morgtage	149.50
" Donation for Sir John Murray Memorial Lecture	250.00
" Bank Interest on Account	41.52
	$ 3,180.49

Expenditures

To Railway Fares of Members	$ 595.20
" Expenses of Annual Meeting	64.75
" Purchase of Canadian War Bond (Victory Loan)	495.54
" Miscellaneous Expenditures	29.00
" Balance in Merchants Bank of Canada, April 30, 1918	1,996.00
	$ 3,180.49

Audited and found correct:

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

C. GORDON HEWITT,
Honorary-Treasurer.

Ottawa, May 16, 1918.

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

Hon. Mr. Justice Riddell, who was elected in 1917, but who was not present at the meeting of that year, was then presented by Dr. Coyne and Colonel Wood.

On Tuesday afternoon, by invitation of Mr. John A. Pearson, Architect, the Fellows of the Society and delegates visited the new Parliament Building in the course of construction.

The Presidential Address, Tuesday Evening.

The Presidential Address was delivered on Tuesday evening in the Concert Hall of the Chateau Laurier. The chair was occupied by the Honorary President, Hon. Mr. Justice Longley. The President's subject was "Canadian Poets of the Great War." The address will be found printed in full as Appendix A.

SESSION II.—(Wednesday Forenoon, May 22).

The President took the chair at 11.30 a.m.

It was moved by Hon. Mr. Justice Riddell, seconded by Dr. A. P. Coleman, that the Report of Council be adopted.—Carried.

It was moved by Hon. L. O. David, seconded by Dr. Victor Morin, that the election of L'abbé Azarie Couillard Després, M. Aegidius Fauteux and L'abbé Lionel Groulx, as Fellows of Section I, be confirmed.—Carried.

It was moved by Dr. P. H. Bryce, seconded by Ven. Archdeacon Raymond, that the election of Dr. Walter Charles Murray as a Fellow of Section II, be confirmed.—Carried.

It was moved by Dr. A. Stanley MacKenzie, seconded by Dr. F. T. Shutt, that the election of Dr. Ebenezer Henry Archibald, as a Fellow of Section III be confirmed.—Carried.

It was moved by Dr. J. J. MacKenzie, seconded by Dr. J. P. McMurrich, that the election of Mr. Charles Camsell, Dr. Francis John Lewis and Dr. Frank Fairchild Wesbrook, as Fellows of Section IV, be confirmed.—Carried.

The following new Fellows who were present were then introduced: —L'abbé Després, M. Fauteux, Dr. Murray, Mr. Camsell, Dr. Lewis and Dr. Wesbrook.

The following proposed amendments to the By-laws were then taken into consideration:—

(1.) By The Honorary Treasurer

That the first paragraph of Section 8 be amended by striking out all the words after "pay" as follows:—

"an annual subscription of $5.00 or the sum of $50.00 in one payment in commutation of the same for life membership."

and substituting therefor the following:—

"a fee of $10.00 upon election and an annual subscription of $10.00."

(2.) By A. P. Coleman, Ph.D., F.R.S.C.

That Section 4 of the By-laws be amended by striking out all the words in Sub-section 4 and substituting the following:—

"Biological and Geological Sciences including Mineralogy."

That Section 6 of the By-laws be amended as follows:—On the fifth line thereof by striking out after Section IV the word "fifty" and substituting the words "fifty-three, (three of the Fellows to be Mineralogists.)"

(3.) By the Honorary Secretary, pursuant to a decision of Council.

That By-law 4 be amended as follows:—

"Sub-section 3 after the word 'Sciences,' add the words 'including Mineralogy.' "

That By-law 6 be amended as follows:—

"on the fifth line thereof after Section III, substitute the word 'forty-three' for the word 'forty.' "

(4.) By J. Playfair McMurrich, M.A., Ph.D.

That Section 4 be amended as follows:—

1. By striking out the word "four" and substituting the word "five" in the first line.

2. By striking out the words "Geological and" in sub-section 4.

3. By adding sub-section 5, as follows:—

"5. Geological Sciences."

(*This has the effect of dividing Section 4 into two Sections.*)

That Section 6 be amended as follows:—In the fifth line thereof substitute for the word "fifty" after Section IV, "thirty-three" and add thereto "Section V, seventeen."

(*By agreement of Section IV, thirty-three of the Fellowships are allotted to Biology and seventeen to Geology.*)

It was moved by the Honorary Treasurer, seconded by the Honorary Secretary, that amendment No. 1 be adopted.—Carried.

The first paragraph of By-law No. 8 will, therefore, read as follows:—

Members shall sign the regulations of the Society, shall be presented by the president to the Society at a general meeting, shall attend its stated meetings or send reasons of absence to the honorary secretary, and shall pay a fee of $10.00 upon election and an annual subscription of $10.00.

Amendments Nos. 2, 3, and 4 were considered together, and, after a full discussion, it was moved by Dr. McMurrich, seconded by Dr. Coleman, that Section 4 and the second paragraph of Section 6 of the By-laws be amended to read as follows:—Carried.

4. *Division into Sections.*

The society shall consist of the five following sections:

1. French Literature, History, Archæology, Sociology, Political Economy and allied subjects.
2. English Literature, History, Archæology, Sociology, Political Economy and allied subjects.
3. Mathematical, Chemical and Physical Sciences.
4. Geological Sciences (including Mineralogy).
5. Biological Sciences.

6. *Members.*

The number of Fellows in each section shall be limited, as follows: Section I. forty; Section II. forty; Section III. forty; Section IV. twenty-five; Section V. forty.

SESSION III.—(Wednesday afternoon, May 22).

The reports of the following Associated Societies were read or presented:—

1.—The Historic Landmarks Association. By Mrs. J. B. Simpson, Delegate.

2.—The Women's Canadian Historical Society of Toronto.

3.—The Ottawa Field-Naturalists' Club. By Dr. C. Gordon Hewitt, F.R.S.C., President and Delegate.

4.—The Royal Astronomical Society of Canada. By Mr. R. M. Motherwell, Delegate.

5.—Niagara Historical Society. By Miss Carnochan, Delegate.

6.—Women's Canadian Historical Society of Ottawa.

7.—L'Institut Canadien-Français d'Ottawa. By M. Jules Tremblay, Delegate.

8.—The Hamilton Association for the Advancement of Literature, Science and Art.

9.—The Huron Institute.

10.—Ontario Historical Society of Toronto.

11.—Elgin Historical and Scientific Institute.

12.—L'Institut Canadien de Québec.

13.—The Literary and Historical Society of Quebec. By Dr. J. M. Harper, Delegate.

14.—La Société Historique de Montréal.

15.—Natural History Society of Montreal.

16.—La Société d'Archéologie et de Numismatique de Montréal.

17.—The Quebec Society for the Protection of Plants. By Prof. W. Lochhead, Delegate.

18.—The New Brunswick Historical Society. By Dr. W. O. Raymond, F.R.S.C., Delegate.

19.—The Nova Scotian Institute of Science. By Dr. A. H· MacKay, F.R.S.C., Delegate.

It was moved by Dr. Shortt, seconded by Dr. Sulte, that The Royal Society of Canada having viewed the new Parliament Building, now in the course of construction, desire to congratulate the Government of Canada and the architects on the design and arrangement of the building; and the Society venture to respectfully suggest to the Government that the scheme for the decoration of the interior of the building should now be most carefully considered; that an important feature of the permanent decoration should be a series of mural paintings by Canadian artists, and that the chief events in the history of the Dominion should be commemorated upon the walls and within the corridors in the way best designed to present to the observer an inspiring view of our past history; that the scheme when formulated should be begun without delay and accomplished gradually; that The Royal Society of Canada respectfully offer the Government their aid and co-operation by representation on an advisory committee, or in any way whereby they may be of service in the accomplishment of the project; that the committee to present the resolution to the Government be named by the Council.—Carried.

It was moved by Dr. Shortt, seconded by Mr. Lemieux, that the committee appointed to present the foregoing resolution should also call the attention of the Government to the necessity of insuring the safety of the Library of Parliament, which is exposed to danger in the present library building. Carried.

The Popular Lecture

The popular lecture was delivered on Wednesday evening in the concert hall of the Chateau Laurier by Professor Dayton C. Miller, D.Sc., of the Case School of Applied Science, Cleveland, Ohio. Professor Miller's subject was "The Science of Musical Sounds." The lecture was very successful. The nature of the subject and the international reputation of the lecturer as a foremost authority on acoustics drew a larger audience than usual. The lecture was fully illustrated by lantern slides and mechanical devices, and the lecturer held his audience interested from the opening to the close.

SESSION III.—(Thursday afternoon, May 23).

It was moved by Dr. Ellis, seconded by Dr. Shutt, that The Royal Society of Canada recommend to the Federal Government the establishment of one or more Fellowships in Chemistry to be known as the "Sir William Ramsay Memorial Fellowships," and urge upon the Government the advisability of making a substantial grant towards the establishment of these Fellowships, to enable chemists trained in Canadian Universities to continue their studies in the Universities of Great Britain.—Carried.

REPORTS OF THE SECTIONS

Section I.

PROCÈS-VERBAL DE LA SECTION I.

Aux quatre séances du 21, 22 et 23 mai, étaient présents: Hon. L.-O. David, M. Eugène Rouillard, Hon. Thomas Chapais, Hon. Rodolphe Lemieux, M. H.-J.-J.-B. Chouinard, Messieurs les abbés Émile Chartier, Lionel Groulx, Azarie Couillard-Després, M. Aegédius Fauteux, M. Ernest Myrand, M. Victor Morin, M. Léon Gérin, M. A.-D. DeCelles, M. Antonio Perrault, M. Pascal Poirier, M. Benjamin Sulte, M. C.-M. Barbeau. Les membres suivants se sont excusés de leur absence: S. G. Mgr. Paul Bruchési, Mgr. A.-E. Gosselin, M. P.-B. Mignault, Mgr. L.-A. Paquet, M. l'abbé Camille Roy, M. P.-G. Roy.

M. Sulte et M. Morin furent choisis comme représentants de la Section pour la mise en nomination des dignitaires généraux de la Société.

Les membres de la Section I étaient d'opinion qu'il était désirable de ne pas amender la constitution de la Société de manière à subdiviser la Section IV en deux sections.

Résolu de rappeler à M. Hector Garneau que par son absence et son silence prolongés il ne se conforme pas aux désirs de la Société et s'expose à voir son nom rayé de la liste des membres.

On élut, pour l'exercice prochain, les dignitaires de la Section I:

M. Eugène Rouillard, président;

M. Victor Morin, vice-président;

M. C.-Marius Barbeau, secrétaire;

Comité de lecture: M. B. Sulte, M. Léon Gérin, M. Aegidius Fauteux.

Représentants au Comité de publication: M. B. Sulte, M. C.-M. Barbeau.

Résolu de demander au Comité général l'autorisation d'élire trois membres nouveaux y compris les vacances accidentelles survenues depuis.

La Section I accepte de donner son appui à la Société de folklore américain à l'occasion d'une requête adressée au Gouvernement de Québec aux fins d'obtenir une assistance efficace pour l'étude des traditions orales au Canada. La première séance annuelle de la Section de Québec a lieu le 22 mai après-midi, sous les auspices de la Section I.

On discute la possibilité de former une nouvelle Section des sciences de langue française; la considération immédiate de ce projet est remis à plus tard.

Les travaux suivants sont lus et remis au Comité de lecture:

"Louis Hébert," par M. Jules Tremblay;

"Critique de l'*Histoire de l'Acadie Françoise* de M. Moreau, Paris, 1873...." par M. l'abbé A. Couillard-Després;

"La femme et la loi," par M. Ferdinand Roy;

"Le dernier effort de la France au Canada," par M. Gustave Lanctôt;

"P.-J.-O. Chauveau (1820-1890), bibliophile," par M. Ernest Myrand;

"Les Français dans l'Ouest; 1671," par M. Benjamin Sulte.

On transmit au Comité de lecture, sans avoir le temps de les lire, les travaux dont voici la liste:

"Les Jarrets-noirs des Rapides-du-diable," par C.-Marius Barbeau;

"La Maréchaussée de Québec sous le régime français" et "Le siège de l'Amirauté de Québec sous le régime français," par M. P.-Geo. Roy;

"Nos ancêtres étaient-ils des ignorants?" par M. Benjamin Sulte;

"Le Portage du Témiscouata," par le Rev. Frère Marie-Victorin;

"Arrêts, édits et ordonnances....; deuxième partie;" M. E. F. Massicotte;

"Le partage de l'immigration canadienne depuis 1897," par M. Geo. Pelletier.

Sans avoir rempli les formalités d'usage, M. le Sénateur P. Poirier expliqua la nature de son travail intitulé "Apogie du dialecte acadien."

La Section I, après des séances intéressantes, s'ajourne à l'année prochaine.

C.-Marius Barbeau,
Secrétaire pour la Section I.

On the motion of Hon. Rodolphe Lemieux, seconded by Mr. Chouinard, the report of Section I was adopted.

REPORT OF SECTION II

Five meetings of Section II were held during this session of the Society.

Members present were 20 in number, namely, Sir Wm. Peterson, President; Dr. Bryce, Dr. Cappon, Dr. J. H. Coyne, Dr. Doughty, Dr. Edgar, Sir Robert Falconer, Principal Grant, Hon. W. L. Mackenzie King, Mr. Lighthall, President of The Royal Society of Canada, Hon. Mr. Justice Longley, Honorary President of the Society, Dr. Macnaughton, Dr. Mavor, Mr. R. W. McLachlan, Venerable Archdeacon Raymond, LL.D., Hon. Mr. Justice Riddell, LL.D., Mr. D. C. Scott, Dr. Adam Shortt, Lieut.-Col. Wm. Wood, Professor George M. Wrong.

In the Secretary's absence on official duties in the United States, Dr. Coyne was elected Secretary *pro tem.*

Lieut.-Col. Wood and Dr. Raymond were elected to represent Section II on the Nominating Committee.

The following members were elected on Advisory Committee on Nominations for membership in the Section. Dr. Adam Shortt, Chairman, Dr. Bryce, Dr. Coyne, Mr. Hill-Tout, Mr. Lighthall, Dr. MacMechan, Mr. Wrong, with the President and Secretary of the Section.

Dr. Shortt, Mr. King and Mr. Burpee were appointed members of the Printing Committee.

It was decided to report to the Society that the Section proposes to elect two members next year.

Dr. Shortt and Sir Robert Falconer, with the President of the Society, were nominated as representatives of the Section on the Special Committee of the Society to draft a resolution with reference to the proposed mural historical paintings in the new Parliament Building.

The following members of the Section are or have been on Military Service:

E. A. Cruikshank
Arthur G. Doughty
Pelham Edgar
W. Lawson Grant
Sir Andrew MacPhail
Frederick George Scott
William Wood

A resolution was carried in favor of the continuance for the present of the practice of printing the Society's Transactions separately for the Sections as well as issuing them in bound volumes.

The Section recommends that the name of Mr. John Ross Robertson be retained on the list of members for another year.

A more systematic arrangement of the time-table for presentation of papers was suggested. It often happens that Fellows of other Sections, as well as persons not members of the Society, are desirous of hearing papers of general interest, or in which they may have a special interest, but find themselves unable to do so, owing to uncertainty as to the time when the papers will be read. A motion was carried requesting the Executive of the Section to endeavour to secure a more satisfactory time-schedule for future sessions, and to cooperate with other Sections to that end.

The following officers were elected:

President: Maurice Hutton, M.A., LL.D.

Vice-President: W. Lawson Grant, M.A.

Secretary: L. J. Burpee, F.R.G.S.

The following papers were read in whole, in part, or by title:—

1.—Presidential Address: By Sir William Peterson, M.A., LL.D., F.R.S.C.

2.—The Actuality of Greek Literature. By John Macnaughton, M.A., F.R.S.C.

3.—The Story of the Cariboo Road. By Judge F. W. Howay, LL.B., F.R.S.C.

4.—Canada's Pacific Seaboard. By E. O. S. Scholefield. Presented by Lawrence J. Burpee, F.R.S.C.

5.—Notes for an Introduction to Confederation and Defence: A Jubilee Study, 1867-1917. By Lieut.-Colonel William Wood, F.R.S.C.

6.—The Art of Construction in the Novel. By Pelham Edgar, Ph.D., F.R.S.C.

7.—Old Church Silver in Canada. By E. Alfred Jones, M.A. Presented by Duncan C. Scott, F.R.S.C.

8.—Pre-Assembly Legislatures in British Canada. By Hon. William Renwick Riddell, LL.D., F.R.S.C.

9.—The Genesis of the University of New Brunswick. By Archdeacon W. O. Raymond, LL.D., F.R.S.C.

10.—Prehistoric Canadian Art as a Source of Distinctive Design. By Harlan I. Smith. Presented by L. J. Burpee, F.R.S.C.

11.—Notes on the Flags of France. By Lieut.-Colonel A. G. Doughty, C.M.G., LL.D., F.R.S.C.

12.—The Tragic Tales of *Tsoqulem and Yaada the Beautiful*. By Lionel Haweis. Presented by Charles Hill-Tout, F.R.S.C.

13.—The Pre-Selkirk Settlers of Old Assiniboia. By Rev. George Bryce, D.D., LL.D., F.R.S.C.

14.—Marriage in Early Upper Canada. By Hon. William Renwick Riddell, LL.D., F.R.S.C.

15.—The Evolution of our Canadianism and the Ethics of Civic Government. By J. M. Harper, M.A., Ph.D. Presented by Duncan C. Scott, F.R.S.C.

JAMES H. COYNE,
Secretary pro tem.

On the motion of Dr. Coyne, seconded by Mr. Justice Riddell, the report of Section II was adopted.

REPORT OF SECTION III.

The Section held five sessions, at all of which there was a good attendance of Fellows and others interested in the programmes.

At the afternoon session of May 22, members of the Convention of the Canadian Section of the Society of Chemical Industry (meeting concurrently in Ottawa) were present by special invitation, the larger number of the chemical papers being reserved for presentation on that occasion.

The attendance of Fellows was exceedingly satisfactory and the interest in the programme of papers and in the business of the Section was keen and well sustained throughout; the meeting of 1918 may be considered as one of the most successful in the history of the Section.

The following Fellows were present at the sessions: Messrs. Allan, Bain, Burton, Clark, Dawson, Deville, Ellis, Fields, Glashan, Goodwin, Harkness, Johnson, King, Klotz, McGill, McIntosh, Mackenzie, Miller, Ruttan, Satterly, Shutt, Stansfield, Stupart.

The programme proved to be one of exceptional interest. Forty-two papers, dealing with subjects in pure mathematics, physics and chemistry, were read in full or in abstract. They contained many distinct and valuable contributions to science and the discussions that followed their presentation may be regarded as an indication of the close attention with which they were received and of the interest they awakened. A list of the titles is appended.

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

President........................Dr. Louis Vessot King.
Vice-President....................Dr. A. S. Eve.
Secretary........................Dr. Frank T. Shutt.

The following Fellows were appointed the Printing Committee of the Section for 1918-19:

Dr. Ruttan, Dr. Deville and Dr. King.

Four new Fellows were elected this year:

Dr. E. Archibald, as the result of the voting that closed on April 1st last, and J. Patterson, M.A., A. T. DeLury, M.A., and J. Bishop Tingle, Ph.D., by ballot at the meeting.

The rule as regards attendance was suspended in the case of Lt.-Col. W. R. Lang, Dr. A. S. Eve, Dr. F. B. Kenrick, Dr. J. C. McLennan and Dr. Tory, absent on Military Service.

Questions relating to the "Publications" of the Society were fully discussed and in connection therewith the following resolutions were put to the meeting and passed:

1. That in view of the present situation this Section is of the opinion that it would be in the best interest of the Society to discontinue the printing of the quarterly or half yearly issues of the Transactions.

2. That this Section strongly recommends to Council the desirability of furnishing, gratis, to each Author in the Science Sections (III and IV) fifty copies of his papers.

3. That no papers be printed which are not in the hands of the Secretary of the Section by July 1st, following the meeting.

4. That the Council be urged in the event of the discontinuance of the quarterlies, to push forward with all possible speed the printing and issue of the bound volume of the Transactions, so that it might be in the hands of the Fellows before the close of the current year.

The following important motions were also carried:

1. That a small committee be appointed by the President of the Section (Dr. A. Stanley MacKenzie) to consider ways and means by which the teaching of elementary science in Canada might be improved and to report to this Section next year.

2. That this Society urge upon the Government the establishment of a Dominion Laboratory for Scientific Measurements, similar to the United Bureau of Standards.

And that the following be appointed a committee to confer with representatives of other scientific societies and make recommendations as to the organization of the proposed institution.

Dr. E. Deville, Dr. Louis Vessot King, Dr. Otto Klotz, Dr. A. Stanley MacKenzie, Dr. W. Lash Miller, Dr. Alfred Stansfield.

List of Papers Read in Section III.

1. Presidential Address. The War and Science. By Dr. A. Stanley MacKenzie, F.R.S.C.

2. Concerning the Integrals of Lelieuvre. By Charles T. Sullivan, Ph.D., F.R.S.C.

3. The Law of Corresponding States Applied to Air. By A. L. Clark, F.R.S.C., Queen's University.

4. The Angle of Contact made with Glass by a Mercury Surface which is Covered with another Liquid. By A. L. Clark, F.R.S.C. Queen's University.

5. On the Embodiment in Actual Numbers of the Kummer Ideals in the Quadratic Realm. By J. C. Glashan, LL.D., F.R.S.C.

6. Concerning a Representation of Irrational Numbers. By Samuel Beatty, Ph.D. Presented by Professor J. C. Fields, F.R.S.C.

7. Some Notes on the Halifax Explosion. By Howard L. Bronson, Ph.D., F.R.S.C.

8. The Penetration of Frost in Concrete Structures. By Louis Vessot King, D.Sc., F.R.S.C., McGill University.

9. Researches on Sound Measurement with references to the Testing of Fog-signal Machinery; an account of tests carried out at Father Point, P.Q., September-October, 1917. By Louis Vessot King, D.Sc., F.R.S.C., McGill University.

10. A Comparison of some Anemometers. By A. Norman Shaw, D.Sc., Macdonald College, McGill University, presented by Dr. Louis Vessot King, F.R.S.C.

11. New Series in Metallic Spectrum. By R. V. Zumstein. Presented by Dr. E. F. Burton, F.R.S.C.

12. Rhythmic Precipitation in Gelatine. By Miss A. W. Foster. Presented by Dr. E. F. Burton, F.R.S.C.

13. New Lines in the Ultra-violet Spectra of Certain Metals. By D. S. Ainslie and D. S. Fuller. Presented by Dr. E. F. Burton, F.R.S.C.

14. The Radioactivity of the Natural Gases of Canada. By John Satterly, D.Sc., F.R.S.C.

15. The Viscosity of Rubber Solutions and its Relation to the Commercial Properties of Rubber. By Richard Hamer. Presented by Dr. E. F. Burton, F.R.S.C.

16. The Application of Wireless by the Dominion Observatory for Longitude Determinations. By R. M. Stewart, M.A. Presented by Dr. Otto Klotz, F.R.S.C.

17. The Transmission of Earthquake Waves. By Dr. Otto Klotz, F.R.S.C., Director, Dominion Observatory.

18. Tests of the 72-inch Mirror. By Dr. J. S. Plaskett, F.R.S.C.

19. On an Electrical Method of Determining the Lime Requirements of Soils. By C. J. Lynde, Ph.D. Macdonald College, presented by Dr. F. T. Shutt, F.R.S.C., Dominion Chemist.

20. Sulphuric Acid Vacuum Pump. By O. Maass. Presented by Dr. R. F. Ruttan, F.R.S.C.

21. The Compounds of Phenol and the Cresols with Pyridine—Part II. (A continuation of the work of Hatcher & Skirrow. Jour. Amer. Chem. Soc. XXXIX 9. 1939, 1917). By F. W. Skirrow, Ph.D. and R. V. Binmore, presented by Dr. R. F. Ruttan, F.R.S.C.

22. Bog Butter. By Dr. R. F. Ruttan, F.R.S.C. and L. Isabel Howe.

23. Fats of the Isomeric Propylene Glycols. By L. Isabel Howe and Dr. R. F. Ruttan, F.R.S.C.

24. Latent Valency of Unsaturation and the Formation of Molecular Compounds. By O. Maass and J. Russell. Presented by Dr. R. F. Ruttan, F.R.S.C.

25. Preparation of Pure Concentrated Solutions of Hydrogen Peroxide. By O. Maass and O. Herzberg. Presented by Dr. R. F. Ruttan, F.R.S.C.

26. Determination of the Gas Constant of Acetylene, Methyl Ether and Hydrobromic Acid. By O. Maass and J. Russell, presented by Dr. R. F. Ruttan, F.R.S.C.

27. A Study of Some of the Properties of Oxynitrilase. By W. A. Wieland and V. K. Krieble. Presented by Dr. R. F. Ruttan, F.R.S.C.

28. An Agricultural Source of Benzoic Acid. By Frank T. Shutt, D.Sc. F.R.S.C. and P. J. Moloney, M.A.

29. The "Alkali" content of Soils as related to Crop Growth. By Frank T. Shutt, D.Sc., F.R.S.C., and E. A. Smith, M.A.

30. The Composition of Bran and Shorts as Milled under Regulations of the Food Control Board. By Frank T. Shutt, D.Sc., F.R.S.C., and R. L. Dorrance, B.A.

31. The Utilization of Nitre Cake in the Manufacture of Superphosphate. By Frank T. Shutt, D.Sc., F.R.S.C., and L. E. Wright, B.Sc.

32. The Absorption of Helium by Charcoal. By Stuart McLean. Presented by Dr. E. F. Burton, F.R.S.C.

33. The Determination of Morphine in Complex Products. Part I. A Revision of the Analytical Reactions Employed. By Alfred Tingle, Ph.D. Presented by Dr. F. T. Shutt, F.R.S.C.

34. The Determination of Morphine in Complex Products. Part II. Mixtures containing Morphine as a Simple Salt. By Alfred Tingle. Ph.D. Presented by Dr. F. T. Shutt, F.R.S.C.

35. The Determination of Morphine in Complex Products. Part III. Opium and Mixtures containing Opium. By Alfred Tingle, Ph.D. Presented by Dr. F. T. Shutt, F.R.S.C.

36. Carbonization and Briquetting of Canadian Lignites, Carbonization. Part II. Large Scale Laboratory Tests. By Edgar

Stansfield, M.Sc., and Ross E. Gilmore, M.Sc., presented by Alfred Stansfield, D.Sc., F.R.S.C.

37. Weathering of Carbonized Lignite, Appendix I. By E. Stansfield, M.Sc., R. E. Gilmore, M.Sc., and J. H. H. Nicolls, M.Sc. Presented by Alfred Stansfield, D.Sc., F.R.S.C.

38. Extraction Tests, Preliminary Note. Appendix II. By E. Stansfield, M.Sc. and R. C. Cantelo, B.Sc. Presented by Alfred Stansfield, D.Sc., F.R.S.C.

39. A Comparative Study of Magnetic Declination at Agincourt and Meanook, during the year 1917. By W. E. W. Jackson, M.A. Presented by Sir Frederick Stupart, Kt., F.R.S.C.

40. The Practical Analysis of Wave Forms by the Harmonic Method. By Dayton C. Miller, D.Sc., Professor of Physics, Case School of Applied Science, Cleveland, Ohio. Presented by Dr. Louis Vessot King, F.R.S.C.

41. Rational Plane Anharmonic Cubics. By Prof. A. M. Harding, M.A., Ph.D. University of Arkansas. Presented by Dr. C. F. Sullivan, F.R.S.C.

42. Polynitro Derivatives of the Benzene Series. By Prof. J. Bishop Tingle, D.Sc., presented by Dr. R. F. Ruttan, F.R.S.C.

FRANK T. SHUTT,
Secretary, Sec. III.

On the motion of Dr. Shutt, seconded by Dr. A. S. MacKenzie, the report of Section III was adopted.

REPORT OF SECTION IV.

Section IV begs to submit the following report:—

Five sessions of the Section were held. Twenty-six Fellows were in attendance. They were:—Sir James Grant, Mr. R. G. McConnell, Professor B. A. Bensley, Professor J. J. MacKenzie, Principal F. C. Harrison, Mr. D. B. Dowling, Mr. Charles Camsell, Professor F. E. Lloyd, Professor F. D. Adams, Mr. William McInnes, Dr. C. Gordon Hewitt, Dr. A. B. Macallum, President F. F. Wesbrook, Mr. E. R. Faribault, Professor E. E. Prince, Professor J. P. McMurrich, Dr. A. G. Huntsman, Mr. John A. Dresser, Dr. A. H. MacKay, Dr. L. W. Bailey, Professor A. H. Buller, Professor A. P. Coleman, Mr. Lawrence M. Lambe, Abbé Victor A. Huard, Mr. James White and Mr. F. J. Lewis.

Two Fellows of the Section are on active service, viz., Lt.-Col. J. G. Adami and Lt.-Col. Brock.

Three new Fellows were added to the membership of the Section: President Wesbrook, Mr. F. J. Lewis and Mr. Charles Camsell.

As a result of the division into two new Sections, the following Sectional Officers were elected for the year 1918-19.

Section IV, Geological Sciences (including Mineralogy).

President—Dr. L. W. Bailey.
Vice-President—Mr. John A. Dresser.
Secretary—Mr. William McInnes.

Section V, Biological Sciences.

President—Principal F. C. Harrison.
Vice-President—Professor J. H. Faull.
Secretary—Professor J. J. MacKenzie.

Professor Coleman and Principal Harrison were appointed to represent old Section IV on the Nomination Committee of the Society and no change was made as a result of the division of the Section.

Professor Harrison, Mr. Dowling and Dr. Hewitt were appointed to the Sectional Printing Committees. Of these Mr. Dowling of Section IV and Dr. Hewitt of Section V were nominated to act upon the General Printing Committee of the Society.

Dr. Adams, Professor Prince and Principal Harrison were appointed to act with the Council upon the selection of new Fellows for both Sections, but the Sections request that the Council ask the assistance of an additional Geological Fellow to act with these three Fellows in the selection of candidates for the two Sections.

A resolution was passed by the Section that it be a recommmendation to Council that three new Fellows be elected to Section IV, Geological Sciences (Including Mineralogy), and two new Fellows be elected to Section V, Biological Sciences.

On motion Sir Thomas Roddick's active membership was extended for one year.

Appended to the report is a list of the Fellows indicating to which of the new Sections they are assigned.

Twenty-eight papers were read at the sessions, the titles of which are appended.

All of which is respectfully submitted,

John J. MacKenzie,
Secretary.

On the motion of Dr. Harrison, seconded by Dr. Huntsman, the report of Section IV was adopted.

LIST OF FELLOWS, SECTIONS IV AND V

Section IV, Geology (including Mineralogy).

Adams, F. D.
Ami, H. M.
Bailey, L. W.
Brock, R. W.
Camsell, Charles
Coleman, A. P.
Dowling, D. B.
Dresser, J. A.
Faribault, E. R.
Lambe, L. M.
McConnell, R. G.
McInnes, W.
Matthew, G. F.
Miller, Willet G.
Parks, W. A.
Tyrrell, J. B.
White, J.

Section V., Biology

Adami, J. G.,
Bensley, B. A.
Bethune, Rev. C. J. S.
Buller, A. H. R.
Burgess, T. J. W.
Faull, J. H.
Fraser, C. M.
Grant, Sir James A.
Harris, D. F.
Harrison, F. C.
Hewitt, C. Gordon
Huard, L'Abbe Victor A.
Hunter, A.
Huntsman, A. G.
Knight, A. P.
Lewis, F. J.
Lloyd, F. E.
Macallum, A. B.
MacKay, A. H.
MacKenzie, J. J.
McMurrich, J. P.
McPhedran, A.
Moore, C. L.
Nicholls, A. G.
Prince, E. E.
Roddick, Sir. T. G.
Thomson, R. B.
Vincent, Swale
Walker, E. M.
Wesbrook, F. F.
Willey, Arthur

List of Papers Presented in Section IV.

1.—Presidential Address. Progress in the Geological Mapping of Canada. By R. G. McConnell, B.A., F.R.S.C.

2.—The Cretaceous genus *Stegoceras* typifying a new family referred provisionally to the Stegosauria (Illustrated). By Lawrence M. Lambe, F.R.S.C.

3.—Some Geological Problems in New Brunswick. By Dr. L. W. Bailey, F.R.S.C., and Dr. G. F. Matthew, F.R.S.C.

4.—Notes on the origin of the new mineral Colerainite. By Mr. Eugène Poitevin. Presented by Mr. W. McInnes, F.R.S.C.

5.—The Periodic Fluctuations of our Fur-Bearing Animals. By C. Gordon Hewitt, D.Sc., F.R.S.C.

6.—Migration of Marine Animals. By C. McLean Fraser, Ph.D., F.R.S.C.

7.—Branchioderma and Branchiotrema. By Arthur Willey, D.Sc., F.R.S.C.

8.—A Report of Results obtained from the Microdissection of Certain Cells. By Robert Chambers, Jr. Presented by J. Playfair McMurrich, F.R.S.C.

9.—A Report on Cross Fertilization Experiments (*Asterias* x *Solaster*). By Robert Chambers and Bessie Mossop. Presented by J. Playfair McMurrich, F.R.S.C.

10.—Exuviation and Variation of Plankton Copepods with special reference to *Calanus finmarchicus*. By Mary E. Currie, B.A. Presented by J. Playfair McMurrich, F.R.S.C.

11.—The Scale Method of calculating the Rate of Growth in Fishes. By A. G. Huntsman, B.A., F.R.S.C.

12.—The Vertical Distribution of Certain Intertidal Animals. By A. G. Huntsman, B.A., F.R.S.C.

13.—The Effect of the Tide on the Distribution of the Fishes of the Canadian Atlantic coast. By A. G. Huntsman, B.A., F.R.S.C.

14.—The Living Unit as a Molecule. By A. G. Huntsman, B.A., F.R.S.C.

15.—A Contribution to the Evolution and Morphology of the Human Skull, by John Cameron, M.D., D.Sc., F.R.S.E. Presented by C. Gordon Hewitt, D.Sc., F.R.S.C.

16.—On the Possibility of a New Metabolic Factor in Toxaemias of Pregnancy. By Victor John Harding and James W. Duncan (Preliminary Note). Presented by Andrew Hunter, B.Sc., M.B., F.R.S.C.

17.—Malignant Tumors as a Fofm of Tissue Mutation. By J. J. MacKenzie, M.B., F.R.S.C.

18.—A Rosette forming Bacillus. (With two photo-micrographs). By F. C. Harrison, D.Sc., F.R.S.C.

19.—Bacteria in Frozen Soils. By J. Vanderleck. Presented by F. C. Harrison, D.Sc., F.R.S.C.

20.—Upon the Social Organization exhibited by *Coprinus sterquilinus*. By A. H. Reginald Buller, D.Sc., F.R.S.C.

21.—Upon the Significance of Chemotropism in the Mycelium of *Coprinus sterquilinus*. By A. H. Reginald Buller, D.Sc., F.R.S.C.

22.—La flore de la Province de Québec. By Fr. Marie-Victorin. Presented by Francis E. Lloyd, M.A., F.R.S.C.

23.—The Inheritance of the Length of the Flowering and Ripening Periods in Wheat. By W. P. Thompson. Presented by J. H. Faull, Ph.D., F.R.S.C.

24.—On Some Canadian Diatoms. By Dr. L. W. Bailey, F.R.S.C. and Dr. A. H. Mackay, F.R.S.C.

25.—Preliminary Study of the Western Gas Fields. By D. B. Dowling, B.Sc., F.R.S.C.

26.—Ferrierite, a new mineral, from British Columbia; with notes on some other Canadian minerals. By Professor R. P. D. Graham, McGill University. Presented by Dr. Frank D. Adams, F.R.S.C.

27.—Bibliography of Canadian Botany for 1917. By A. H. MacKay, LL.D., F.R.S.C.

28.—Bibliography of Canadian Geology for 1917. By Wyatt Malcolm, M.A. Presented by R. G. McConnell, B.A., F.R.S.C.

The report of the Nominating Committee was then presented by Dr. A. S. MacKenzie. The following nominations were made:—

President—Hon. Rodolphe Lemieux.

Vice-President—Dr. R. F. Ruttan.

Honorary Secretary—Mr. Duncan C. Scott.

Honorary Treasurer—Dr. C. Gordon Hewitt.

Honorary Librarian—Mr. D. B. Dowling.

It was moved by Dr. A. S. MacKenzie, seconded by Colonel William Wood, that the report of the Nominating Committee be received and adopted.—Carried.

It was moved by Mr. Lawrence M. Lambe, seconded by Sir James Grant, that the following Fellows be appointed Auditors for the year 1918-19, Dr. Adam Shortt and Dr. J. C. Glashan.—Carried.

It was moved by Dr. Bryce, seconded by Dr. Shutt, that the following Fellows constitute the General Printing Committee of the Society for the year:—

Dr. Sulte, Mr. Barbeau, Mr. Burpee, Mr. Scott, Dr. Shutt, Dr. Ruttan, Dr. Hewitt and Mr. Dowling.—Carried.

It was moved by Mr. Barbeau, seconded by Dr. King, that the thanks of this meeting be presented to the officers of the Society and the members of the Council for their very efficient services during the past year.

The meeting was then declared adjourned by the newly elected President, Hon. Mr. Lemieux.

APPENDIX A

PRESIDENTIAL ADDRESS

CANADIAN POETS OF THE GREAT WAR

BY

W. D. LIGHTHALL, M.A., B.C.L., F.R.S.C.

I must be pardoned for the far from original remark that a period of intense national exaltation is usually followed by a period of intense literary activity. The Augustan Age, the Medicean, the Isabellan, the Elizabethan, the Louis XIV, the Victorian—are they not common examples? Sometimes local difficulties have prevented the sequence, such as in the United States after the Revolution, and in Canada after the migration of the Loyalists—though in the end these movements have produced profound effects in thought and expression; for even if the "Great American novel," and the Great Canadian one, be still missing, the traditions of Independence and of United Empire have both been vastly fruitful. It is fair to prognosticate an intense literary activity in Canada, as well as elsewhere, in the near future, resulting from the Great War and it is well to scrutinize the straws in the wind even now, because that literary activity will not be merely a bookish matter, but a voice issuing out of our people's deepest soul.

What took place after that much less stirring, although momentous event, Confederation? Momentous, for Confederation made us a nation. By the way, it is amusing to hear every now and then that So-and-so "made Canada a nation." The feat has been attributed to at least a dozen different gentlemen by their admirers on fanciful grounds, from time to time; and to the C.P.R., and the McKinley tariff. But regarding even the superior claim of the Fathers of Confederation, had as many as two of them any real idea of the effects of what they were doing, beyond the solution of the old Provincial deadlock? Was it not only after the deed was done that the true scope of it began to dawn on our people?

The word "nation" itself is one used in too many senses, and needs some standardization by the British Academic Committee, or, in a suggestive way, by some such literary body as The Royal Society of Canada. At any rate a word used in so many confusing senses as "The Five Nations" for the Iroquois tribes; "la nation canadienne" for the French-Canadian race, in Lord Durham's Report, and its French sources; "le parti national" for the old Mercier Race Party in Quebec; "the British nation" for the people of the British Isles, and also for the British Imperial stock; "the Scotch nation", "the Irish nation," for two dialectic British provinces represented in the Parliament of the United Kingdom; "the Imperial nation" for the British peoples at large, and "the Canadian nation" for that part of it municipally organized in Canada:—a word used in such a jumble of significations requires definition for any particular context. When therefore I say "Confederation made us a nation," what is meant by the word is, *a people brought together as a working political organism within a certain territory.* This by no means implies a sovereign state: Canada's nationhood is still a statehood in the United States of Britain, and perhaps sooner than we expect may, as part of the British Commonwealth, be combined with a different and larger quality still, of membership in the Federation of the World. Our ultimate nationality is humanity. I confess to have long had a hope of a larger Union between the British Empire, France and the United States. Anyway, Confederation lifted us out of the pettiness of provincialism. It brought us a territory larger than Europe to work in, and a wondrous ideal of what that new Europe might become for our seers to sing of.

Thus arose the Confederation School of Canadian poets. Why the prose writers lagged behind is another story. The compact and spirited message of lyric verse is doubtless the main secret of its influence in an age averse to long compositions and diluted thought. As the first anthologist of the Confederation poets, I had the privilege of intimate acquaintance with the principal men and women of the school and preserve their letters as valued treasures. Among them were John Reade, (now the delightful Dean of the guild), Archibald Lampman, Charles George Douglas Roberts, Bliss Carman, Charles Mair, Frederick George Scott, Hunter Duvar, William Wilfred Campbell, Dr. William Henry Drummond, Duncan Campbell Scott, John E. Logan, George Murray, George Martin, William McLennan, "Seranus," Ethelwyn Wetherald, Agnes Maule Machar, Pauline Johnson and Isabella Valancy Crawford. These appeared practically together like a flight of songbirds from the South in April, wafted in by some mighty wind of the spirit. The birthdates of most of them are within a few years of each other, not far from 1860. Roberts had the greatest promise. The new and spontaneous patriotic outburst of his

"O Child of Nations, giant-limbed
Who stand'st among the nations now"

evoked an immediate emotional response throughout the Dominion:

"But thou, my Country, dream not thou.
  Wake and behold how night is done!—
How on thy breast and o'er thy brow,
  Bursts the uprising sun!"

and again, his "Ode for the Canadian Confederacy," beginning:

"Awake! my country, the hour is great with change."

If the song of each of the poets of Confederation is analyzed we find in it the note of a new freedom and mastery—a cry which had been lacking before, of relief from the small provincial outlook, and a devotion to the beauty of this most beautiful of all lands. Archibald Lampman, for instance, seems at first sight to deal in themes and measures far away from national outlook. What have his titles, "Alcyone," "The Favorites of Pan," or, "The Story of an Affinity," to do with Canada? Or "The Frogs"—those "quaint uncouth dreamers, voices high and strange?"—by which he told me he really intended the tree-toads! But in that exquisite poem, what a picture of the charm of his country!

"And ever as ye piped, on every tree,
  The great buds swelled; among the pensive woods
The spirits of first flowers awoke and flung
  From their buried faces the close-fitting hoods,
And listened to your piping till they fell,
  The frail spring-beauty with her perfumed bell,
The windflower, and the spotted adder-tongue."

After all, in his most distant excursions, he was working at the enrichment of Canadian life. In "Freedom," he turns to the Laurentians; painting in clear, firm tones the new wide land:

"Up to the hills, where the winds restore us,
  Clearing our eyes to the beauty before us;
Earth with the glory of life on her breast,
  Earth with the gleam of her cities and streams."

Lampman's amplest expression of his lovely and attractive soul,—for all who knew him loved him deeply—is his "Land of Pallas" that noble picture of the ideal country:

"A land where Beauty dwelt supreme; and Right, the donor
  Of peaceful days, a land of equal gifts and deeds,
Of limitless fair fields, and plenty had with honor;
  A land of kindly tillage and untroubled meads.

A land of lovely speech, where every tone was fashioned
  By generations of emotion, high and sweet;
Of thought and deed and bearing lofty and impassioned;
  A land of golden calm, grave forms and fretless feet.

There were no castes of rich or poor, of slave or master,
  Where all were brothers and the curse of gold was dead;
But all that wise fair race to kindlier ends and vaster
  Moved on together with the same majestic tread."

That "land of golden calm" was the ideal Canada, the new vision of the community to be, to which his full heart yearned, and to which he gave prophetic utterance.

Every one of the Confederation School instinctively contributed his share to the edifice, some more directly than others. Some were the landscape artists of our verse, some the historical composers, others the mystics, others refined musicians in the art of words. None composed with more Celtic passion of patriotism than our late colleague Wilfred Campbell. Of him one could always feel that he was the thoroughgoing poet, his own first convert to his message, untamed in soul, unapologetic for his art, the incarnation of noble earnestness, a despiser of ignoble things and ignoble men:

"Earth's dream of poetry will never die.
* * * * * * * *
Wrong cannot kill it. Man's material scheme
May scorn its uses, worship baser hope
Of life's high purpose, build about the world
A brazen rampart: through it all will come
The iron moan of life's unresting sea;
And through its floors, as filtered blooms of dawn,
Those flowers of dream will spring, eternal, sweet."

His lyric pictures are often most happy:

"Along the line of smoky hills,
  The crimson forest stands;
And all the day the bluejay calls
  Throughout the autumn lands."

And his "Lake Lyrics" are transcripts reflecting all the misty vastness of our inland seas. To him the best moral impulses we have came from our British ancestors, and present and future generations could not do better than treasure and build upon the deposit of British traditions.

"England, England, England,
  Girdled by ocean and skies,
And the power of a world and the heart of a race,
  And a hope that never dies.
England, England, England,
  Wherever a true heart beats,
Whereever the glories of liberty grow,
  'Tis the name that the world repeats.
* * * * * * *
Till the last great freedom is found,
  And the last great truth is taught,
Till the last great deed is done,
  And the last great battle is fought,
Till the last great fighter is slain in the last great fight,
  And the warwolf is dead in his den,
England, breeder of hope and valor and might,
  Iron mother of men."

The Confederation School indeed expressed something which was at the root of the chivalrous conduct of our young Canadians in the Great War. They both expressed and inspired it.

It would be very easy to trace the elements of the common task in the product of others of the school, but as two of the most eminent are among our own Fellowship, I shall quote a brief distinctive note from each.

Frederick George Scott wrote the following inscription for the Soldiers' Monument at Quebec:

"Not by the power of Commerce, Art or Pen
Shall our great Empire stand, nor has it stood,
But by the noble deeds of noble men,
Heroic lives and heroes' outpoured blood."

And from Duncan Campbell Scott may be chosen the exquisite sonnet:

OTTAWA

Before Dawn.

"The stars are stars of morn; a keen wind wakes
The birches on the slope; the distant hills,
Rise in the vacant North; the Chaudière fills
The calm with its hushed roar; the river takes
An unquiet rest, and a bird stirs, and shakes
The morn with music; a snatch of singing thrills
From the river; and the air clings and chills.

Fair in the South: fair as a shrine that makes
The wonder of a dream, imperious towers,
Pierce and possess the sky, guarding the halls,
Where our young strength is welded strenuously;
While in the East the Star of morning dowers
The land with a large tremulous light, that falls
A pledge and presage of our destiny."

The Great War is vastly more stirring as an era than Confederation was. We are passing through the Valley of the Shadow of Death, and many of our sons have crossed the dark river itself and disappeared into the night. Fierce tests are forging men and will turn into our home life a stern and determined army, hating shams, not afraid of true revolutions, and accustomed to ideals, although singularly silent about them Momentous views and profound feelings have already begun to find some utterance here as well as in other allied lands. By examining the body of scattered verse from Canadian pens, we may hope to construct a dim picture of our coming poetic generation. Never mind the form. The mass must be regarded in the same light as those absorbing wash-and-pencil drawings, which come from the front, whose interest lies in their transcript character—transcripts of hourly trial and danger; of incidents of battle; of sad and tragic partings with the dying brave; of regimental losses in the charge; of heroic merriment under the miseries and privations of the winter dugout, the cold, the flooded trenches and the Flanders mud.

Naturally, several of the surviving Confederation Poets overlap the nascent Afterwar School by treating of such themes. Frederick George Scott has served at the front as chaplain since 1914, has lost one son killed in action and has seen another part with an eye by a German bullet. Out of the fulness of his heart he has composed several of our finest poems on the war. Charles G. D. Roberts, who also holds a commission at the front, Duncan Campbell Scott, Wilfred Campbell, Mrs. Harrison ("Seranus"), Mrs. Isabella Ecclestone Mackay, and Miss Machar, have all contributed to the expression of war life. And Robert W. Service—who might be called a belated member of the Confederation School, because of his creation of the poetic Yukon—and Theodore Goodridge Roberts, son and literary pupil of his father Charles G. D. Roberts, are doing good work in France. All these writers of pre-war attainment are giving our war verse some of its first forms and part of its lines of impulse. By reason of their previous experience, they promptly seize some of its characteristics. Yet it is a question whether they do or do not have, in their previous training, a disadvantage as well as an advantage over the new writers who will be wholly inspired by the new era.

The Great War period itself must be regarded as a new starting point, the foundation of the After-War literary edifice.

What then do we find in this Great War period, now evidently shaped with considerable distinctness? Is it not the following qualities:

1. Dreadful experiences.

2. Supreme heroism.

3. Ideals of fidelity—chivalry, honor, patriotism to Canada, Empire, and humanity.

4. Hatred of Wrong.

From these have resulted self-confidence, intensity of convictions, directness of view, dignity and new outlook,—strong elements of impulse which are certain to lead to constructive action in the near future, and that action will, when it arrives at maturity in our national affairs, necessarily flow along the lines of those experiences, ideals and impulses.

Canon Scott, the heroic chaplain, always in the thick of danger and adored by the men, gives the following, among his "Poems written at the Front."

THE SILENT TOAST.

"They stand with reverent faces,
And their merriment give o'er,
As they drink the toast to the unseen host,
Who have fought and gone before.

It is only a passing moment,
In the midst of the feast and song,
But it grips the breath, as the wing of death
In a vision sweeps along.

No more they see the banquet,
And the brilliant lights around,
But they charge again on the hideous plain
When the shell-bursts rip the ground.

Or they creep at night, like panthers,
Through the waste of No Man's Land,
Their hearts afire with a wild desire
And death on every hand;

And out of the roar and tumult,
Or the black night loud with rain,
Some face comes back from the fiery track
And looks in their eyes again.

And the love that is passing woman's
And the bonds that are forged by death
Now grip the soul with a strange control
And speak what no man saith;

The vision dies off in the stillness,
Once more the tables shine,
But the eyes of all in the banquet hall
Are lit with a light divine."

Vimy Ridge, April, 1917.

In "Requiescant" he sees the same "unseen host."

"In lonely watches night by night,
Great visions burst upon my sight,
For down the stretches of the sky,
The hosts of dead go marching by.

Strange ghostly banners o'er them float,
Strange bugles sound an awful note;
And all their faces and their eyes
Are lit with starlight from the skies."

Robert W. Service, the "Red Cross Man," (who lost his brother, Lieutenant Albert Service, killed in action in 1916) has sought his subject with a sure instinct:

"OVER THE PARAPET"

"All day long when the shells sail over,
  I stand at the sandbags and take my chance;
But at night, at night, I'm a reckless rover,
  And over the parapet gleams Romance.
Romance! Romance! How I've dreamed it, writing
  Dreary old records of money and mart,
Me with my head chock full of fighting,
  And the blood of vikings to thrill my heart!

But little I thought that my time was coming,
  Sudden and splendid, supreme and soon;
And here I am with the bullets humming,
  As I crawl and I curse the light of the moon;
Out alone, for adventure thirsting!
  Out in mysterious No Man's Land!
Prone with the dead when a star shell bursting,
  Flares on the horrors on every hand."

Theodore Goodridge Roberts gives us such stanzas as this:

"A CANADIAN DAY, SEPTEMBER 15, 1916."

"Steady they come, as those who had come in the morning,
  Unshaken they passed where the bursting barrage was set;
They passed their victorious comrades; they passed to their goal—
  The machine-gunned houses and gardens of Courcellette.

Into and through it, they flamed like fire through stubble;
  With death before them, behind them, and swift in the air;
They struck stark fear to the hearts of the craven foemen;
  With bomb and steel they dug the Boche from his lair.

September the Fifteenth. That was a day of glory,
  With blood, with life, they captured the fortress town;
While far way, in the dear land they died for,
  In frosty coverts the red leaves fluttered down."

Others of the older writers, who have not been at the front, have also been stirred by phases of the struggle. Duncan Campbell Scott has seen the vision of the aviator's soul in his Miltonic "Lines on a Canadian Aviator who died for his Country in France."

"But Death, who has learned to fly,
Still matchless when his work is to be done,
Met thee between the armies and the sun;
Thy speck of shadow faltered in the sky;
Then thy dead engine and thy broken wings
Drooped through the arc and passed in fire;
A wreath of smoke,—a breathless exhalation;
But ere that came, a vision sealed thine eyes,
Lulling thy senses with oblivion;
And from its sliding station in the skies
Thy dauntless soul upward in circles soared
To the sublime and purest radiance whence it sprang."

Robert Stanley Weir's "Treason" gives vigorous voice to the intense anger at traitors:

TREASON.

To............

Because when your own Mother had sore need;
Because you knew it well and would not heed;
Because, though ruffians from the raging Rhine
Assailed with roar her very door;
You said Her quarrel is not mine.
Because of this:
Yours shall forever be a name to hiss!
* * * * *
Because not only have you failed to fight,
At Armageddon 'gainst all Devil's might;
But held your brothers back when they would go,
Blinding their eyes with dastard lies
So that they went not up against the foe;
Because of this;
Yours shall forever be a name to hiss."

His "Were You Not There?" is an equally stern arraignment of the slacker. And the true tone rings in Charles Twining, from whose numerous lyrics of the time we may quote:

WHO WIN THE FIGHT.

Yes, they have peace, as they have peace who wait,—
Returning, conquerors, from a distant field,
Upon the King, when every brow of state,
Against their coming, must its homage yield;
Or, as a savant, who has studied long
Framing a rich elixir, of such worth,
That, having found it, a triumphant song
Is his, for he has changed man's lot on earth;
Or as a youth, who, bending in the race
Beyond his fellows, stumbles at the goal;
What cares he if he slipped in his last place
When, winning, he has made his being whole?
And do they trouble that their breath may cease,
Who win the fight, when only such have peace?"

From Samuel Mathewson Baylis, author of the volumes "Camp and Lamp", and "At the Sign of the Beaver", come good fighting lines:—

"THOROUGHBRED."

All unafraid, as sire the seed,
    Indomitable, undismayed,
Fronts the ringed teeth of mongrel breed
            All unafraid.

'If few the greater honor paid!—
   Adown the years our Henry's creed
Still fires high souls in arms arrayed.

Though eyes be dim and torn hearts bleed,
   On! still unshaken, firmly stayed,
They greatly rise to greater need,
            All unafraid!"

It would be invidious and inopportune to attempt a list of the others who have written well.

But the deepest interest lies in that often formless mass of new utterance which is welling up day by day hot from the lifesprings of the new generation. The famous lines of Lt.-Col. John McCrae, who lately died of pneumonia at the McGill Hospital, Boulogne, are inseparable from the Great War:

IN FLANDERS FIELDS.

In Flanders fields the poppies grow,
Between the crosses row on row,
That mark our place; and in the sky,
The larks, still bravely singing, fly;
Scarce heard amid the guns below.

We are the dead. Short days ago,
We lived, felt dawn, saw sunset glow;
Loved and were loved, and now we lie
    In Flanders fields.

Take up our quarrel with the foe,
To you from failing hands we throw
The torch. Be yours to lift it high.
If ye break faith with us who die
We shall not sleep, though poppies blow
    In Flanders fields."

One of these dead in Flanders fields, Lieutenant Bernard Freeman Trotter, who was killed by a high explosive shell on May 7th, 1917, wrote passages of lofty feeling. He exclaims while detained by ill health from enlisting:

O God, the blood of Outram in these veins
Cries shame upon the doom that dams it there
In useless impotence, while the red torrent runs
In glorious spate for Liberty and Right.
O to have died that day at Langemarck!
In one fierce moment to have paid it all!
The debt of Life to Earth and Hell and Heaven.
To have perished nobly in a noble cause,
Untarnished, unpolluted, undismayed,
By the dark world's corruption; to have passed,
A flaming beacon light to gods and men,
For in the years to come it shall be told
How these laid down their lives not for their homes,
Their orchards, fields, and cities; they were driven
To slaughter by no tyrant's lust for power;
Of their free manhood's choice they crossed the sea,
To save a stricken people from its foe
They died for justice. Justice owes them this;
That what they died for, be not overthrown."

And again:

"O happy dead, who sleep embalmed in glory,
Safe from corruption, purified by fire!
We shall grow old and tainted with the rotten
Effluvia of the peace we fought to win;
But you have conquered Time, and sleep forever,
Like gods with a white halo on your brows;
Your souls our lodestars, your death-crowned endeavour
The spur that holds the nations to their vows."

These words, written in France in April, 1917, were the last he wrote before he himself "conquered Time, and slept forever."

The verses from Lt. Peregrine Acland's Poem "The Reveille of Romance" which I am about to quote show the spirit of high resolve and the imaginative outlook which actuated those who sprang to arms at the first call. This spirit upheld many throughout the stress of the campaigns. The author, who wrote the lines at sea on his way to the front, proved himself a fine soldier, received the Military Cross, was promoted to the rank of Major and was severely wounded.

Regret no more the age of arms,
Nor sigh, "Romance is dead."
Out of life's dull and dreary maze
Romance has raised her head.

* * *

From East and West and South and North
The hosts are crowding still;
The long rails hum as troop-trains come
By valley, plain and hill;

And whence came yearly argosies
  Laden with silks and corn,
Vast fleets of countless armed men
  O'er the broad seas are borne.

* * *

Though warriors fall like frosted leaves
  Before November winds,
They only lose what all must lose,
  But find what none else finds.

Their bodies lie beside the way,
  In trench, by barricade,
Discarded by the titan Will
  That shatters what it made.

Poor empty sheaths, they mark the course
  Of spirits bold as young;
Whatever checked that fiery charge
  As dust to dust was flung.

For terrible it is to slay
  And bitter to be slain,
But joy it is to crown the soul
  In its heroic reign.

And better far to make or mar,
  Godlike, but for a day,
Than pace the sluggard's slavish round
  In life-long, mean decay.

* * *

Who sighs, then, for the Golden Age?
  Romance has raised her head,
And in the sad and sombre days
  Walks proudly o'er your dead.

The women have contributed largely. Mrs. Annie Bethune Macdougald speaks the gift of the mothers:

WAR DEBT.

Some pay the tax in riven gold,
  But we in blood and tears,
Heart throbs, lone vigils, and passionate tendance through the years;
First bending low to cull the drifting smile of sleeping innocence
  incarnate
Then level, eye to eye, with love's divining glance,
Would read the riddle of the dawning man innate;
Held hostage still by roguish straight-limbed youth
And then with lifted eyes do we behold the flower
Of manly strength stand up above us

* * * * * * * *

And then, with miser fingers, we con the hoarded treasure of the years
And wonder, even as Mary, all human, all divine;
That all such fair investment of fine gold,
Should buy us but a crown of glistening, bitter tears.

* * * * * * *

'Tis thus we women pay."

Miss Helen Coleman, in her volume entitled "Marching Men—War Verses" has thoughts of

AUTUMN, 1917.

"Are there young hearts in France recalling
These dream-filled, blue Canadian days,
When gold and scarlet flames are falling
From beech and maple set ablaze?

Pluck they again the pale wild aster
The bending plume of golden-rod?
And do their exiled hearts beat faster,
Roaming in thought their native sod;

Dream they of Canada, crowned and golden,
Flushed with her autumn diadem.
In years to come, when time is olden,
Canada's dream shall be of them;

Shall be of them who gave for others,
The ardor of their radiant years;
Your name in Canada's heart, my brothers,
Shall be remembered long with tears."

Some of these poets have been inspired to verse for the first time in their lives. Miss Esther Kerry, a young lady of a well-known and gifted family of Montreal, who served in England as a V.A.D. nurse, wrote one day in London these happy lines:—

HE IS A CANADIAN.

"He is a Canadian—I wonder has he stood
In some thick forest, on a mountain slope,
Silent beneath a pine.
And looking out across a valley seen
Nothing but bristling tree trunks far below
And storm-scarred grey mountains
Whose snow-caps
Rise to a sunswept blue.

He is a Canadian—I wonder has he stood
On some still morning by a tiny lake
And watched the water ripple on the beach,—
One little clearing
In the mighty woods—
And know that he is first to breathe that air
Not weighted by a thousand lives and thoughts,
But rare and pure,
A breathing straight from God.

Oh, Canada, of bigness, beauty, strength,
Whom we thy wondering children know as ne'er before
In exile's retrospect of glorious hours,
We love thee with a love we never felt till now,
A love not all our own, a heritage
From those who to thy shores no more return.
Their love of thee, unconscious, pent,
Which drove them forth, they knew not why
And urged them on
All glad for thee to die
In this great love may we be consecrate
And made a nation new,
Strong as thy mountains,
Generous as thy plains,
Pure as thy winters,
And with depths unknown
As all thy forest lakes—
Still pools of peace."

And a lovely lament is the elegy "A Cry from the Canadian Hills" by Lilian Leveridge of Carrying Place, Ontario, over her young brother Frank, who died of wounds in France:

"Laddie, little laddie, come with me over the hills,
Where blossom the white May lilies and the dogwood and daffodils;
For the spirit of spring is calling to our spirits that love to roam;
Over the hills of home, laddie, over the hills of home.

Laddie, little laddie, here's hazel and meadow rue,
And wreaths of the rare arbutus ablowing for me and you;
And cherry and bilberry blossoms and hawthorn as white as foam;
We'll carry them all to mother, laddie, over the hills of home;

Brother, little brother, your childhood is passing by,
And the dawn of a noble purpose I see in your thoughtful eye.
* * * * * * *

Laddie, soldier laddie, a call comes over the sea,
A call to the best and bravest in the land of liberty,
To shatter the despot's power, to lift up the weak that fall;
Whistle a song as you go, laddie, to answer your country's call.

Brother, soldier brother, the spring has come back again;
But her voice from the windy hilltops is calling your name in vain;
For never shall we together, mid the birds and the blossoms roam,
Over the hills of home, brother, over the hills of home;
* * * * * * *

Laddie, Laddie, Laddie! How dim is the sunshine grown;
As Mother and I together speak softly in tender tone,
And the lips that quiver and falter have ever a single theme,
As we list for your dear lost whistle, laddie, over the hills of dream."

Many are expressing themselves in similar outbursts of utmost sincerity. Then there are ruder things of ballad type, with the ring of valor and the interest of truth:

"THE TAKING OF THE RIDGE"

(By Sapper J. T. Peck, C.E.F., 2005647).

'Twas a beast of a night. God! the mud
Up to our necks and red with blood,
Held fast like glue, both horse and gun—
That night the famous ridge was won.

For months we had stood a grilling fire
From Fritz's guns across the mire,
Our graveyards grew mid the bursting shell,
The living breathed and tasted hell.

Mud—the cursed Flanders mud:—
Up to our necks and red with blood
Barred the way to that coveted ridge
Where the heaping corpses made a bridge.

O'er No Man's Land, a bog of hell.
A seething mass of hissing shell,
Lit by the tongues of a thousand guns;
Our brave lads dashed to meet the Huns.

On, on through the mud they pressed their way,
Machine guns spat, but ne'er did stay
That gallant charge o'er No Man's Land,
Where war is hell, and hell is grand;

The dawn rose grey, when a British cheer
From the lofty ridge broke strong and clear;
It drowned the cowardly cry "Kamerade"
From the cowering Hun who feared the blade;

We marched them down through the oozing mud,
With the dead piled high, congealed in blood,
Those fiends of hell, they paved the way
From the conquered ridge in suits of grey;

But no one knows how the ridge was won;
Save those who faced the hated Hun
And our pals who rest beneath yon sod
Who lie in peace at rest with God.

In the silent depth of the Flanders mud
Made sacred by their own heart's blood
God rest their souls, and Heaven keep
Their loved ones, waiting across the deep."

Some new Western men have written well. Robert J. C. Stead, of Calgary, has given notable verses on "Kitchener", among others in his volume "Kitchener and Other Poems". This dirge strikes the chord of Empire:

KITCHENER.

Weep, waves of England. Nobler clay
Was ne'er to nobler grave consigned;
The wild waves weep with us today
Who mourn a nation's master mind.

We hoped an honored age for him,
And ashes laid with England's great,
And rapturous music, and the dim
Deep hush that veils our Tomb of State.

But this is better. Let him sleep
Where sleep the men who made us free,
For England's heart is in the deep
And England's glory is the sea;

One only vow above his bier—
One only oath beside his bed—
We swear our flag shall shield him here
Until the sea gives up its dead:

Leap, waves of England. Boastful be.
And fling defiance in the blast
For earth is envious of the Sea,
Which shelters England's dead at last."

James Mabon is a gentleman of Scottish birth who has lived a number of years in Saskatchewan. His poetic grasp of Western war problems is evident in

HAYSEED.

"Hayseed." That's what you called him,
With his overalls patched and worn,
And his get-up rather straggly,
And his buttons, somewhat forlorn.

And he stooped a bit in his walking,
Had naught of the martial stride,
And there were marks on his forehead
That his thick locks could not hide;

And his hands were hard and gnarled,
And you saw as he crossed the street,
That the binder twine and the laces
Were chums in the shoes of his feet;

And his open shirt-neck showed you
The bare throat ruddy and brown,
And you dubbed him "Hayseed,"
Taking your stroll uptown.

Perhaps he chewed and squinted
And "darned" not a little, "you bet,"
And you smiled in condescension
And, talked to your cigarette.

But he sent his boys to the trenches,
And his wife did the work of two,
Tho' you'll look pretty long for his record
In the pages of "Who is Who".

But Old Mother Earth keeps writings
For all the world to read,
The tale of Creation's Conscript
Whose life is a long brave deed.

And a cry comes up from the city,
And over the sleeping lea,
Rides on the wings of the tempest,
Sweeping the sundering sea.

Bearing the call of the hungry,
Ever the old refrain,
And the gnarled hands are lifted
And the back is bent again

And the wise man in his wisdom,
And the foolish in pride's disguise,
And the boy who fights for Freedom
With the God-light in his eyes,

And the rich man with his riches,
And the poor man at his toil,
Make, gladly, meek obeisance
To the Craftsman of the Soil.

Hyman Edelstein, a young Jew of Montreal, introduces one of the strangest notes of the incredible contest, when he voices the gratitude of Canadian Israel regarding the Restoration of Palestine,—the re-wedding of the Holy Land to the Chosen People,—in which indeed a number of our young Canadian soldiers took part:

ZION IS FREE!

From Lebanon comes a shout of glee,
And Carmel echoes long.
* * * * *
And Jordan sings with a newfound rhyme
And the valleys ring with the mingled chime,
As the trees whirl in a rustling dance,
Over the strange divine romance:
Shulamith and her lost are met—
Zion and Judah are lovers yet!

What saith the Jordan to the sea?
And thou, old Kishon, what aileth thee?
    Why run the rivers with hurrying gait?
    And what the tidings they relate
To the fields that can no longer wait,
And the woods that with wild joy vibrate?—

O it is the 'Earth of Israel' singing,
Which feels the tread of her children's feet,
And it is the shout of the strong hills ringing
Which thus their ancient tenant greet:
Zion is free! Zion is free!
My children, my children, come back to me!"

Yielding to the urgings of friends, I take the anthologist's privilege of inserting some lines of my own:

THE GALAHADS

* * * * *

Yet faint above the din, on ether borne,
A clear voice rang the ancient battle cries:
"Freedom and honor! truth and chivalry!
St. George, defend thy pledges unto death!
St. George, defend the weak, and save the world!"
And all true sons of Britain felt it vain
To live, unless as British knights of old,

Then lo! with reverence and pride we saw
The knights of old appear,—Sir Galahads,
None purer, none more brave. They had been known
Till then but as the schoolboys of the camps,
Carefree and merry, warming elder blood
By pranks of diving, reckless climbing feats
Up sheerest precipices. Trackless wilds
Knew them as tenters. The shy beaver heard
Their paddles unafraid. Widely they ranged
The peaks and dales uncharted, seeking risks
For love of danger and the jest with Death.

Yesterday they were children. Scarcely yet
Knew we they needed less our tender care,
Until some grave look or some manly deed
Warned us the soul was ripe. We pondered then.

So came the world's great need and Honor's call,
And silent, modest, up they rose to serve,—
Then in our wonder we beheld them men
And saw the Knights of Arthur's Table stand
Before us in their sacred panoply.
Little they said and naught delayed their going,
Farewells to launch, canoe, fair lake and range,
A tender word to mother, and forth they fared,
As thousands like them fared from lake and stream,
Crusaders of the Grail. Rude knights were some
But knightly all: God loves all faithful men.

Galahads of the camps! For this you learnt
The fearless life and strenuous company
Of the wild North, contempt of hurt and cold,
Joy of unmeasured contest, wit to meet
Emergency, deft skill and steady nerve.
What seemed but sport was training, and the best
Was inner,—loyal will and heart humane.
And in your battles you remembered oft
The mountains of the Land of Manitou.

Some shall return with honor, henceforth called
The heroes of the world. But where are those
Who shall never return?

Alas! to earthly eyes they sleep afar
In fields of glory famed to end of time.
Yet ever shall they clothe these leafy hills
With visions of the noblest deeds of men
And hold before Canadian youths to come
The quest eternal of the Holy Grail.

To treat of the part of the gallant French-Canadian Contingent in France would be to encroach on the field of the French Section of this Society. The glory of Talbot Papineau, of Major Roy, of Dumont Laviolette, and of the immortal 22nd, will assuredly be cherished in the Old Province in future years. I may, however, be permitted to quote one tribute to them by a French writer interested in Canada:—

'MONTREAL AU FRONT DE FRANCE.

by René d'Avril.

"Beaux et forts, l'œil hardi, cambrant leur haute taille
Affrontant les dangers trops connus,—la mitraille,
Les gaz, le froid, le chaud, la boue, et loin des leurs
Ne pensant qu'au pays dont flottent les couleurs,—
Pays qui les rassemble en un même uniforme:
Ils sont aux premiers rangs de cette lutte énorme;
Héros de bronze clair qu'envierait un sculpteur.

Ils ont quitté le sole du logis enchanteur.
Plus de rire d'enfants, sous le ciel gris de France
Mais l'attaque de nuit, l'implacable défense
Et la gloire qui passe en funèbre appareil

* * * * *

Ils sont du Canada, non loin de Montréal.....
Vaste image émergeant des brouillards de la Somme:
O grands lacs, O grands fleuves lents, grands champs de blé,
Pays ou tout est grand, même le cœur de l'homme!

(*Paris, Hôpital de l'Ecosse.*)

Captain Harwood Steele, of Winnipeg and the front, has written many clever poetic tributes to the Navy, and other lyrical descriptions of the great struggle. One of our most promising singers, he strikes a worthy note of Empire in

THE IMPERIAL ANTHEM

Lord God of hosts, Thy people cry to Thee,
Who smote for them, a path upon the sea.
Here at Thy feet, and looking still for aid
Kneeleth an Empire, great and unafraid.
Should foes appear, and war clouds darken man,
God of our sires, stand forward in our van.

Death crowned the fleet, that keeps our restless tide,
Death crowned the line, wherein our fathers died.
Strong in our faith, and bound to Thee alone,
Six nations one, we wait before Thy throne.
When in Thy name, we let the legions fly,
Lord God of Battles, hear their battle cry.

Then bound six-fold, by ties of blood and tears,
Shed each for each, through all our thousand years,
Under one King, our faces set to Thee,
Shall we be one, in peace eternally."

This has been set to excellent music by Mrs. de Lotbinière-Harwood, of Edmonton.

Having now taken a survey, more or less incomplete, of our war verse, we may try to measure its place and divine its future. In what qualities does it differ from the large and well-developed body of war poetry of the rest of the English speaking world? Two interesting comparisons are easily made. One is with the Anthology called "Poems of Today" in which some of the best things of the recent English poets regarding the war are collected: the other is with the "Poems and Songs of the South African War" brought together by the late Dr. J. D. Borthwick, (who was somewhat over liberal in his inclusions). The great South African contest looks today almost an excursion by the side of monstrous Armageddon, and the output of verse it occasioned might be contained in a leaflet. Yet on reflection, its national and even literary impulse was not negligible, and had a much larger result than is generally supposed. And it had a definite and close relation to, and influence upon, our part in Armageddon.

In technique, only a small part of our poetry of the present war compares with the product of such British writers as Kipling, Binyon, Masefield, Rupert Brooke, Henry Newbolt. And in volume, it is of course but a little stream. Perhaps in both these respects—technique and volume—it may equal the work of the poets of the United States. But in three aspects it is unexcelled: no other verse is more bathed in the blood and agony of bitter struggle: none speaks from a soul of more uncompelled and undiluted chivalry; and none other proceeds specifically from our Canadian point of view, and so to speak courses directly in our national veins. It has indeed a notable relation to the whole present and subsequent revolution which the war is bringing, and is to bring, into the life of nations. All over the world these common impulses are taking form, and all humanity will surely aim at closer links of fraternity, mercy, justice and liberty and the attempt to establish a better world.

It is bound up, too, with the incoming tide of vital changes in the British Commonwealth. We have made it clear that the Empire is a living family, that all its people are our brethren, all its territory our country, its greatness our pride, its unity our concern, its organization one of our tasks, its future one of our grandest hopes. Those who have dreamed the British Commonwealth would fall apart have proved as foolish as those who proclaimed that chivalry is a myth.

The office of our war verse will be to apply the deep lessons of the struggle to the making of a better Canada as well as a more secure Empire. Racial passions, appetites for domination, ignorance, cowardice, materialistic ideals, will receive strong shocks from the forces of the new crusade; and the next generation will see many resultant changes in Canadian affairs. Few ideals are ever perfectly successful here below. But just as certainly, they form an enriching alloy when poured into the baser metal of the world: and just as certainly the world is advanced by each, to some extent. The law of conservation of moral energy is as valid and exact as the law of conservation of physical energy. None is ever lost. Whoever does a heroic deed, whoever enshrines it in a lyric line, have both achieved something immortal and eternal in their influence. The poets of Confederation had and will have a profound though noiseless influence. So will the War School. And as the war is a greater, wider, nobler event for us than Confederation, its influence will be so much the stronger.

But are those who have already written on the War the whole of our War School of Canadian poets? Are they not rather the precursors? In Pisgah view, I think I descry the real school as yet to come. The Confederation Poets came chiefly after Confederation. The War School will, I believe, appear chiefly after the war. Young men and women of genius—some probably returned from the contest—will celebrate its glorious deeds, will drink deep inspiration from that brilliant band of heroes who are already beginning to render our circles illustrious with their presence, will develop the depths of feeling, the stirring calls to action, the picturesque adventures, the world-wide range of interests, the passion for true living, the insistent calls for a better people, for improved institutions, for a more dignified civilization, worthy of the new, hardwon tradition of Canadian valor, which is to go down to our children and children's children.

This is our Homeric Age. There never will be a greater fight. There never will be a vaster battlefield. There never will be richer experiences, more terrible shadows, more tragic trials, more glorious courage, more splendid triumphs, a higher tide of Empire, a worthier cause to live and die for.

The art of song cannot hurriedly attain to fit celebration of this epic period. The poets may perhaps not yet be born who shall invent utterances that shall be truly worthy of the innumerable heroic achievements, the Galahadic dedications to the supreme sacrifice, the wonderful idealism of the whole crusade. The story is too grand to be forgotten. It will sound the trumpet of the breast until it finds and calls out our supreme minstrel to supremely chant our Idylls of the Heroes.

APPENDIX B

THE METEOROLOGICAL SERVICE OF CANADA

BY

SIR FREDERIC STUPART, Kt., F.R.S.C.
Director, Dominion Meteorological Service

METEOROLOGICAL SERVICE REPORT

Meteorological returns have been received at the Central Office from 607 stations, inclusive of 32 new climatological stations, but exclusive of 112 storm signal stations, and 7 stations which have ceased reporting.

The following are the new stations, together with the names of the observers:

Dome Creek, B.C.	E. L. Webber.
Field, B.C.	Charles Statham.
Harper's Camp, B.C.	H. L. Waters.
Lake Hill, B.C.	E. L. Fleming.
Port Alberni, B.C.	C. T. Hilton.
Bow Island, Alta	M. Mortensen.
Entrance, Alta	C. MacFayden.
Meanook, Alta	H. E. Cook.
Munson, Alta	P. R. Fraser.
North Cooking Lake, Alta	C. C. Bailey.
Whitla, Alta	R. H. Babe.
Alingly, Sask	K. Vavasour.
Biggar, Sask	Dr. S. E. Shaw.
Herbert, Sask	Chas. A. Stewart.
Lodge Creek, Sask	W. G. Edgerton.
Usherville, Sask	H. M. Morrison.
Crystal City, Man	Ralph Greenway.
Morden, Man	E. M. Straight.
Portage la Prairie, Man	John Simpson.
Algonquin Park, Ont	G. W. Bartlett.
Franz, Ont	D. J. Bolton.
Harrow, Ont	D. D. Digges.
Kapuskasing, Ont	S. Ballantyne.
Bonaventure, Que	H. Lane.
Farnham, Que	L. E. Lorquet.
Spirit Lake, Que	Pascal Fortier.
McAdam Junction, N.B.	W. J. Vaughan.
South Alton, N.S.	Thos. Welton.
Truro, Normal College, N.S.	J. A. Benoit.
Belle Isle, Nfd	P. Thomas.
Fogo, Nfd	Harry Randell.

The daily forecasts have been issued twice daily throughout the year and disseminated widely in all parts of the Dominion. In the Western Provinces good progress has been made in extending the bulletins to the more important points served by the Canadian

Northern Railway, and arrangements have recently been made to issue a daily forecast to places in the Interior of British Columbia. The percentage of verification of the daily forecasts was 87·5.

The Monthly Record of Meteorological Observations which as stated in my last Report has taken the place of the Annual Climatological Report, has been brought almost as closely to date as is possible, and the Service can no longer be reproached for issuing belated reports. The Monthly Map published from four to five days after the close of each month gives most valuable information regarding the progress of the seasons and is greatly appreciated by all directly concerned with agricultural operations. The daily weather map has been issued without a break throughout the year and much of the data it contains is telegraphed to all parts of the Dominion. The Report of the Toronto Observatory which has been issued annually since 1860 is now printed in the Meteorological Office press and was in print at an earlier date this year than ever before. It contains data which is of much interest now and will be of the utmost value in the future. Never in the history of the Service have there been so many applications for Meteorological data as during the past year, and in many instances the preparation of the particular data asked for has entailed considerable clerical work. Applications have been received from Government offices, electrical development engineers, railways, legal firms, cities, pulp wood companies, irrigation engineers, agricultural institutes, farmers, prospective immigrants and many others, and all enquiries have been replied to as fully and promptly as possible.

The Percentage of verification of storm warnings issued for Canada was 84·1.

Physics Branch

Balloons with self-recording instruments for upper air investigation were sent up from Woodstock on the international days until November, 1917, when the supply of instruments was exhausted.

The particulars of those received are given in the following table:

Date	Greatest height.	Temperature at greatest height.	Height of Stratosphere.	Temperature at base of Stratosphere.
	Miles		Miles	
April 12th...........	7·3	–58 F	6·4	–60
May 2nd............	6·7	–60	6·3	–62
June 3rd.............	9·3	–62	6·9	–64
June 6th.............	9·4	–80	9·3	–80
June 7th..............	8·6	–42		Did not reach Stratosphere.

The recoveries have again been poor and it is the intention when the ascensions are resumed to try some other locality that the balloons may stand a better chance of being found. All the results of balloon ascents have been published to date.

During September, 1917, Mr. Patterson took meteorological observations at Father Point, Quebec, during the acoustic survey by Dr. L. V. King. Small balloons were used for the determination of the wind direction and velocity in the upper atmosphere during each set of observations on the sound signals, and observations with a pilot tube to determine the gustiness of the wind were taken. At the same time records of temperature, pressure, humidity and wind were obtained on self-recording instruments. The work was essentially preliminary in character and it revealed the very great importance of a knowledge of the upper air conditions and the gustiness of the wind, in any investigation on the propagation of fog signals. It also showed that in order to correlate the different phenomena, the special self-recording instruments with an open time scale and the time given by our clocks are required. A special report was made on the subject to Dr. King.

On Mr. Patterson's return from Father Point, P.Q., he was requested to undertake important war work, and as he has had to give almost all his time to his new duties it has been found necessary to curtail the work of the physics branch.

The observations on evaporation and radiation have been continued, and for the greater part of the year the electrical potential of the air has been measured, but it has not been possible to complete the installation of the earth thermometers.

All mercury used in barometers is now so carefully purified that the most delicate tests give no trace of impurities, and all barometers that become damaged through breakage of the tubes, etc., are repaired with a new tube and filled in the laboratory by a new process which has given very excellent results.

Agricultural Meteorology

The division of Agricultural Meteorology has arranged with the Department of Trade & Commerce to have the assistance and co-operation of the Census & Statistics Office in collecting data regarding wheat growth and the weather changes. Details of this arrangement will be found described in the March number of the "Bulletin of Agricultural Statistics". The experimental plots maintained on the Dominion Experimental Farms are being continued for another year. The data from these plots is now in hand from three successive seasons

A preliminary article upon the results of the analysis up to the present time will be found in the April number of the "Monthly Bulletin of Agricultural Statistics."

Seismological Observations

The Milne Seismographs at Toronto and Victoria have been successfully kept in operation throughout the year without change in adjustment, both booms being kept at a period of 18 seconds. A small, illuminating lamp introduced in the Victoria instrument, has reduced the thickness of the centre line on the trace. Previously, the line was so thick, it was impossible to detect small earth tremors.

Toronto registered 144 earthquakes during the year, two of which were very large, five of moderate character, and the remainder with amplitudes from 0·1 to 2 mm. The largest were recorded on May 1st, and June 26th, with centres in the South Pacific Ocean and were doubtless of submarine origin. The more moderate occurred on June 8th, June 27th, August 16th, December 29th and February 13th, with centres generally in the Caribbean Sea region. The quake on the 29th of December caused considerable damage and loss of life in Guatemala, whilst that on February 13th practically destroyed the Chinese city of Swatow with loss of life amounting to 10,000. Victoria recorded 122 disturbances during the year.

Magnetic Observations

At Agincourt from March 1917 to March 1918 the mean Declination for the month increased from 6° 35·6′ West to 6° 38·1′ West. The mean Horizontal Force decreased from 0·15960 dyne to 0·15925 dyne. The mean vertical Force decreased from 0·58485 dyne to 0·58405 dyne. The mean Total Force decreased from 0·60623 dyne to 0·60537 dyne and the mean Inclination increased from 74° 44·2′ to 74° 44·9′.

At Meanook mean Declination has changed from 27° 45·9′ E to 27° 45·4′ E.

Magnetic disturbances were of frequent occurrence during the year. During the month of August they were particularly active, the largest ones occurring on the 8th, 9th, 20th, and 21st. The Maximum Range in the different elements occurred on the 9th; at Agincourt in Declination the change of direction was from 5° 26·2′ W to 8° 48·7′W, in Horizontal Force from 0·15427 dyne to 0·16414 dyne and in Vertical Force from 0·57517 dyne to 0·58753 dyne, and at Meanook the change of direction was from 25° 16·1′ E to 28° 59·0′ E.

A large number of storms were of the type having sudden commencements where the time of the first movement is practically instantaneous throughout the Globe.

The Mean Diurnal Range obtained from the hourly measures of the different elements shows a variation throughout the year at Agincourt having a maximum value in Horizontal Force of 97 gammas in August 1917 and a minimum of 33 gammas in February 1918. In Vertical Force a maximum of 51 gammas in August 1917, and a minimum of 9 gammas in January 1918, in Declination a maximum of 17·1 in August 1917 and a minimum of 7·2′ in December 1917, whilst at Meanook it shows in Declination a maximum of 21·5′ in July 1917 and a minimum of 6·3′ in January 1918.

At Meanook the instrument was remounted on a slate base on August 27th, and since then the base line value has kept fairly constant.

Phenological Observations, 1917

The following report on the phenological observations of 1917 is presented by Mr. F. F. Payne of the Central Office of the Meteorological Service.

"Throughout Canada vegetation was slow in developing and the flowering of plants was unusually late. This was more especially the condition in British Columbia, Alberta, Ontario and Quebec."

"Somewhat more interest was shown in the phenological observation of 1917 than in the previous year and the number of reports received was forty-five. Of these several were from new observers whilst a few previous contributors failed to report. In Saskatchewan more interest in the work is shown by school children and teachers, and we are indebted to Mr. W. H. Magee, Inspector of Schools, for seven reports from his section."

"Excellent schedules as usual have been received from Nova Scotia and great credit is due Dr. A. H. Mackay, Superintendent of Education, and his assistants, for the care shewn in the selection from about 450 reports received from which these schedules were computed. These are given with average dates in a separate table."

"The Province of Nova Scotia is divided into its main climatic slopes or regions which are not in some cases co-terminous 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 of Slopes	Belts
I.	Yarmouth and Digby Counties......	(a) Coast, (b) Low inlands, (c) High inlands.
II.	Shelburne, Queens & Lunen'g Co's...	" "
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.W....................	(a) Coast, (b) Inlands.
VII.	North'rland Sts. Slopes (to the north)	(a) Coast, (b) Low Inlands (c) High Inlands.
VIII.	Richmond & Cape Breton Co.'s.....	" "
IX.	Bras 'Or Slope (to the southeast).....	" "
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.
Lionel Stevenson, Sydney, B.C.
Geo. W. Johnson, Yale, B.C.
A. S. Barton, Victoria, B.C.
Mrs. W. L. Fulton, Halkirk, Alta.
Thomas B. Waite, Ranfurly, Alta.
Ralf J. Good and pupils. Blaine Lake, Sask.
I. F. Stalker and pupils. Denholm, Sask.
L. B. Potter, Eastend, Sask.
R. H. Carter, Fort Qu'Appelle, Sask.
Geo. Lang, Indian Head, Sask.
R. A. Sim, Noremac, Sask.
Miss E. M. O. Seaboyer and pupils, North Battleford, Sask.
Miss Olive Parker and pupils, Oldbury, Sask.
Miss M. E. Brown and pupils, Babbit Lake, Sask.
C. W. Bryden, Shellbrook, Sask.
Mrs. Helena Graham and pupils, Wanganui, Sask.
Ernest Symons, Wapella, Sask.
Mrs. R. E. Good and pupils, Windsor Lake, Sask.
William Irvine, Almasippi, Man.
C. I. Baragar, Elm Creek, Man..
Miss M. R. Dutton, Gilbert Plains, Man.
Patients and staff of Manitoba Sanatorium. Ninette, Man.
A. Goodridge, Oak Bank, Man.
Jas. D. Plaice, Rapid City, Man.
John Hollingworth, Beatrice, Ont.
Rev. Charles J. Young, Brighton, Ont.
Miss Mary Moffitt, Cape Croker, Ont.
Dr. Parfitt, Gravenhurst, Ont.
W. E. McDonald, Lucknow, Ont.
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.
Brother Dentonin, Beauceville, Que.
A. C. Gorham, Macdonald College, Que.
R. J. Mowat, Dalhousie, N.B.
Maple Ridge School, Maple Ridge, N.B.
Miss Rawena Waye, Charlottetown, P.E.I.

PHENOLOGICAL OBSERVATIONS, CANADA, 1917

Day 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 1917	When becoming common											
Agassiz, B.C.	Alberni, B.C.	Atlin, B.C.	Fort St. James, B.C.	Princeton, B.C.	Quesnel, B.C.	Sydney, B.C.	Summerland, B.C.	Victoria, B.C.	Halkirk, Alta.	Ranfurly, Alta.	Blaine Lake, Sask.		Agassiz, B.C.	Alberni, B.C.	Atlin, B.C.	Fort St. James, B.C.	Princeton, B.C.	Quesnel, B.C.	Sydney, B.C.	Summerland, B.C.	Victoria, B.C.	Halkirk, Alta.	Ranfurly, Alta.	Blaine Lake, Sask.
145		131		106		95	98					1. Alder (Alnus incana).....Shedding pollen	148				109		105					
173					188	130	174			188		2. Canada Thistle (Cirsium arvense) Fl'w'rng	181	197					140	181				
							125					3. Trailing Arbutus (Epigæa repens) "												
114	110	151	158	128	128	100	122	74	146	143		4. Dandelion (Taraxacum officinale) "	120						115		103	150	150	
92	115	154	151	124	125	98		66	138	134		5. Violet, Blue (Viola palmata cucullata) "	100				128		118		91		139	
	125			129	130	111		78		144		6. Violet, White (Viola blanda).... "		127			140		115		94		147	
144	144	171	158	157		122	144			165		7. Columbine (Aquilegia).......... "	153				165		132					
115	131		130	131	108	125	121	102	134	134		8. Trees appear green.....................	127				147				121		140	
147	148			171	144	144	152	152		179		9. Red Clover (Trifolium pratense) Flowering	160				181		154	161	163			
134	150			166	139	130	134	152		140		10. White Clover (Trifolium repens) "	145				171		151	140	163		147	
	140			158	194	130				164		11. Wild Raspberry (Rubus strigosus) "					200		135				171	
124	126			131		109	135	112		131	144	12. Cultivated Currant (Ribes rubrum) "	126				201		113		119		135	146
150		172		152	156	139	146	146	176	165		13. Wild Rose (Rosa)........ "	159				166		152	151	152	182	171	
92	106					91		112				14. Trillium (Trillium)......... "	97	115					93		119			
149		110		150		88			118	121	121	15. Anemone (Anemone)....... "	162						93			123	125	125
144	124					118		114		132		16. Maple (Acer)......... "	149	130					121		121		136	
128	126	160	149	130	121	124	130	119	145	128	139	17. Strawberry Wild (Fragaria Virginiana)...	134	130			139		128			150	132	145
166	125		163	158	156	185	154	152	182	189	170	18. Strawberry Wild (Fragaria Virginiana) Fruit ripe..........................	172			186			189		166	182	196	
74	68					74		71		125		19. Crocus, Cultivated (Crocus) Flowering	85						79		79			
132	148			166	143	136	145	140		151		20. Lilac (Syringa vulgaris)......... "	140	151			170		140	151	144		162	
129	140			147		135	129	130		140		21. Apple (Pyrus malus)........... "	139	144			151		138	135	136		144	
114	130					130	133	118		163		22. Plum, Cultivated (Prunus domestica) "	126						135	135	124		167	
	137					130				140	142	23. Cherry, Wild (Prunes)...... "		144									145	146
120	126					125	126	115		142		24. Cherry, Cultivated (Prunus cerasus) "	128	135					130	127	122		146	

135	126			103	110	132	96	99	132	161		25. Buttercup (Ranunculus acris)... "	146	140			115	120	140		104	132	165	
154										169		26. Yellow Pond Lilly (Nuphar advena) "	161										176	
148	162						155		152	166	166	27. Blue-eyed Grass (Sisyrinchium) "	155									163	171	172
	141			140		132	121			144	139	28. Saskatoon (Amalanchier Canadensis)"		144			143		135	127			148	145
216				203	165	181	203		198	196		29. Golden Rod (Solidago)..... "	222				208		191			203	201	
		122	102		172		79		96	100	95	30. Wild Geese..........................									126	99	103	
		106	103		104				99	100		31. Wild Ducks..........................					79					103	102	
69		122	100	75	85				130	104	99	32. Robins (Merula).................	93				91						106	
85				75					109	146	98	33. Meadow Larks (Sturnella)........					99						150	
95		108	95	76	91	79	74			212		34. Blue Birds (Sialia sialis)................	100					117		84				
		133								65		35. Flickers or Golden Woodpeckers (Colaptes auratus)..........................					106						110	
				95		79				103	127	36. Song Sparrows (Melospiza fasciata)......					145				105		110	
138	96	134	133	138	119	91	98	70		136		37. Swallows (Clivicola riparia).............	146	98						105	105		140	
			93							95		38. Juncoes (Junco hyemalis)...............											97	
	156											39. Orioles (Icterus galbula)................												
	118					100	146			138	124	40. King Birds (Tyrannus tyrannus).........											142	
121	105	132		121	138	100	127	105		160		41. Humming Birds (Trochilus colubris).....	135	115							121			
91	67	132		117	139	78	103			118	107	42. Frogs Piping..........................		100			118				93	124	120	
89				113		69	89					43. Earth Worm Casts (frost out of ground) .												
		152	138						130	129		44. Lakes Open..........................											134	
			115	97	106		79					45. Rivers Open..........................												
74			125	111	102		86	60	106	120	110	46. Ploughing..........................					114				79		126	115
106	69	126	127	115	121	84	109	91		118	116	47. Sowing..........................	117				122		130		102		125	121
165	174		181	186	196	172	165	152	197	206		48. Hay Cutting..........................	185				190				166	200	211	
219	228		256	226	244	191	201		232	239	218	49. Grain Cutting..........................	227	237			230					235	246	225
113	74	132	267	111	134	84	118	60	134	142		50. Potato Planting........................	125				128		135		91	142	149	

II. Phenological Observations, Canada, 1917

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

January	31	July	212
February	59	August	243
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When first seen												Year 1917	When becoming common											
Denholm, Sask.	Eastend, Sask.	Fort Qu'Appelle, Sask.	Indian Head, Sask.	Noremac, Sask.	North Battleford, Sask.	Oldbury, Sask.	Rabbit Lake, Sask.	Shellbrook, Sask.	Wanganui, Sask.	Wapella, Sask.	Windsor Lake, Sask.		Denholm, Sask.	Eastend, Sask.	Fort Qu'Appelle, Sask.	Indian Head, Sask.	Noremac, Sask.	North Battleford, Sask.	Oldbury, Sask.	Rabbit Lake, Sask.	Shellbrook, Sask.	Wanganui, Sask.	Wapella, Sask.	Windsor Lake, Sask.
												1. Alder (Alnus incana).....Shedding pollen												
			173									2. Canada Thistle (Cirsium arvense) Fl'w'ng			189	193								
												3. Trailing Arbutus (Epigæa repens) "												
139		137	135		144	158		139				4. Dandelion (Taraxacum officinale) "	144		144	140		147			142		145	
	145	135	136	145			122	103		135		5. Violet, Blue (Viola palmata cucullata) "			144	141	152			131	105		142	
		139	152							144		6. Violet, White (Viola blanda).... "			150	156								
			176									7. Columbine (Aquilegia)... "				185								
	135	131	137				134	133		132		8. Trees appear green.....................			138	145				135	134		135	
		167	130									9. Red Clover (Trifolium pratense) Fl'wring				196								
			175									10. White Clover (Trifolium repens) "				182								
	175		157									11. Wild Raspberry (Rubus strigosus) "				160								
144	145	140	145			132						12. Cultivated Currant (Ribes rubrum) "				147		209						
181	168	154	154	159	167	174			152		163	13. Wild Rose (Rosa)......... "	200		165	171	171	178	176			163		166
												14. Trillium (Trillium)....... "												
119	121	113	116	116	118	115	114	121	122		123	15. Anemone (Anemone)....... "			123	121	118	124	122	91	124	126		125
	134		136									16. Maple (Acer)............. "				140								
138	145	136	145		138	139	135	139	157	135	138	17. Strawberry Wild (Fragaria Virginiana)...	143			147		141		140	142	162	140	139
147			157		167						175	18. Strawberry Wild (Fragaria Virginiana)												
												Fruit ripe.........................				161								
			135									19. Crocus, Cultivated (Crocus) Fl'w'rng				140								
	171		157									20. Lilac (Syringa vulgaris)......... "				163								
			153									21. Apple (Pyrus malus)........... "				158								
	161		142									22. Plum, Cultivated (Prunus domestica)"				145								
138	147	142	148		139			145	155	140	140	23. Cherry, Wild (Prunes)..... "	143		144	151		147					145	142
	166											24. Cherry, Cultivated (Prunus cerasus) "												

			186							130		25. Buttercup (Ranunculus acris) . . . "				193								
												26. Yellow Pond Lilly (Nuphar advena) "												
176		140	191		159	160			164			27. Blue-eyed Grass (Sisyrinchium) "				201						167		
138	145	139	142		139	144			145	143		28. Saskatoon (Amalanchier Canadensis)"	143		144	146		147				152	145	
250			203			209						29. Golden Rod (Solidago) . . . . . "				217								
110	93	95	93	98	68		101	127		90	100	30. Wild Geese			110	102	105			111			94	
	93	98	95	98			95	112		99		31. Wild Ducks		99	105	100	110			109			104	
119	96	87	98	112	97		105	109		98	110	32. Robins (Merula)			105	104				115			104	
98	92	88	91	98			90	112		94	101	33. Meadow Larks (Sturnella)			105	96	105			104			96	
	93		115	105						98		34. Blue Birds (Sialia sialis)		103										
	108	108	120				117			103		35. Flickers or Golden Woodpeckers (Colaptes auratus)			123	126				119			107	
	99	99	118	130	102		118			98		36. Song Sparrows (Melospiza fasciata)		101		123	135						101	
	152	152	153							144		37. Swallows (Clivicola riparia)		153		155								
127	94	88	87	96	95			109				38. Juncoes (Junco hyemalis)		96	133	95	112							
		139	139									39. Orioles (Icterus galbula)			144	142							140	
129	147	138	145							102		40. King Birds (Tyrannus tyrannus)		157	144	146								
			157									41. Humming Birds (Trochilus colubris)				161								
110	110	103	114	106	118		114	117		116		42. Frogs Piping				117	110			119			119	
	102		130									43. Earth Worm Casts (frost out of ground)				140								
		121	136									44. Lakes Open												
	110	121	110									45. Rivers Open												
120		113	122	110	109	116	111	113	116	122	113	46. Ploughing			114	130		117	120	114			125	115
121	131	119	122	116	115	118	115	120	119	126	121	47. Sowing			119	128		121	120	121				125
	193	164	193	197				197		222		48. Hay Cutting				196	201				204			
	227	228	227	226	226	223	244	227	217	236	227	49. Grain Cutting			232	232	233	229	227	247				
	134	140	140	142			124	144		140		50. Potato Planting					145			129	147		146	

III. Phenological Observations, Canada, 1917

Year 1917

Day 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												When becoming common											
	Almasippi, Man.	Elm Creek, Man.	Gilbert Plains, Man.	Ninette, Man.	Oak Bank, Man.	Rapid City, Man.	Beatrice, Ont.	Brighton, Ont.	Cape Croker, Ont.	Gravenhurst, Ont.	Lucknow, Ont.	Perth, Ont.	Almasippi, Man.	Elm Creek, Man.	Gilbert Plains, Man.	Ninette, Man.	Oak Bank, Man.	Rapid City, Man.	Beatrice, Ont.	Brighton, Ont.	Cape Croker, Ont.	Gravenhurst, Ont.	Lucknow, Ont.	Perth, Ont.
1. Alder (Alnus incana)..... Shedding pollen			144				154					115			152									115
2. Canada Thistle (Cirsium arvense) Fl'w'rng	197		191			212					200	187	201		201								206	196
3. Trailing Arbutus (Epigæa repens) "																								
4. Dandelion (Taraxacum officinale) "	139	134	137		138	136	125	123	124		125	124	142	145	152	139	146	138	153	130	139	135	135	135
5. Violet, Blue (Viola palmata cucullata) "	140		135	132		132	118	136	121		138	132	149		152			137			145	136	143	134
6. Violet, White (Viola blanda)..... "	146		133	130		136		158		128	139	132	149		152			141		158			147	134
7. Columbine (Aquilegia).... "			186	179				155				155								155	161			160
8. Trees appear green....................	130	140	140	133	134	139	133	148	121	127	139	131	134	152	152						139	137		139
9. Red Clover (Trifolium pratense) Flowering			150		185			164	172		169	136			161					165	176		180	170
10. White Clover (Trifolium repens) "			148					164	162		163	136			161					165	174		175	170
11. Wild Raspberry (Rubus strigosus) "			166					170			168				171								176	
12. Cultivated Currant (Ribes rubrum) "		157	164			153					151	115			171			156	150		151		155	145
13. Wild Rose (Rosa)......... "	169	157	170		166	166		168				175	171		182			170			166			177
14. Trillium (Trillium)........ "								130	127		127	141									135	135	136	135
15. Anemone (Anemone)....... "	133	119	122	91		119		168	135			172	135	127	132	105		121			169			175
16. Maple (Acer)........... "			156					138			137	110			161						149	147	141	120
17. Strawberry Wild (Fragaria Virginiana)...	141	140	137	136		142		136			132	132	146		152			145			144		140	141
18. Strawberry Wild (Fragaria Virginiana) Fruit ripe..........................			179					170	168		176	172			186						179		179	176
19. Crocus, Cultivated (Crocus) Flowering		127	145							108	100	108		134	154							110	108	108
20. Lilac (Syringa vulgaris)......... "		153	166			168		159		156	157	157			181			171	158	166	170	159	164	159
21. Apple (Pyrus malus)........... "		147	166					152	164		157	152		152	179					164	169	156	160	154
22. Plum, Cultivated (Prunus domestica) "		147	164					151	161		151	145		152	179					161	163		154	146
23. Cherry, Wild (Prunus)..... "	144	146	144	138	157	145		147		151	151	156	146	146	152			147	150		152		154	159
24. Cherry, Cultivated (Prunus cerasus) "			161					149			147	145			153					150	154		150	150

123	112	133	121		127		165	134			156	25. Buttercup (Ranunculus acris)... "	127	121	148			129		166	160			161
							172					26. Yellow Pond Lily (Nuphar advena) "								176				
		156		176	162		164	169			157	27. Blue-eyed Grass (Sisyrinchium) "			161			164		164	174			160
138	132	143	136	140	175							28. Saskatoon (Amalanchier Canadensis) "	144	140	152			146						
		201		236	210					185	189	29. Golden Rod (Solidago) ..... "			206			213	239				194	
89	89	97	89	106	88			92	108		96	30. Wild Geese..........................	96	95	104		120	97			108			
89	98	99	83		98		80	83	108		91	31. Wild Ducks..........................	96	106	104			102		91	108			
102	113	103	99	125	100		83	80	79	80	82	32. Robins (Merula)..................	105	121	116			103		84	94	90	83	84
96	88	99	93	126	92	114	84	81	98	81	93	33. Meadow Larks (Sturnella).........	105	100	104			99		107	94			93
130		148			100		84	85	93	81	84	34. Blue Birds (Sialia sialis)................	135		154					98	105			91
108	117	103					108		110		106	35. Flickers or Golden Woodpeckers (Colaptes auratus).........................	115	122	116					110		128		110
95		118					85	88	90	82	83	36. Song Sparrows (Melospiza fasciata)......	100		125					89	99			85
		123	135				130	124			105	37. Swallows (Clivicola riparia).............			134					137	138	147		118
95		98	91				99				85	38. Juncoes (Junco hyemalis)...............	100		106					101	97	82		93
136	153	140			152		139	149	147	137	150	39. Orioles (Icterus galbula)................	139		152					145	151			141
96	145	135			144		141	144		138	139	40. King Birds (Tyrannus tyrannus)........	100		148					147	148			144
165	152	176					158	145	138		147	41. Humming Birds (Trochilus colubris).....	169	159	183									148
105	101	115	132	105	109		85	85	107	85	94	42. Frogs Piping..........................	113	108	123			113		103	98	109	94	106
111	112	108						102	110		91	43. Earth Worm Casts (frost out of ground)...	113		118						117			91
		148	128				98		111		110	44. Lakes Open............................									116			
98		113			94	103	78	83			86	45. Rivers Open...........................			123									
104	109	104	97		109	108	117	110		106	113	46. Ploughing.............................	108	120	116			110			121	113	111	121
104	110	108			110	110	125	108		113	118	47. Sowing...............................	108	120	120	121		113			123			128
197	191	201			205	202	188	180		186		48. Hay Cutting...........................	199	206	211			207		194			204	
219	222	226			229	239						49. Grain Cutting.........................	222	227	237			230						
127	140	131	110		139	141	144	143			129	50. Potato Planting........................	135	148	114			139		159	165		149	145

IV. Phenological Observations, Canada, 1917

Year 1917

Day 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										When becoming common								
Port Dover, Ont.	Queensboro, Ont.	Toronto, Ont.	Abitibi, Que.	Beauceville, Que.	Macdonald College, Que.	Dalhousie, N.B.	Maple Ridge, N.B.	Charlottetown, P.E.I.		Port Dover, Ont.	Queensboro, Ont.	Toronto, Ont.	Abitibi, Que.	Beauceville, Que.	Macdonald College, Que.	Dalhousie, N.B.	Maple Ridge, N.B.	Charlottetown, P.E.I.
115	107	94	148	110	113	147	91	71	1. Alder (Alnus incana) ... Shedding pollen		110	100		130		152		79
181	193							228	2. Canada Thistle (Cirsium arvense) ... Flowering		199							242
140		118		116		134	113	114	3. Trailing Arbutus (Epigæa repens) ... "	147		127				138		120
109	115	126	172	137	125	144		124	4. Dandelion (Taraxacum officinale) ... "		133	135		151		153		130
104		134		128	145	151	126	154	5. Violet, Blue (Viola palmata cucullata) ... "	110	140	137		136		153		167
108		134		130		143	125	154	6. Violet, White (Viola blanda) ... "	115	140	169		139		148		160
179		155		166				180	7. Columbine (Aquilegia) ... "	186	147	163		171				186
152	136	145	158	140	139	154		157	8. Trees appear green ...	157	141			152		158		160
155		176		168				191	9. Red Clover (Trifolium pratense) ... Flowering	160	173	178		176				201
159		171		173				180	10. White Clover (Trifolium repens) ... "	163	173	176						184
161		171				176		165	11. Wild Raspberry (Rubus strigosus) ... "		173	176				182		176
171	141	138				163		158	12. Cultivated Currant (Ribes rubrum) ... "		148	143				166		166
176		176		181		196		183	13. Wild Rose (Rosa) ... "			182		188		201		193
137	120	135		130	122	145		155	14. Trillium (Trillium) ... "	139	140	138		141		153		169
131	157	134		137					15. Anemone (Anemone) ... "	138	161	140						
135	136	97			100	144		154	16. Maple (Acer) ... "		144	105				147		161
138	128	134		140	138	141		159	17. Strawberry Wild (Fragaria Virginiana) ...		140	139		152		152		171
174	164	176	171	182	145	176		190	18. Strawberry Wild (Fragaria Virginiana) ... Fruit ripe	181	189	181		190		181		210
79	106	99			107	138		115	19. Crocus, Cultivated (Crocus) ... Flowering	84	113	105						121
151	158	159		168	154	171		169	20. Lilac (Syringa vulgaris) ... "	161	162	166		170		174		180
144	153	152		161	156	166		163	21. Apple (Pyrus malus) ... "		157	157		164		171		171
140	140	151			154	168		164	22. Plum, Cultivated (Prunus domestica) ... "		146	156				172		171
135	154	148		159	147	159		162	23. Cherry, Wild (Prunus) ... "		159	150		169		161		171
141		148				162		162	24. Cherry, Cultivated (Prunus cerasus) ... "			157				166		174
158	159	151		165		169		160	25. Buttercup (Ranunculus acris) ... "	161	163	161		171		172		170

181	169							144	26. Yellow Pond Lilly (Nuphar advena) "		173	185						156
155		175		169				156	27. Blue-eyed Grass (Sisyrinchium) "		165			173				167
	143			152					28. Saskatoon (Amalanchier Canadensis) "		147			154				
233		216		210		227		227	29. Golden Rod (Solidago) "		223	222				242		240
79			112		102	92		95	30. Wild Geese	124						104		111
75	116		110					99	31. Wild Ducks	128								111
69	111	80	117		84	105	94	98	32. Robins (Merula)	75	115	90				112		111
72	116	83			84				33. Meadow Larks (Sturnella)	74	120	90						
72	111	84		116	84	142		185	34. Blue Birds (Sialia sialis)	73	115	89				154		196
76		107	112		108			181	35. Flickers or Golden Woodpeckers (Colaptes auratus)	80		120						190
71	114	113		107	85		100	156	36. Song Sparrows (Melospiza fasciata)	76	115	120				138		163
122		120	128		107	118		201	37. Swallows (Clivicola riparia)	129		124				159		204
	116	113			87	88		141	38. Juncoes (Junco hyemalis)		116	120				111		154
176	138	136			148				39. Orioles (Icterus galbula)	186	138	145						
167		152	128			156		178	40. King Birds (Tyrannus tyrannus)			155						196
169	146	147		155		153		191	41. Humming Birds (Trochilus colubris)					157				202
84	91		146		108	125	111	118	42. Frogs Piping	87	98	100				138		131
62	112	105	158	112	105	124	136	106	43. Earth Worm Casts (frost out of ground)		121					135		114
82	90	84	133		108			101	44. Lakes Open		94							110
85		76		110	108	114	102	101	45. Rivers Open		90							110
102		94		123	105	134	90	132	46. Ploughing		121	110		126				143
107		110		142	108	138	115	139	47. Sowing		140	118		165		150		152
184	166	199		227		206	195	215	48. Hay Cutting		197	209				210		225
212	216	220		255		244	227	258	49. Grain Cutting		227							270
130	120	132		139	135	138	96	139	50. Potato Planting		144	140		164	145	144		150

V. Phenological Observations, Canada 1917

Year, 1917

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

Plant	I. Yarmouth and Digby Counties, N.S.	II. Shelburne, Queens and Lunenburg 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. Chignecto and Cobequid Slopes, N.S.	VIB. Chignecto and Cobequid Slopes, N.S.	VII. Northumberland Sts. Slope, N.S.	VIII. Richmond and Cape Breton Counties, N.S.	IX. & X. Bras d'Or and Inverness Slope, N.S.	Average Dates, N.S.
1. Alder (Alnus incana, Wild)	110	106	109	106	129	123	104	114	128	107	113
2. Aspen (Populus tremuloides)	124	117	161	118			127	134	121	120	127
3. May Flower (Epigea repens, L.)	95	100	105	109	107	115	111	110	118	125	109
4. Field Horsetail (Equisetum arvense)	115	124	127	129	126	120	134	138	145	131	128
5. Blood Root (Sanguinaria Canadensis)		121	129	126			153	141	135	122	132
6. White Violet (Viola Blanda)	119	123	132	130	129	123	131	135	131	140	129
7. Blue Violet (Viola palmata, *cucullata*)	122	127	135	133	131	134	137	139	137	143	133
8. Hepatica (Hepatica triloba, etc.)	140	125	124					129		166	136
9. Red Maple (Acer rubrum)	130	135	132	133	132		141	141	140	141	137
10. Strawberry (Fragaria Virginiana)	124	127	131	131	129	130	132	136	133	138	131
11. Strawberry (Fragaria Virginiana) Fruit ripe	169	170	171	170	174	169	175	174	174	178	172
12. Dandelion (Taraxacum officinale)	124	129	136	134	136	136	143	141	139	143	136
13. Adder's Tongue (Erythronium Americanum)		143	143	132	144	138	142	138	158	142	142
14. Gold Thread (Coptis trifolia)	130	135	147	142	137	140	145	145	148	146	141
15. Spring Beauty (Claytonia Caroliniana)	115	121	129	135	145	121	141	137	144	142	133
16. Ground Ivy (Nepeta Glechoma)	148	136	149	142	142	143	138	154	152	157	146
17. Indian Pear (Amelanchier Canadensis	146	147	151	151	147	155	154	154	157	157	151
18. Indian Pear (Amelanchier Canadensis Fruit ripe							228				228
19. Wild Red Cherry (Prunus Pennsylvanica)	154	154	155	156	156	162	157	159	162	164	158
20. Wild Red Cherry (Prunus Pennsylvanica) Fruit rip			159		246		230		226		217
21. Blackberry (Vaccinium Can. and Penn)	141	146	156	154	155	156	159	158	162	161	155
22. Blackberry (Vaccinium Can. and Penn) Fruit ripe		180	211	219	216		215		226		211
23. Tall Buttercup (Ranunculus acris)	155	156	159	153	161	151	164	163	165	167	159
24. Creeping Buttercup (R. Repens)	168	159	167	164	163	165	168	168	169	166	166
25. Painted Trillium (Trill. erthyrocarpum)	149	152	150	150	151	150	153	155	157	179	155

When becoming common

Plant	Average Dates, N.S.	I. Yarmouth and Digby Counties, N.S.	II. Shelburne, Queens and Lunenburg 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. Chignecto and Cobequid Slopes, N.S.	VIB. Chignecto and Cobequid Slopes, N.S.	VII. Northumberland Sts. Slope, N.S	VIII. Richmond and Cape Breton Counties, N.S.	IX. & X. Bras d'Or & Inverness Slope, N.S.
1. Alder (Alnus incana, Wild)	121	117	112	118	109	134	147	110	120	133	113
2. Aspen (Populus tremuloides)	127	130	128	117	121			134	132	126	128
3. May Flower (Epigea repens, L.)	118	106	109	114	116	116	124	118	121	125	133
4. Field Horsetail (Equisetum arvense)	133	119	127	128	135	132	123	138	144	149	132
5. Blood Root (Sanguinaria Canadensis)	137		126		130			159	146	138	126
6. White Violet (Viola Blanda)	141	128	130	144	138	135	132	138	141	138	147
7. Blue Violet (Viola palmata, *cucullata*)	141	133	134	143	139	138	142	144	145	145	147
8. Hepatica (Hepatica triloba, etc.)	143	138	128	149					134		169
9. Red Maple (Acer rubrum)	144	141	140	141	140	145	144	146	146	147	148
10. Strawberry (Fragaria Virginiana)	142	136	136	142	141	142	145	145	146	144	146
11. Strawberry (Fragaria Virginiana) Fruit ripe	178	178	178	176	179	177	181	179	179	180	178
12. Dandelion (Taraxacum officinale)	143	138	136	143	142	145	139	149	144	146	149
13. Adder's Tongue (Erythronium Americanum)	150	165	155	153	139	148	143	148	144	162	144
14. Gold Thread (Coptis trifolia)	149	138	142	140	177	143	145	150	152	152	151
15. Spring Beauty (Claytonia Caroliniana)	143	129	130	148	143	147	128	150	142	150	159
16. Ground Ivy (Nepeta Glechoma)	154	161	142	159	151	147	147	143	160	159	169
17. Indian Pear (Amelanchier Canadensis	157	156	153	156	155	155	161	157	159	159	160
18. Indian Pear (Amelanchier Canadensis Fruit ripe	232							228	224	244	
19. Wild Red Cherry (Prunus Pennsylvanica)	163	160	159	161	161	161	167	161	163	167	166
20. Wild Red Cherry (Prunus Pennsylvanica) Fruit rip	243					250			237	242	
21. Blackberry (Vaccinium Can. and Penn)	161	153	152	161	161	163	160	164	163	167	168
22. Blackberry (Vaccinium Can. and Penn) Fruit ripe	228			220	242	223			220	235	
23. Tall Buttercup (Ranunculus acris)	165	163	162	166	166	159	160	167	168	171	172
24. Creeping Buttercup (R. Repens)	169	173	163	174	169	169	158	170	173	172	171
25. Painted Trillium (Trill. erthyrocarpum)	159	157	157	156	158	159	155	158	160	162	167

153	157	161	161	157	160	163	159	165	165	160	26. Rhodora (Rhododendron Rhodora)	166	160	162	165	165	163	163	166	164	171	178
153	154	157	157	158	154	159	161	161	166	158	27. Pigeon Berry (Cornus Canadensis)	163	160	160	160	162	162	159	164	166	166	167
		164	245	175			216	213		202	28. Pigeon Berry (Cornus Canadensis .... Fruit ripe	205			164	245	180			220	218	
153	158	155	154	158	155	162	158	157	161	157	29. Star Flower (Trientalis Americana)	163	158	164	162	160	164	163	165	163	163	169
156	157	158	163	161	162	166	162	166	165	162	30. Clintonia (Clintonia borealis)	169	162	163	164	168	169	165	169	168	171	169
156	165	163	166	163	165	160	168	160	164	163	31. Marsh Calla (Calla palustris)	168	163	172		171	165	167	167	173	166	168
162	159	164	164	157	164	166	168	169	171	164	32. Lady's Slipper (Cypripedium acaule)	168	167	165	169	160	163	167	167	172	175	175
163	165	165	165	164	169	163	168	168	174	166	33. Blue-eyed Grass (Sisyrinchium augustifol)	172	173	171	169	170	169	171	171	172	173	177
168	169	165	172	169	171	172	175	164	168	169	34. Twinflower (Linnæa borealis)	174	172	174	170	174	174		176	178	171	175
164	161	160	163	165	165	163	168	163	169	164	35. Pale Laurel (Kalmia glauca)	169	172	166	168	170	171	169	167	174	162	172
169	170	163	168	171	168	165	137	168	172	165	36. Lambkill (Kalmia augustifolia)	172	173	171	168	172	175	175	167	172	173	177
168	167	166	170	169	170	167	167	171	172	169	37. English Hawthorn (Cratægus oxyacantha)	172	173	172	173	169	174	171	170	173	174	170
168	168	167	172	169		168	167	168	171	168	38. Scarlet fruited Thorn (Cratægus coccinea, etc.)	172	172	173	171	174	172		171	171	172	172
167	169	172	171	169	177	172	171	175	173	172	39. Blue Flag (Iris versicolor)	176	173	174	176	175	174	180	175	176	180	178
169	169	171	171	172	170	174	172	174	173	171	40. Ox-eye Daisy (Chrysanthemum Leucanthi)	176	173	174	175	176	177	176	179	177	179	177
175	171	173	167	173		174	173	174	173	173	41. Yellow Pond Lily (Nuphar advena)	176	177	172	179	173	177		178	179	179	177
171	168	162	163	167	159	173	162	164	162	165	42. Raspberry (Rubus strigosus)	170	173	173	168	171	172	164	175	167	170	167
	211		208	222			210			212	43. Raspberry (Rubus strigosus) .... Fruit ripe	229		215			227			216	232	
169	172	178	178	182			175	177		176	44. Yellow Rattle (Rhinanthus Crista-galli)	179	176	177		180	186			178	179	
174	172	173	167	167	162	171	167	163	169	168	45. High Blackberry (Rubus villosus)	174	178	173	179	170	171	172	175	173	169	180
245		173		230		233	232	244		223	46. High Blackberry (Rubus villosus) .... Fruit ripe	232			177	247	238		240	242	249	
173	171	176	172	175	177	170	171	174	175	173	47. Pitcher Plant (Sarracenia purpurea)	177	175	176	177	177	178	180		175	179	179
172	174	153	167	181	135	179	175	224		167	48. Heal All (Brunella vulgaris)	175	180	180	160	167	189			177	178	
175	173	173	179	176	177	178	177	209		179	49. Common Wild Rose (Rosa lucida)	183	179	180	174	180	177	179		177	215	
172	171	165	172	172	176	177	174	168	176	172	50. Fall Dandelion (Leontodon autumnale)	176	172	172	179	176	178	176	180	177	175	179
163	168	170	166	173		164	172	164		167	51. Butter-and-Eggs (Linaria vulgaris)	171	163	171		170	178		169	173	173	
149	144	147	148	143	142	152	148	144	151	147	52. Expanding Leaves (Trees appear green)	158	158	153	156	162	155	155	159	157	155	166
152	150	158	120	151	162	160	158	160	159	153	53. Red Currant (Ribes rubrum) (cultivated)	163	157	157	161	159	158	168	164	164	170	172
				198			204	231		211	54. Red Currant (Ribes rubrum) .... Fruit ripe	239									239	

V. Phenological Observations, Canada, 1917

Year, 1917

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, Queens and Lunenburg 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. Chignecto and Cobequid Slopes, N.S.	VIB. Chignecto and Cobequid Slopes, N.S.	VII. Northumberland Sts. Slope, N.S.	VIII. Richmond and Cape Breton Counties, N.S.	IX. & X. Bras d'Or and Inverness Slope, N.S.	Average Dates, N.S.
55. Black Currant (R. nigrum) (cultivated)	151	156	156	157	155	165	161	159	161	163	158
56. Black Currant (R. nigrum) Fruit ripe								200	210		210
57. Cherry (Prunus Cerasus)	155	158	157	160	159	164	163	163	163	164	161
58. Cherry (Prunus Cerasus) Fruit ripe					215			209	223		219
59. Plum (Prunus domestica)	163	160	157	162	164	165	165	163	166	165	163
60. Apple (Pyrus Malus)	160	160	160	163	162	168	166	165	166	169	164
61. Lilac (Syringa vulgaris)	169	168	169	167	166	171	169	168	173	175	169
62. White Clover (Trifolium repens)	166	167	168	167	169	167	174	172	170	177	170
63. Red Clover (Trifolium pratense)	156	161	165	168	168	169	174	170	169	170	167
64. Timothy (Phleum pratense)	166	160	167	171	169	170	162	173	170	167	167
65. Potato (Solanum tuberosum)		178			195		179	192	203		186
66. Ploughing (first of season)	102	116	118	128	119	110	114	134	113	122	118
67. Sowing	127	121	137	139	131	131	137	150	137	141	135
68. Potato-planting	113	124	139	142	132	129	138	142	129	135	132
69. Sheep-shearing	135	125	135	130	146	129	116	136	123	123	130
70. Hay-cutting	181	178	157	221	207			207	212		193
71. Grain-cutting	250		240	253	248		239	238	243	241	244
72. Potato-digging	251	236	265	275	273		268	258	264	282	263
73a. Opening of rivers	76	87	112	74	90		90	94	97	113	93
73b. Opening of lakes	86	102		97	101		113	74	107	122	100
74a. Last snow to whiten ground	115	127	125	120	125	125	123	134	125	127	125
74b. Last snow to fly in air	128	131	108	120	131	129	126	137	132	131	127
75a. Last spring frost—hard	123	111	135	95	120		121	134	139	139	124
75b. Last spring frost—hoar	129	132		140	141		147	151	159	134	142

When becoming common

	Average Dates, N.S.	I. Yarmouth and Digby Counties, N.S.	II. Shelburne, Queens and Lunenburg 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. Chignecto and Cobequid Slopes, N.S.	VIB. Chignecto and Cobequid Slopes, N.S.	VII. Northumberland Sts. Slope, N.S.	VIII. Richmond and Cape Breton Counties, N.S.	IX. & X. Bras d'Or & Inverness Slope, N.S.
55. Black Currant (R. nigrum) (cultivated)	164	158	162	164	162	160	170	164	164	164	169
56. Black Currant (R. nigrum) Fruit ripe	214								209	220	
57. Cherry (Prunus Cerasus)	164	163	162	162	163	160	168	166	166	168	167
58. Cherry (Prunus Cerasus) Fruit ripe	222								215	229	
59. Plum (Prunus domestica)	168	171	165	163	165	168	168	167	167	171	173
60. Apple (Pyrus Malus)	169	168	167	168	168	165	173	168	169	170	173
61. Lilac (Syringa vulgaris)	174	173	173	174	172	171	177	173	173	177	175
62. White Clover (Trifolium repens)	174	172	173	174	175	172	176	171	179	175	171
63. Red Clover (Trifolium pratense)	173	167	169	171	172	173	178	179	177	173	176
64. Timothy (Phleum pratense)	174	175	165	172	175	173	179	163	178	176	174
65. Potato (Solanum tuberosum)	186			180		203			192	215	
66. Ploughing (first of season)	128	113	126	130	141	130	119	128	145	122	126
67. Sowing	146	138	131	146	165	136	138	151	156	147	152
68. Potato-planting	144	128	135	148	155	142	135	154	154	141	148
69. Sheep-shearing	140	140	135	143	150	151	149	120	151	135	131
70. Hay-cutting	216					212			215	222	
71. Grain-cutting	253	260		241	243	254		247	246	252	
72. Potato-digging	271	258		271	267	282		275	279	270	298
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											

98	98	114	96	115		94	137	55	107	100	76a. Water in streams—high											
							263			263	76b. Water in streams—low											
248		244	252	246		251	253	261	251	250	77a. First autumn frost—hoar											
255		290	302	283		270	284	286		273	77b. First autumn frost—hard											
307	306	297	313	283		308	309	290	309	302	78a. First snow to fly in air											
308	309	308	317	307		310	312	315	314	311	78b. First snow to whiten ground											
15		332	348	361			327	187		261	79a. Closing of lakes											
22			345	340			331	173		242	79b. Closing of rivers											
91	86	96	84	93	85	86	93	94	98	91	81a. Wild ducks migrating, N.											
312		302	305			254	292	264		288	81b. Wild ducks migrating, S.											
88	87	90	82	85	87	86	86	87	85	86	82a. Wild geese migrating, N.											
302		326	314	96			274	274		263	82b. Wild geese migrating, S.											
84	85	88	89	90	87	83	88	98	95	88	83. Song Sparrow (Melospiza fasciata)	North										
83	85	82	80	86	84	85	85	93	90	85	84. Robin (Turdus migratorius)	"										
89	87	92	89		83	88	94	91	101	90	85. Junco (Junco hiemalis)	"										
	128	134	129	131	144		143	128	117	132	86. Spotted Sandpiper (Actitis macularia)	"										
116	121	130	122	133			131	117		124	87. Meadow Lark (Sturnella magna)	"										
135	123	125	130	125		139	134	125	143	131	88. Kingfisher (Ceryle Alcyon)	"										
139	136	160	144	100	114	114	142	99	139	129	89. Myrtle Warbler (Dendrœca coronata)	"										
139	119	151	141	142	134	132	151	121	155	138	90. Yellow Warbler (D. æstiva)	"										
133	129	129	129	132		109	139	108	136	127	91. White-throated Warbler (Zonotrichia alba	"										
152	147	148	134	161	157	150	156	172	165	154	92. Hummingbird (Trochilus colubris)	"										
123	151	136	148	137	151	142	150	90	137	146	93. Kingbird (Tyrannus Carolinensis)	"										
128		139	144	125	157	152	141	150	159	143	94. Bobolink (Dolychonyx oryzivorus)	"										
136	151	153	140	139	158	156	158	126		146	95. American Goldfinch (Pyrinis tristis)	"										
144	158	164	145	144	144		162		157	152	96. American Redstart (Setophaga ruticilla)	"										
120	157	154	163	147	152	163	160			152	97. Cedar Waxwing (Ampelis cedrorum)	"										
114	151	146	152	144	157		140	151	155	145	98. Night Hawk (Chordeiles Virginianus)	"										
100	103	107	106	110	110	109	106	111	118	108	99. First piping of rogs	"										
102	107	119	123	128	119	127	124	125	137	121	100. First appearance of snakes	"										

APPENDIX C

DEPARTMENT OF THE INTERIOR, FORESTRY BRANCH

FOREST PRODUCTS LABORATORIES

BY

DR. J. S. BATES,
Superintendent of Laboratories

Work of the Forest Products Laboratories of Canada for Year Ending March 31st, 1918.

The Forest Products Laboratories in connection with the Forestry Branch of the Department of the Interior have continued a number of the investigations that were under way last year, but have not been able to develop any special new lines of investigation owing to the shortage of men and money consequent on the war conditions. The work under way has, however, been kept up and the development in the main lines of special investigation that have been carried out are detailed as follows:

Testing Clear Specimens

The staff of the Timber Testing Division, greatly depleted in size on account of the war, was occupied for the entire year on the testing of Nova Scotia mine timbers. Samples of black spruce, "gray" spruce, white spruce, white pine and red pine have been air drying since last year and will be ready for test early this coming summer. The testing of the corresponding green material was finished last year. After many delays Forestry Branch Bulletin No. 60, Canadian Douglas Fir, has been received from the printer and is available for distribution. This publication is of particular interest since it not only deals with our most important species but it is also the first publication of a series which will eventually be produced and which will cover all Canadian woods.

Nova Scotia Mine Timbers

Strength tests on 270 props and booms of black spruce, red spruce, balsam fir, yellow birch, white birch and jack pine were completed in 1915. Corresponding samples were allowed to season in our yard until air dry and were tested during the past year. Half of the samples were seasoned with the bark on, and the other half were peeled. Both lots were under exactly the same conditions so that some very interesting and valuable data have been derived from this part of the work. All the testing in connection with this investigation is now complete and it only requires that the data be analysed and put in shape for publication to complete our share of the work. Sixty booms in 12-foot lengths and 152 props in 6-foot lengths have been tested since last report.

Drying of Wood

Working with oven dried samples of the heart and sap wood of black spruce, white spruce, red pine, white pine, and heart wood of Douglas fir, the rate of absorption of moisture of these woods in an atmosphere saturated with water vapour was studied and a mathematical expression derived from the data. This mathematical expression takes a rather unexpected form and publication of it is withheld until it can be supported sufficiently by further work. If confirmed, it will be of considerable scientific interest.

Working with green and air dry white spruce, air dry Douglas fir, natural and resin-free Southern pine and sulphite pulp, determinations were made of the moisture content when in equilibrium with atmospheres of various relative humidities from 0 per cent to 100 per cent at temperatures from 35°C to 75°C, and results obtained of practical though not scientific accuracy.

Waste Sulphite Liquor

As planned last year, no experimental work was attempted on waste sulphite liquor, but a great deal of work was done in collecting, abstracting and classyifing the literature of the subject. The compilation of this material was a very much more extensive undertaking than was at first anticipated. The work is now complete and the manuscript—about 400 pages, cap size—has been forwarded for publication as a bulletin. To those interested in the manufacture of pulp and paper, one of the greatest of our Canadian industries, this should prove an extremely valuable book of reference, covering as it does all the available literature of waste sulphite liquor, and the attempts to utilize it. This literature has appeared mostly in the form of short papers scattered throughout the technical literature of the English, Scandinavian, German, and French languages, and it has been all covered up to the end of 1917. It is hoped that this work will prove of help to those working to stop this great waste of valuable material, amounting as it does in Canada to some 2,000,000 gallons per day containing 1,000 tons of organic matter originating from the wood.

Railway Ties

Experimental work was continued on the investigation of the possibilities of preservative treatment of jack pine and hemlock railway ties. It was found possible to give a satisfactory creosote treatment to jack pine by methods already in commercial use for other woods, provided that the material is sufficiently dry. A study of the rate of drying of ties under commercial conditions has been started so as to provide data as to the time and expense incurred in bringing the material to a suitable condition for treatment. It was not found possible to secure a satisfactory treatment of hemlock by any means now in use without going beyond the bounds of expense imposed by practical considerations. By means of a new method and apparatus which have been worked out at the Laboratories, however, it has been possible to give a satisfactory treatment to hemlock at a moderate cost. The same system applied to other woods, including jack pine, will give a satisfactory treatment at a much lower cost than now prevails. A patent covering the apparatus used has been applied for and a bulletin descriptive of the work and results is in preparation.

Pulpwood Measurement

In connection with the investigation of the possibilitiies and advantages of the system of barking, chipping, drying and baling pulpwood for shipping to the pulp mills, an installation of a Hess drier in Wisconsin was inspected during a test run and information was obtained at first hand as to the costs and operation of baling presses. This information, together with that previously at hand, led to the conclusion that it should be possible to effect a saving by handling pulpwood in this way under certain circumstances. The work has already borne fruit and the Davison Lumber Company, Bridgewater, N.S., are already using the system on a commercial scale. When the commercial possibilities are sufficiently demonstrated, as we fully expect they will be, the system may be expected to spread to a great extent. Its main value is in making available as pulpwood, material such as slabs which are now wasted, and in opening up districts where species suitable for pulp are now growing, but which are too far from the mills to allow of the pulpwood being shipped under the present system.

Chemistry of Wood

Efficient and reliable methods of analysis of woods have been developed and standardized and preliminary data regarding the composition of black spruce, white spruce, red spruce, balsam fir, jack pine, and poplar have been obtained. A study of the resin content of black spruce, white spruce, balsam fir, hemlock and jack pine and the effect of river driving and of storage on the resin content has been started. Good progress has been made, though it will take at least a year longer for the present staff to complete the work planned. Besides investigating the resin content, the plan also includes a determination of the composition of the wood and an investigation of the factors concerned with seasoning of pulpwood. In addition to the systematic work on pulpwood some analyses have been made of decayed poplar ("punky poplar"). Although this latter work opens up some possibilities of utilization of the waste poplar of the west, further work must be abandoned for the present on account of lack of staff.

Oils for ore Flotation.

While no further work has been done at the laboratories on the investigation of Canadian wood oils as regards their possibilities in connection with ore flotation, it is worth noting here that since the last annual report, the hardwood distillation oils recommended as a result of work of these laboratories in co-operation with the Mines Branch have been tried out commercially and found satisfactory. This result is very gratifying since not only are the mines rendered independent of imported pine oil, but a use has been found for a Canadian product which was previously wasted.

Durability of Wood

Work was continued on the study of decay of wood but no conclusions of value can be drawn as yet. A set of 335 pieces of 12 different species of wood were placed in a specially prepared fungus bed, and will be examined at appropriate intervals to note the comparative rates of deterioration. A specially constructed box was designed and built at the laboratories for the study of the effect of humidity on fungus growth. This is arranged with chambers, each of which can be maintained indefinitely at constant and controllable temperature and humidity. With the aid of this apparatus it is hoped that definite information can be obtained as to the limits of humidity at which the wood-destroying fungi cease to develop.

Fibre Measurements

Work on the measurement of the fibre dimensions of Canadian woods has been continued and studies of the fibre of red pine, white pine, jack pine, white spruce, black spruce, balsam fir, and hemlock have been completed. Approximately 11,000 measurements have been made during the year on these woods and the data obtained cover the variation in length of fibre both at different ages of the tree and at different heights from the ground. Mr. H. N. Lee, who had charge of this work, resigned to take up work on airplane woods for the United States Government before completing the preparation of a paper embodying the results. They will, however, be put into shape and published as soon as possible.

Mémoires de la Société Royale du Canada
SECTION I

Série III — JUIN ET SEPTEMBRE, 1918 — Vol. XII

Les Français dans l'Ouest en 1671.

Par M. Benjamin Sulte, LL.D., M.S.R.C.

(Lu à la réunion de mai 1918).

Avant 1660, tout ce qui est au delà de la baie Georgienne demeurait inconnu, sauf la notion de la baie Verte et du lac Supérieur, celui-ci vu et probablement visité par Brulé et Grenolle dès 1622. De 1660 à 1670, les coureurs de bois se rendaient au fond du lac, parfois aux sources du Mississipi, ainsi qu'à la baie Verte, et enfin remontaient la rivière des Renards. L'intendant Talon jugea que le moment était arrivé d'étendre jusqu'à ces régions lointaines le nom et l'autorité du roi. En 1671 il y eut prise de possession solennelle du pays sans toutefois y inclure la contrée des Sioux, située aux sources du Mississipi, ni rien de plus au sud que le Wisconsin. Le présent article donne une description de l'état général des choses et place les nations sauvages dans leurs foyers respectifs.

Le Père Claude Dablon dit, dans la Relation de 1670, (p. 79, édition de Québec): "Soixante nations (peuplades, tribus volantes) sont gens de la mer du nord (Hudson) comme les Guilistinons et les Ouenibigons, errant dans les terres aux environs de cette même mer, dont la plupart ont été chassés de leur pays par la famine et se rendent au saut Sainte-Marie, de temps en temps, pour y jouir de l'abondance du poisson." Dans sa Relation de 1671 (page 1,) il ajoute: "Cet été, un de nos Pères est parti pour la mer du nord jusqu'où aucun Français n'a encore pénétré, bien résolu de pousser par terre jusqu'à cette fameuse baie d'Hudson."

L'intendant Talon écrivait le 10 novembre 1670: "Je suis dans le dessein de faire passer à la baie d'Hudson, par terre, quelques hommes de résolution[1] pour inviter les Kilistinons, qui sont en grand nombre dans le voisinage de cette baie (baie James) de descendre chez nous ainsi que les Outaouas, afin que nous puissions avoir de la première main ce que ces Sauvages (les Outaouas) nous apportent,

[1] La cause des Français était perdue: en ce moment, Chouart et Radisson entraient dans la baie James sur des navires anglais.

qui, faisant entre ces nations et nous le métier de revendeurs, nous font payer le détour des 300 ou 400 lieues."

On serait porté à croire que Talon eût tenté d'ouvrir ce commerce par la voie du Saguenay, mais, visiblement, il essaye d'attirer les peuplades du nord vers la rivière Ottawa, nommée alors rivière des Outaouas parceque, depuis 1654, ceux-ci la descendaient chaque été pour vendre à Montréal les pelleteries qu'ils achetaient partout autour du lac Supérieur. Les aptitudes commerciales des Outaouas et leur esprit d'organisation pour exécuter ces grands voyages ne se trouvaient nullement chez les Kilistinons, appelés aussi Gens des Terres, de sorte que Talon en fut pour ses frais de négociations diplomatiques. Les Outaouas gardèrent le monopole de la traite. Du côté du lac Ontario les Iroquois en faisaient autant, mais ils portaient leurs pelleteries aux gens de New-York.

Comme toute l'histoire des découvertes et des courses des Français dans l'étendue du Canada actuel se résume en un seul mot: la récolte des fourrures, écoutons ce que l'intendant disait encore dans la même lettre: "Si les observations que j'ai fait faire se trouvent justes, les Anglais de Boston et les Hollandais de Manate (New-York) et d'Orange (Albany) tuent (obtiennent) par les Iroquois et les autres nations sauvages de leur voisinage, plus de douze cent mille livres de castor, presque tous secs et les mieux fournis, dont ils (les Anglais et Hollandais) se servent pour faire partie de leur commerce avec les Moscovites."

N'est-il pas singulier que le castor du Canada trouve un si grand débit chez les Russes qui habitent une contrée riche en fourrures?

Talon continue: "Comme tout ce castor se chasse, par les Iroquois, sur les terres de la domination du roi (de France) ou pour mieux expliquer, sur celles dans l'étendue desquelles il peut seul donner la loi, et où les Européens ne peuvent percer pour peu qu'on prenne la précaution de s'assurer les postes favorables, je trouve beaucoup de joie à faire tourner naturellement et sans violence la meilleure partie de ce commerce au bénéfice des sujets de Sa Majesté."

Retournons à l'ouest. "A huit journées de la Pointe (Chagouamigon,[1] sud-ouest du lac Supérieur) du côté du couchant, est le premier des trente villages des Nadouessi.[2] La grosse guerre[3] qu'ils ont avec nos Hurons et quelques autres nations de ces quartiers, les tient plus

[1] En pointe droite. La baie en forme de V fait un angle aigu dans les terres.

[2] Les Sioux. *Nadoue* l'ennemi.

[3] De 1657 à 1670, ils avaient repoussé au moins quatre fois les Hurons du sud du lac Supérieur qui allaient les surprendre chez eux et cela sans motif, au grand déplaisir des Outaouas et des Français.

resserrés et les oblige à ne venir à la Pointe qu'en petit nombre et comme en embassade." (Le Père Claude Allouez: Relation, 1670, page 86).

"Les Nadouessi, dit le Père Marquette (Relation, 1670, p. 91) sont les Iroquois de ce pays, mais moins perfides et qui n'attaquent jamais qu'après avoir été attaqués. Ils sont au sud-ouest de la mission du Saint-Esprit (Chagouamigon). C'est une grande nation et qu'on n'a point encore visitée,[1] nous étant attachés à la conversion des Outaouas. Ils craignent le Français à cause qu'il apporte le fer en ce pays. Ils ont une langue toute différente de l'algonquine et de la huronne. Il y a quantité de bourgs, mais ils s'étendent bien loin. Ils ont des façons de faire toutes extraordinaires. Ils adorent principalement le calumet, ne disent mot dans leurs festins et, quand quelqu'étranger arrive, ils lui donnent à manger avec une fourchette de bois, comme on ferait à un enfant. Toutes les nations du lac (Supérieur) leur font la guerre, mais avec peu de succès."

Les Sioux[2] habitaient la région des mille lacs sources du Mississipi et comme ils savaient se loger, se nourrir et vivre plus confortablement que les petites bandes algonquines des environs du lac Supérieur, celles-ci cherchaient à les piller. Voilà le genre de guerre que les Sioux, mieux organisés, avaient à subir, sans toutefois la redouter.

"Ils ont de la fausse avoine, se servent de petits canots, gardent inviolablement leur parole. Je leur ai envoyé un présent par l'interprète, pour leur dire qu'ils eussent à reconnaître le Français partout où ils se rencontreraient; qu'ils eussent à ne le point tuer, ni les Sauvages qui l'accompagneraient; que la Robe Noire voulait passer dans le pays des Assinipours et dans celui des Kilistinaux; qu'elle était déjà aux Outagamis (Wisconsin) et que je partais cet automne pour aller aux Illinois (dans l'Iowa) dont ils laisseraient le passage libre. Ils y ont consenti, mais pour ce qui est de mon présent, ils attendaient que tout le monde fut retourné (revenu) de la chasse et (disent) qu'ils se trouveraient cet automne à la Pointe pour m'en parler."

L'hiver de 1669-1670, le même Père mentionnait les Assinipours (Assinipoels) "qui ont quasi la même langue que les Nadouessi. Ils sont vers l'ouest de la mission du Saint-Esprit, à quinze ou vingt journées, sur un lac où ils ont de la fausse avoine et où la pêche est très abondante. J'ai ouï dire qu'il y a dans leur pays (Manitoba) une grande rivière qui mène à la mer de l'ouest et où, me dit un Sau-

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[1] Les missionnaires n'y étaient point allés, mais, dès 1659, Chouart et Radisson y avaient été bien reçus; ensuite les coureurs de bois devaient avoir fréquenté ces villages pour acheter des pelleteries.

[2] Société Royale, 1911, p. 256-259; 1912, p. 29, 30; 1913, p. 81, 85.

vage, qu'étant à l'embouchure il avait vu des Français et quatre grands canots à voile." Cette rivière devait se décharger dans la baie d'Hudson.

Le territoire occupé par les Sioux dépassait au sud les chutes où sont les villes de Saint-Paul et Minneapolis par conséquent les Illinois réfugiés[1] dans l'Iowa se trouvaient leurs voisins. Partant de Chaguamigon, tirant à l'ouest et même au sud-ouest on traverse le pays des Sioux et le commencement du Mississipi qui est fort étroit; puis, allant au sud en ligne droite, on arrive à l'Iowa, nouvelle patrie des Illinois, où le fleuve est très large; c'est pour éviter cette dernière traversée que le missionnaire voulait passer par le pays des Sioux.

Les Sauvages de Chagouamigon s'étant dispersés après les fêtes de Pâques de 1670 pour aller chercher à vivre, le Père Marquette se proposait de pénétrer dans la région de l'Iowa pour commencer une mission chez les Illinois, projet qui ne fut pas exécuté parceque dès l'année suivante, il était question du retour de ce peuple dans son ancien pays, aux environs de Chicago. Ce que le Père Marquette raconte (Relation de 1670, page 90) montre qu'il possédait nombre de renseignements sur ces gens qu'il n'avait jamais vus: "Les Illinois sont éloignés de la Pointe de trente journées par terre, par un chemin très difficile. Ils sont au sud-sud-ouest de la Pointe.

"L'on passe par la nation des Ketchigamins[2] qui sont plus de vingt grandes cabanes; ils sont dans les terres.[3] Ils cherchent d'avoir connaissance des Français, espérant en avoir des haches, des couteaux et autres ferrailles. Ils les craignent de telle sorte que deux Illinois qui ont dit, étant attachés aux poteaux, que le Français dit qu'il voulait que la paix fut sur toute la terre, ont été libérés.

"L'on passe ensuite chez les Miamiouk[4] et on arrive, par de grands déserts, aux Illinois, qui sont principalement réunis en deux bourgades, qui font plus de huit à neuf mille âmes. Ces peuples sont assez bien disposés pour le christianisme. Depuis que le Père Allouez leur a parlé, à la Pointe, d'adorer Dieu ils ont commencé de quitter leur fausse divinité: ils adorent le soleil et le tonnerre. Ceux que j'ai vus paraissent être d'assez bon naturel.

"Les Outaouas m'ont donné un jeune homme qui en est nouvellement venu et qui m'a donné les commencements de la langue: à peine peut-on l'entendre, quoiqu'il y ait quelque chose de l'algonquine. Les Illinois nous souhaitent, à la façon des Sauvages, pour participer

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[1] Société Royale, 1912, p. 28.

[2] Ceci veut dire grande eau ou un lac.

[3] Assez éloignés du lac Supérieur.

[4] Peut-être une tribu de Miamis mais leur nation occupait alors aux environs de Chicago le territoire abandonné par les Illinois en 1657.

avec eux à leurs misères et souffrir tout ce qui se peut imaginer de la barbarie. C'est pour cela qu'ils sont allés, ce printemps, dans le pays avertir les anciens de me venir quérir l'automne.

"Quand les Illinois viennent à la Pointe, ils passent une grande rivière (Mississipi) qui a quasi une lieue de large.[1] Elle va du nord au sud et si loin que les Illinois, qui ne savent ce que c'est que de canot, n'ont point encore entendu parler de la sortie. Les Illinois vont toujours par terre.

"Ils sèment du blé-d'Inde qu'ils ont en grande abondance; ont des citrouilles aussi grosses que celles de France; ont quantité de racines (légumes) et de fruits. La chasse des bœufs sauvages, d'ours, de cerfs, cocqs d'Inde, canards, outardes, tourtres et grues y est très belle. Ils quittent leurs bourgs pour quelque temps de l'année, pour aller tous ensemble sur les lieux où se tuent les bêtes et pour mieux résister aux ennemis qui les viennent attaquer. Ils croient que, si j'y vais, je mettrai la paix partout, (afin) qu'ils demeurent toujours dans un même lieu et qu'il n'y aura que la jeunesse qui ira chasser.

"Les Illinois sont guerriers. Ils font quantité d'esclaves[2] dont ils font trafic avec les Outaouaks pour avoir des fusils, de la poudre, des chaudières, des haches et des couteaux. Ils avaient autrefois la guerre avec les Nadouessi et ayant fait la paix depuis quelques années, je l'ai affermie pour leur faciliter le voyage de la Pointe où je vais les attendre pour les accompagner dans leur pays.

"A six ou sept journées plus bas que les Illinois (descendant le Mississipi) il y a une autre grande rivière dans laquelle sont des nations prodigieuses qui se servent de canots de bois.

"Les Illinois ont connaissance qu'il y a de très grandes nations plus bas qu'eux, dont les unes font deux fois du blé-d'Inde l'année. Du côté de l'est-sud-est de leur pays, il y a une nation qu'ils appellent Chaouanon (Ohio supérieur) laquelle est venue les visiter l'été passé. Ce jeune homme qu'on m'a donné, qui m'enseigne la langue, les a vus. Ils sont chargés de rasades qui font voir qu'ils ont communication avec des Européens (en effet). Ils avaient traversé une terre durant près de trente jours devant que d'arriver. Il est difficile que cette grande rivière (Mississipi) se décharge dans la Virginie et nous croyons plutôt qu'elle à son embouchure dans la Californie. Si les Sauvages qui me promettent de faire un canot ne manquent pas de parole, nous irons dans cette rivière tant que nous pourrons, avec un

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[1] Devant le territoire de l'Iowa. Le Père nous dit que les Illinois "vont toujours par terre." Alors, ils remontaient la rive droite du Mississipi jusqu'au dessus de Minneapolis et traversaient ce fleuve dans sa partie la plus étroite, au pays des Sioux.

[2] Chez les Panis du Nebraska ?

Français et ce jeune homme qu'on m'a donné, qui sait quelques-unes de ces langues et qui a une facilité pour apprendre les autres. Nous visiterons les nations afin d'ouvrir un passage à tant de nos Pères qui attendent ce bonheur il y a si longtemps. Cette découverte nous donnera une entière connaissance de la mer, ou du sud, ou de l'ouest."

Dans la liste du clergé que M. le grand-vicaire Noiseux avait commencée, il y a plus de cent ans, et qui a été publiée malgré sa défense, on voit le nom de "Hugues Pinet, missionnaire chez les Illinois en 1670." La chose est impossible; du reste, nous n'avions pas de prêtre de ce nom. Je mettrais 1690, alors que les Illinois étaient dans l'Etat actuel qui porte leur nom. Le *Répertoire* de Mgr. Tanguay renferme l'erreur en question, comme aussi le *State Historical Society of Wisconsin*, tome III, 95, 112.

Entre le lac Supérieur et la baie Verte il y avait des villages qui n'étaient pas toujours les mêmes, mais entre ces deux grandes nappes d'eau les communications des Sauvages étaient constantes. Citons, à la baie Verte,[1] le long de la rivière aux Renards et s'étendant jusqu'à Chicago: les Noquets, Sacs, Poutéouatamis, Malhomines, Puants, Outagamis, une petite tribu d'Illinois,[2] les Kikabous, Mascoutins, Miamis, tous de langue algonquine, excepté les Puants qui parlaient un langage différent des Algonquins et des Sioux, et ils étaient en petit nombre, mal vus, ayant une réputation de méchanceté qui datait de longtemps.

Les peuplades de la baie Verte s'étaient familiarisées avec les missionnaires en fréquentant Chagouamigon, depuis 1665, et une mission permanente s'était formée chez eux, sous le nom de Saint-Marc, en 1669. Les Poutéouatamis étaient les plus avenants et les plus renommés des groupes de la baie Verte, et après eux les Malhomines. De temps à autre une bande d'Iroquois allait tomber sur un village et le détruisait. Sur la rivière aux Renards, les Outagamis faisaient barrage aux Iroquois qui n'osaient s'aventurer jusque là.

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[1] Dans le volume IV, 226, 227 de *State Historical Society of Wisconsin*, le révérend M. Bronson dit que, en 1641, les Poutéouatamis furent chassés du Saut par les Iroquois et que l'année suivante un missionnaire fut tué à Keewanee, c'est-à-dire au lac Supérieur, rive sud, plus loin que le Saut. Dans le *Minona*, journal du Minnesota, le 14 février 1891, B. F. Heuston dit que le Père Le Jeune alla à la baie Verte en 1640 et décrivit les Puants, les Malhomines, etc. Il est certain que ni les Iroquois ni les missionnaires ne fréquentaient ces deux régions en 1640. Une mauvaise lecture a fait croire que le Père Rymbaut avait été tué au lac Supérieur, tandis qu'il est mort à Québec. La description mentionnée ici est dans les lettres des Jésuites et empruntée à Nicolet.

[2] Les Oumamis, qu'il ne faut pas confondre avec les Outagamis ou Renards. Les Oumamis étaient sur la rivière des Renards, à une journée des Outagamis, soit à soixante lieues des Poutéouatamis qui demeuraient vers l'entrée de la baie Verte.

Les Miamis et les Mascoutins du pays de Chicago vivaient dans un climat plus favorable. La baie Verte est déjà beaucoup mieux que le sud du lac Supérieur sous ce rapport. Le Père Dablon écrit: "J'étais, l'été dernier (1670) avec un de nos Pères, chez la nation du Feu (Mascoutins) où nous trouvâmes d'autres peuples qui nous promirent de porter à plus de cinq cents lieues des bonnes nouvelles du salut que nous leur annoncions."

Les Nipissiriniens, dont le nom indique la patrie, s'étaient dispersés depuis vingt ans sous les attaques des Iroquois et rôdaient dans le nord du lac Supérieur, comme aussi les Amikoués, les Mississagua, de la côte d'Algoma, et encore les Achiligouins des îles de la baie Georgienne, tous gens de langue algonquine, chassés par les mêmes ennemis.

Les Outaouas s'étaient placés, depuis 1657, au sud du lac Supérieur. Ce peuple commerçant servait d'intermédiaire entre les Sauvages de toutes les nations et les marchands du Canada. Chaque été, une ou deux caravanes partaient du lac, de la baie Verte, de la côte d'Algoma pour Montréal, sous la direction des Outaouas et c'est ainsi que leur nom a été donné à la rivière par où ils passaient. Talon aurait voulu échapper au contrôle commercial des Outaouas, mais ni lui ni ses successeurs n'y parvinrent, du moins d'une manière absolue.

Parlant de traite il faut dire que, depuis 1660 et toujours par la suite, les petites compagnies indépendantes de coureurs de bois agissaient pour leur compte; on les trouvait partout et ce ne sont pas elles qui ont fait le moins de découvertes; tous les découvreurs ont marché sur les traces des coureurs de bois.

La mission Sainte-Marie-du-Saut étant devenue le centre des autres, les nations s'y portaient pour rencontrer les missionnaires, les acheteurs de pelleteries, ou pour y vivre de poisson parce que nul endroit, dans une grande distance à la ronde, n'offrait de pareilles pêcheries.

Le père Dablon nous dit que "les premiers et les naturels habitants de ce lieu sont ceux qui s'appellent Paouiting8achirini, que les Français nomment Sauteurs[1] parce qu'ils demeurent au Saut comme dans leur pays, les autres n'y étant que comme d'emprunt. Ils ne sont que cent cinquante âmes, mais ils se sont unis à trois autres nations auxquelles ils ont fait comme cession des droits de leur pays natal, aussi y résident-elles fixement, excepté le temps où elles vont à la chasse.

Ces mots "nation, tribu, peuple" ne représentent jamais que des petits nombres d'individus, ayant pour toutes ressources la pêche et

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[1] Société Royale, 1911, p. 262; 1912, p. 27; 1913, p. 78.

la chasse, conséquemment éparpillés sur un assez grand territoire qui ferait au moins un comté actuel parmi les plus grands. Les écrivains ont trop cru que la phrase "les innombrables tribus sauvages" exprime une vérité. Si nous dressions la liste des tribus, peuples et nations de l'ouest, elle serait assez longue, mais le total, par âmes, ne va pas loin. Nous n'avons donc mentionné que les principaux groupes. Il y a exception pour les Sioux qui, vivant d'agriculture et établis, formaient une nation, de même pour les Illinois et les Poutéouatamis qui cultivaient assez la terre pour se tenir ensemble dans des villages permanents. Une autre nation qui joue un rôle au premier plan, c'est celle des Outaouas, très peu nombreuse cependant, mais toujours à la tête du commerce. Dix-sept localités portent de nos jours le nom d'Ottawa parceque les opérations de ces Sauvages les entraînaient partout, et là où ils allaient ils faisaient leur marque.

Tous les écrits du temps des Outaouas portent "Outaoua" au singulier et "Outaouac" au pluriel, jamais "Outaouais," qui a été inventé plus tard par Charlevoix ou ses typographes.

II.

Les Iroquois voyaient clairement qu'ils ne pouvaient soutenir la lutte contre les Français et, en 1670, ils négociaient un projet d'entente ou de paix, mais l'arrangement traîna en langueur parce que les Français exigaient que leurs alliés de l'ouest fussent compris dans le traité.

La grande traite des Outaouas et autres peuples avait lieu à Montréal, comme de coutume, l'été de 1670. Nicolas Perrot y était,[1] et voici ce qu'il raconte: "La traite allait finir quand arriva un canot de la part de M. de Courcelles avec ordre de faire descendre à Québec tous les chefs.[2] . . ." La paix ne fut signée cependant que l'hiver d'après, alors que l'on permit à près de quatre cents hommes du régiment de Carignan de rester dans la colonie,—le régiment retournant en France. Ces soldats, du moins presque tous, se mirent à vagabonder dans les forêts, ayant pour chefs sept ou huit de leurs officiers, et c'est ainsi que commença l'ère dite des coureurs de bois, qu'il ne faut pas confondre avec les Canadiens de 1660 à 1670 employés par les marchands au même genre d'occupation: la récolte des fourrures.

M. de Courcelles demanda à Perrot[3] d'accompagner le sieur de

[1] Société Royale, 1913, p. 96.

[2] Mémoire de Perrot, p. 125, 127.

[3] Juillet. Approuvé par Talon fin d'août.

Saint-Lusson[1] au saut Sainte-Marie, pour y promulguer la paix générale et prendre possession de la contrée au nom du roi de France.[2] Ces deux délégués partirent de Québec et arrivèrent à Montréal dans les premiers jours d'octobre. C'est à Québec, Trois-Rivières et Montréal, qu'ils engagèrent des "voyageurs" pour faire route avec eux. Talon écrivait à Colbert qu'il faisait partir Saint-Lusson pour voir s'il y a "quelque communication avec la mer du Sud qui sépare ce continent de la Chine." Il explique que, pour trouver "l'ouverture du Mexique", il a envoyé, avec le concours de M. de Courcelles, gouverneur général, le sieur de La Salle "qui a bien de la chaleur pour ces entreprises."

Ce voyage de La Salle a pu avoir lieu, mais il ne reste aucun écrit connu pour nous le raconter. On a prétendu que, cette fois, l'explorateur aurait passé par le saut Sainte-Marie, et de là au Mississipi qu'il suivit jusqu'au Kentucky. Colbert répondit à Talon le 2 février 1671; "La résolution que vous avez prise d'envoyer le sieur de La Salle du côté du sud et le sieur de Saint-Lusson du côté du nord, pour découvrir le passage de la mer du sud, est fort bonne, mais la principale chose à laquelle vous devriez vous appliquer dans ces sortes de découvertes est de faire rechercher les mines de cuivre, ce qui serait un moyen assuré pour attirer plusieurs Français de l'ancienne dans la Nouvelle France, si une fois cette mine avait été trouvée et que l'utilité en fût sensible."

La recherche du cuivre occupe fort l'administration à cette époque. Les mines furent trouvées, mais le transport de ce métal en canot d'écorce était impossible.

Saint-Lusson et Perrot prirent la voie de l'Ottawa, la Matawan, le lac Nipissing, la rivière des Français et parvinrent, au commencement de l'hiver, dans le district actuel d'Algoma.

"Nous fûmes contraints d'hiverner chez les Amikoués, dit Perrot, et les Sauteurs hivernèrent aussi dans les mêmes endroits; ils firent une chasse de plus de deux mille quatre cents élans, dans l'île des Outaouas[3] qui a quarante lieues de longueur et contient (est située dans) l'étendue du lac Huron, depuis la partie vis-à-vis de la rivière Saint-

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[1] Dans les notes du Père Tailhan sur le Mémoire de Perrot il dit que Talon donna ses ordres au sieur de Saint-Lusson le 3 juillet, mais c'est plutôt le 3 septembre, d'après le texte de Perrot. Le 3 juillet Talon n'était pas de retour de France.

[2] Le 2 mai 1670 le roi d'Angleterre avait signé la charte de la compagnie de la Baie d'Hudson donnant à celle-ci une étendue de territoire vaguement définie mais immense. Les intérêts du commerce français exigaient une barrière à cette invasion.

[3] Manitoualine. En 1615 et jusqu'à 1650, les Outaouas y demeuraient tous ensemble. Elle était restée déserte. Les Outaouas en reprirent possession vers 1672.

François jusqu'à celles des Missisakis, en allant vers Michillimakinac. Cette chasse extraordinaire ne fut cependant faite qu'avec des lacets.

"Je fis avertir les Sauvages de se rendre chez eux (au Saut) dans le printemps, le plus tôt qu'ils pourraient, afin d'entendre la parole du roi, que le sieur de Saint-Lusson leur porterait ainsi qu'à toutes les nations. J'envoyai des Sauvages aussi pour faire savoir à ceux du nord de ne pas manquer de se rendre dans leur pays (le pays des Sauteurs: au Saut). Je traînai et portai ensuite un canot de l'autre côté de l'île où je m'embarquai, car il est à remarquer que le lac (Huron) ne se glace jamais que du côté où nous hivernâmes et non pas vers sa largeur, à cause des vagues continuelles que le vent y exite.[1] Nous partîmes de la côte sud de l'île Manitoualine pour aller dans la baie des Renards et des Miamis[2] qui n'en est pas éloignée et je fis venir (convoquai) tous les chefs au saut Sainte-Marie où se devaient planter le piquet et afficher les armes de France pour prendre possession du pays des Outaouas."[3] Pays des Outaouas, c'est vague.

L'on fut cinq ou six mois pour avertir les nations. A la fin il ne restait que celle des Puants, assez peu abordable, et Perrot voulait y aller lui-même. Il rencontra le Père Allouez qui y avait hiverné avec quelques Français, au milieu de toutes sortes de désagréments. Ce peuple était tellement choqué de ce qu'on lui avait vendu à Montréal des marchandises à un prix excessif que, pour s'en dédommager, il ne cédait le castor aux Français qu'à triple prix de l'ordinaire. Perrot voulut y aller, sans tenir compte des duretés que l'on avait fait subir à ses compatriotes. Il arriva donc à la baie Verte au mois de mai (1671) et, trouvant les Sauvages à la pêche, il les engagea à se rendre dans leur village où il aurait quelque chose d'important à leur communiquer. La réunion s'étant formée, il leur expliquua les motifs qui l'avaient conduit chez eux et, sans difficulté, ils consentirent à se trouver au Saut pour la cérémonie annoncée.

Il fallait de plus gagner les peuples de la rivière aux Renards en la remontant jusqu'au territoire de Chicago: les Kikabous, Maskoutins, Outagamis ou Renards, la tribu illinoise des Oumamis et les Miamis. Pour cet objet les Poutéouatamis (de la baie) lui donnèrent une escorte, vu que les Sioux rôdaient dans cette région et venaient

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[1] De la côte d'Algoma à l'île Manitoualine, il traîne son canot sur la glace, traverse l'île du nord au sud et s'embarque pour aller à la baie Verte.

[2] Les Miamis habitaient vers Chicago, les Renards en haut de la rivière qui porte leur nom et tombe à la baie Verte, où étaient les Malhomines, les Poutéouatamis et autres nations. Il est inexact de dire comme Perrot "la baie des Renards et des Miamis" mais dans son langage c'est la baie qui mène chez les Renards et les Miamis.

[3] Mémoire de Perrot, p. 127.

de tuer douze Makoutins[1] qui pêchaient le long de la rivière des Renards.

Perrot arrivant avec sa compagnie à quatre lieues du village des Miamis[2] envoya avertir de sa présence. Le chef ordonna d'aller le recevoir "en guerrier," à une demi-lieue. Le cérémonial est connu. On donna au Petit-blé-d'Inde (Perrot) une garde de cinquante hommes pour le servir. Il y eut jeu de crosse, danses, festins. Tous étaient d'accord de se trouver du rendez-vous du Saut.[3] Dans ce voyage, Perrot n'alla pas jusqu'à Chicago mais il était dans la contrée environnante. Nous le reverrons du saut Sainte-Marie.

Le Père Dablon raconte (Relation, 1671, p. 45-48) ce qu'étaient une partie des Sauvages mentionnés par Perrot: "La nation du Feu porte ce nom par erreur[4] s'appelant proprement Mascoutench. Elle est jointe dans l'enceinte d'une même palissade à un autre peuple nommé Oumami,[5] qui est des nations des Illinois, laquelle s'est comme démembrée des autres pour s'habituer en ces quartiers.[6] Ils font ensemble plus de trois mille âmes. Le chef des Illinois est respecté dans sa cabane comme serait un prince dans son palais. Il y est toujours environné des plus considérables du bourg, que nous pourrions presque appeler des courtisans tant ils ont dans une posture honnête,[7] pleine de déférence, y gardant toujours un silence respectueux pour faire paraître l'estime qu'ils font de sa personne. . . . Pendant notre séjour, il s'y trouva douze ou quinze hommes venus du vrai[8] des Illinois, en partie pour visiter leurs parents et en partie pour faire quelque commerce."

Durant l'hiver de 1670-1671 qu'il passa à la baie Verte, le Père Allouez dit que les Sauvages demandaient la construction d'une chapelle et il ajoute: "Les Illinois, qu'on dit être déjà arrivés pour demeurer en ce pays, grossiront cette Église, car ils ont de très belles dispositions pour le christianisme." (Relation, 1671, p. 43). Il est

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[1] Leur village était près de Governor's Bend sur la rivière aux Renards, mission Saint-Jacques. (L'*Echo de l'Ouest*, Minneapolis, 15 août 1902).

[2] Environs de Chicago. *State Historical Society of Wisconsin*, III, 102.

[3] La Potherie, II, 124-128.

[4] Erreur des Iroquois, puis des Français qui confondaient la prononciation de Mascoutence, gens de la plaine—avec trois autres syllables très ressemblantes qui signifient: gens du feu.

[5] Seule tribu illinoise restée sur le haut de la rivière des Renards après 1657.

[6] Au contraire, elle y avait toujours demeuré. Les autres tribus en partant, s'étaient démembrées des Oumamis.

[7] Le mot "honnête", à cette époque, signifiait civilité, politesse, bienséance, urbanité.

[8] Au contraire, ces hommes venaient du pays d'adoption des Illinois et ils arrivaient dans le vrai pays de ce peuple. Le Père Dablon ne savait donc pas que le gros de la nation avait quitté Chicago pour aller habiter l'Iowa en 1657.

évident que la nouvelle de la paix générale qui se concluait au Canada en ce moment était répandue jusqu'au Mississipi et que les Illinois se préparaient à retourner dans leur patrie.

Le 20 février 1671 le Père Allouez partit de la baie Verte, où il faisait sa résidence, et, en six jours, sur les neiges et les glaces, fit vingt-quatre lieues pour arriver chez les Outagamis en remontant la rivière. On le reçut très bien, il prêcha avec succès, puis retourna promptement à la baie. (Relation, 1671, p. 49-50). C'était avant la visite de Perrot.

Au sujet de la baie, le Père Dablon écrit: "A tous les avantages de ce lieu, on peut ajouter qu'il est l'unique et le grand passage de toutes les nations circonvoisines, qui ont un commerce continuel entre elles, ou de visite ou de trafic. C'est ce qui nous a fait jeter les yeux sur cet endroit pour y placer notre chapelle, comme au centre de plus de dix nations différentes qui nous peuvent fournir plus de quinze mille âmes pour être instruites des vérités du christianisme. C'est la où le Père Claude Allouez et le Père Louis André se sont arrêtés pour travailler au salut de tous ces peuples, et pour le faire plus commodément, ils se sont partagés, l'un s'appliquant aux nations qui sont plus reculées dans les bois et l'autre à celles qui sont sur les bords de la baie" (Relation, 1672, p. 37, 40). Le Père André se tenait à la baie. Le Père Allouez allait chez les Renards, Mascoutins, Outagamis, Miamis.

A la baie,[1] le 21 janvier 1671, parut un phénomène céleste qui impressionna vivement les Sauvages, mais que les Français comprenaient très bien: c'était la figure du soleil réfléchie dans les nuages. La chose eut lieu l'après-midi. On voyait trois soleils un peu ternes ou embrouillés. Le tout est nettement décrit dans la Relation de 1671, p. 41. Jugez de l'effet sur l'imagination des indigènes. Il nous semble voir Perrot exploitant ce phénomène avec son adresse ordinaire.

Le 21 mars on eut un spectacle plus grandiose, visible, cette fois, à Michillimakinac, à l'île Manitoualine, au saut Sainte-Marie. Dans la première de ces places le parhélie se manifesta deux fois le même jour, formé de trois images ou copies du soleil paraissant à une demi-lieue les unes des autres. L'un de ces faux astres était presque aussi bien dessiné et aussi brillant que le vrai soleil.

A Manitoualine, du côté de l'ouest, on remarqua que les trois apparitions ensemble ne donnaient pas autant de lumière que l'astre du jour lui-même quand l'atmosphère est pure. La lune se voyait

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[1] Les missionnaires disent "baie des Puants." Perrot met toujours: "la Baie." Plus tard on adopta "baie Verte."

distinctement. Le vent chassait les nuages. De temps en temps, tout disparaissait pour revenir. En un certain moment, il y eut quatre soleil disposés comme suit:

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Ces étranges réflexions des ondes lumineuses furent encore plus frappantes au Saut. Le matin, il se montra trois soleils. Un peu après midi, on en vit huit ensemble. "Le vrai soleil était couronné d'un cercle formé des couleurs de l'arc-en-ciel dont il était le centre. Il y avait à ses côtés deux soleils contrefaits, et deux autres, l'un comme sur sa tête et l'autre comme à ses pieds. Ces quatre derniers étaient placés sur la circonférence de ce cercle en égale distance et directement opposés les uns aux autres. De plus, on voyait un autre cercle, de même couleur que le premier, mais beaucoup plus grand, qui passait par en haut par le centre du vrai soleil et avait le bas et les deux côtés chargés de trois soleils apparents, et tous ces huit luminaires faisaient ensemble un spectacle très agréable aux yeux, comme on en peut juger par la figure qui suit:

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Le 27 janvier 1671, la maison des Jésuites au Saut fut consumée par le feu avec la chapelle et tout ce qui était dedans. Un Frère sauva le Saint-Sacrement. On dit que trois cents Sauvages avaient reçu le baptême, dans cette chapelle. Les Pères étaient alors en mission à quelques lieues plus loin. Au retour, se voyant dénués de tout, ils ne perdirent pas courage et se mirent aussitôt, avec leurs hommes et quelques Français, à charpenter un église et des demeures plus belles, plus spacieuses que les premières. "Ces bâtiments," nous dit la Mère de l'Incarnation, "sont des poutres équarries et posées les unes sur les autres. Tout est de bois, excepté la cheminée. Les couvertures mêmes sont des planches de pin. L'église ne fut pas plutôt refaite qu'on y apporta quarante enfants pour y être baptisés." (voir aussi Relations 1671, p. 31; 1672, p. 36).[1]

III.

Parlant de la grande cérémonie qui nous occupe, La Potherie (II, 124) qui tenait ses renseignements de Perrot et aussi des Pères Jésuites, mais trente ans plus tard, commence par dire que le Saut

[1] Le climat du saut Sainte-Marie étant le même qu'à Montréal, la belle saison compte à partir de la fin de mai.

"était le lieu où se faisaient les assemblées générales de toutes les nations," mais ceci ne peut se rapporter qu'à 1670 et 1671, puisque, de 1665 à 1669, ces réunions avaient eu lieu à la Pointe ou mission du Saint-Esprit, autrement Chagouamigon, vers l'extrémité sud-ouest du lac Supérieur, où se tenaient les missionnaires. Comme le grand nombre des Sauvages émigra vers l'Est en 1670, on avait transféré la résidence des Jésuites au Saut, et de suite les coureurs de bois s'y étaient concentrés. A partir de 1670 le Saut prit le nom de Sainte-Marie et devint capitale de l'ouest.

Perrot écrit: "Je me rendis, le 5 mai, au saut Sainte-Marie avec les principaux chefs des Poutéouatamis, Sakis, Puants et Malhonines." Ce qui veut dire que, en descendant la rivière des Renards, Perrot traversa la baie Verte et y prit les chefs en question, allant avec eux tout droit au Saut où devait le rejoindre Saint-Lusson, qui avait passé l'hiver à la côte d'Algoma. Il ajoute: "Les chefs des Renards, Mascoutechs, Kikabous et Miamis, ne passèrent pas la Baie, entre autre le nommé Tetinchoua, principal chef des Miamis, qui, comme s'il en avait été le roi, avait, jour et nuit, en sa cabane, quarante jeunes gens pour la garde de sa personne. Le village qu'il commandait était de quatre à cinq mille combattants. Il était, en un mot, craint et respecté de tous ses voisins. On dit cependant qu'il était d'un naturel fort doux et qu'il n'avait point d'autre conversation qu'avec ses lieutenants ou gens de son conseil chargés de ses ordres. Les Poutéouatamis n'osèrent, par considération, l'exposer à faire le voyage, appréhendant pour lui les fatigues du canot et craignant qu'il n'en tombât malade. Ils lui représentèrent que, s'il arrivait quelque accident, sa nation les en croirait responsables et qu'elles les entreprendrait pour ce sujet. Il se rendit enfin à leurs raisons et les pria même de faire pour lui, dans l'affaire qui se présentait, comme il ferait pour eux s'il était présent. Je leur avais expliqué de quoi il était question et pourquoi on les faisait appeler." (Perrot: page 127).

"Je trouvai, à mon arrivée, dit Perrot (p. 128) non seulement les chefs du nord, mais encore tous les Kiristinons, Monsonis et des villages entiers de leurs voisins. Les chefs des Nepissings y étaient aussi, ceux des Amikouets, et tous les Sauteurs qui avaient leur établissement dans l'endroit même.

"Tout le monde étant assemblé pour un grand conseil public, raconte le Père Dablon (Relation, 1671, p. 26-28) et ayant choisi une éminence très propre à son dessein, qui dominait la bourgade des Sauteurs, il (Saint-Lusson) y fit planter la croix et ensuite arborer les armes du roi, avec toute la magnifiscence dont il put aviser."

Ceci avait lieu le 14 juin et non le 4 juin, comme on l'a écrit assez souvent. Perrot fit piocher la terre par trois fois et dit: "Je prends possession de cette terre au nom de celui que nous appelons notre roi; cette terre est sienne et tous ces peuples qui m'entendent sont ses sujets, qu'il protègera comme ses enfants. Il veut qu'ils vivent en paix; il prendra leurs affaires en main. Si quelques ennemis se soulèvent contre eux il les détruira. S'ils forment entre eux quelques différends il veut en être le juge."

D'après Perrot et La Potherie, "on planta le piquet" et à ce poteau M. de Saint-Lusson attacha une plaque de fer sur laquelle était dessiné l'écusson du roi. La Potherie ajoute que l'on glissa entre la plaque et le bois une copie de la proclamation, mais les Sauvages retirèrent bientôt après le papier et le brulèrent, "craignant que cette écriture ne fut un sort qui ferait mourrir tous ceux qui habiteraient ou fréquenteraient cette terre." La croix et l'écusson furent respectés.

Des discours, entre autre celui du Père Allouez, furent prononcés à la grande satisfaction des "quatorze nations présentes." Toutes promirent allégeance au grand Ononthio et signèrent de leurs marques l'acte de prise de possession. Un service religieux termina la démonstration avec des salves de fusil. Le soir, feu d'artifice et chant du *Te Deum.*

D'après le code européen concernant la prise de possession des pays nouvellement découverts, il suffisait de prouver que les peuples indigènes avaient reconnu, tel jour, telle année, en telle circonstance, l'acte en question. L'ensemble et les détails de la démonstration ou cérémonie officielle étaient de toute conséquence. Aussi avait-on le soin de les accompagner de formules solennelles, de gestes imposants, de déclarations authentiques et de toute la pompe qui pouvait s'adapter aux circonstances. Il importait fort peu que, dès le lendemain de la cérémonie, quelques mécontents s'avisassent de détruire le symbolique poteau avec les insignes qu'il supportait. Sa permanence sur le terrain n'était pas de rigueur. Le contrat signé de consentement mutuel—le procès-verbal—faisait foi. L'appareil du moment devait forcément disparaître tôt ou tard: il avait servi à son objet, cela suffisait. Ajoutons ce point de toute importance: la compagnie de la baie d'Hudson se contenta de trafiquer dans ses postes aux bords de la baie sans rien connaître des autres régions, tandis que les Français en faisaient la découverte et les occupaient constamment, ce qui vaut mieux qu'un titre sur le papier.

Voyons ce procès-verbal: "Simon-Français Daumont, écuyer, sieur de Saint-Lusson, commissaire subdélégué de monseigneur l'intendant de la Nouvelle-France pour la recherche de la mine de cuivre au pays des Outaouacs,[1] Nez-Percés,[2] Illinois[3] et autres nations sauvages découvertes et à découvrir en Amérique Septentrionale du côté du lac Supérieur ou Mer Douce—sur les ordres que nous avons reçus de monseigneur l'intendant de la Nouvelle-France, le 3 septembre dernier, signés et paraphés: "Talon" et, au dessous: "par Mgr." (signé) "Varnier," avec paraphe, de nous transporter incessamment au pays des Sauvages Outaouacs, Nez-Percés, Illinois et autres nations[4] découvertes et à découvrir en l'Amérique Septentrionale, du côté du lac Supérieur ou Mer Douce, pour y faire la recherche et découverte des mines de toute façon, surtout de celle de cuivre, nous ordonnant au surplus de prendre possession au nom du roi de tout le pays habité et non habité où nous passerons, plantant à la première bourgade la croix pour y produire les fruits du christianisme, et l'écu de France pour y assurer l'autorité de Sa Majesté et la domination française. Nous, en vertu de notre commission, ayant fait notre premier débarquement au village ou bourgade de Sainte-Marie-du-Saut, lieu où Les Révérends Pères Jésuites font leurs missions, et les nations de Sauvages[5] nommés Achipoés,[6] Malamechs,[7] Noquets, et autres, font leurs actuelles résidences, nous avons fait assembler le plus des autres nations voisines qu'il nous a été possible, lesquelles s'y sont trouvées au nombre de quatorze nations, à savoir:—Les Achipoés,[8] les Malamechs et les Noquets habitant ledit lieu de Sainte-Marie du Saut, et les Banabéouiks[9] et Makomiteks,[10] les Poulteattemis, Oumalominis, Sassassaouacottons[11] habitant dans la baie nommée des Puants, et lesquels se sont chargés de le faire savoir à leurs voisins qui sont les Illinois, Mascouttins, Outtougamis et autres nations; les Christinos, Assinoppals, Aumoussonnites, Outaouas,[12] Bouscouttons, Niscaks et

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[1] Les Outaouas et les Hurons (non mentionnés dans cet acte) n'arrivèrent au Saut qu'après la prise de possession, parce qu'ils s'étaient enfuis de Chagouamigon "pour avoir mangé du Sioux." Ils agréèrent comme les autres à tout ce qui avait été conclu et arrêté. (Perrot, page 128).

[2] Amikoués.

[3] La tribu des Oumamis.

[4] Les Sioux ne sont pas mentionnés.

[5] Dans cette pièce, évidemment toute rédigée à Québec, les noms des tribus sauvages sont mal écrits et mal placés géographiquement.

[6] Chippewa.

[7] Malhomines.

[8] Chippewa.

[9] Ouinipegons.

[10] Maskoutechs.

[11] Sacks ou Sakis.

[12] Les Outaouas et les Hurons s'étant éloignés de Chagouamigon dès 1670 étaient errants. Le Père Marquette les rassembla et, arrivant en retard avec eux au rendez-vous, ne signa point l'acte.

Masquikoukiodks tous habitants des terres du nord et proches voisins de la mer, lesquels se sont chargés de le dire et faire savoir à leurs voisins, que l'ont tient être en très grand nombre, habitant sur le bord de la mer même—auxquels, en présence des Révérends Pères de la Compagnie de Jésus et de tous les Français ci-après nommés, nous avons fait faire lecture de notre commission et icelle interprêté en leur langue par Nicolas Perrot, interprête pour Sa Majesté en cette partie, afin qu'ils n'en puissent ignorer, faisant ensuite dresser une croix pour y produire les fruits du Christianisme et, proche d'icelle, un bois de cèdre auquel nous avons arboré les armes de France, en disant, par trois fois et à haute voix et cri public, qu'au "nom du très haut, très puissant et très redouté monarque Louis XIVe de nom, très chrétien, roi de France et de Navarre"—nous prenons possession dudit lieu Sainte-Marie-du-Saut, comme aussi des lacs Huron et Supérieur, île de Caientaton (Manitoualine) et de tous les autres pays, fleuves, lacs et rivières, contiguës et adjecentes icelui tant découverts qu'à découvrir, qui se borne d'un côté aux mers du nord et de l'ouest, et de l'autre côté à la mer du sud, comme de toute leur longitude ou profondeur—levant, à chacune desdites trois fois (les trois cris) un gazon de terre en criant Vive le Roi, et le faisant crier à toute l'assemblée, tant Français que Sauvages déclarant auxdites nations ci-dessus que, dorénavant, comme dès à présent, ils étaient relevants de Sa Majesté, sujets à subir ses lois et suivres ses coutumes, leur promettant toute protection et secours de sa part contre l'incurse ou invasion de leurs ennemis, déclarant à tous autres potentats, princes, souverains, tant Etats que Républiques, eux ou leurs sujets, qu'ils ne peuvent ni ne doivent s'emparer, ni s'habituer en aucun lieu de ce dit pays que sous le bon plaisir de Sa Majesté Très-Chrétienne et de celui qui gouvernera le pays de sa part, à peine d'en encourir sa haîne et les efforts de ses armes; et, afin qu'aucune n'en prétende cause d'ignorance, nous avons attaché, au derrière des armoiries de France, extrait de notre présent procès-verbal de prise de possession, signé de nous et des personnes ci-après nommées, lesquelles étaient toutes présentes:

"Fait à Sainte-Marie-du-Saut le 14e jour de juin de l'an de grâce 1671, en présences des Révérends Pères: le révérend Père Claude d'Ablon supérieur des missions de ce pays-là; le révérend Père Gabriel Dreuilletes, le révérend Père Claude Allouez, le révérend Père André tous de la Compagnie de Jésus; du sieur Nicolas Perrot interprête pour Sa Majesté en cette partie, le sieur Jolliet, Jacques Mogras habitant des Trois-Rivières, Pierre Moreau sieur de la Taupine soldat de la garmison du château de Québec, Denis Masse, François de Chavigny sieur de la Chevrottière, Jacques Lagillier, Jean Mayseré, Nicolas Dupuis, Françait Bibaud, Jacques Joviel, Pierre Porteret, Robert Duprat, Vital Driol, Guillaume Bonhomme et autres témoins (suivent les figures d'animaux tracées par les chefs des nations sauvages).

"Ainsi signé: Daumont de Saint Lusson." (Ernest Gagnon: *Louis Jolliet*, p. 20.)

Perrot, dans son Mémoire, page 128, dit que le Père Marquette signa ce document. La copie de M. Ernest Gagnon ne le mentionne point.

Deux siècles plus tard, en 1870, les titres de la Baie d'Hudson et du roi de France étant sous la couronne britannique passèrent au Canada pour tous ces territoires.

Simon-François Daumont sieur de Saint-Lusson, envoyé de France par Louis XIV pour servir au Canada avait dû arriver en 1663 avec le commissaire Gaudais-Dupont. Le 6 janvier 1664, il se fait donner une terre d'habitant au fief Hébert, près Beauport, mais les recensements de 1666, 1667, ne renferment point son nom. En tous cas il n'appartenait point au régiment de Carignan. Vers 1668 il demandait la permission de passer en France. Peut-être y alla-t-il. Cependant en 1668, 1670, 1671, dans le procès qu'il soutint au sujet de la terre ci-dessus, il n'est pas considéré absent. Il est plutôt probable qu'en 1669 il était employé du côté de l'Acadie.

D'après La Potherie (II, 130) à la suite de la prise de possession de l'ouest, Daumont alla "faire la découverte d'une mine de cuivre au lac Supérieur, en la rivière Antanogan, mais sa conduite fut si irrégulière dans cette entreprise, pour ne rien dire de plus fort, que je me contenterai de rapporter qu'on le fit passer dans l'Acadie." En effet, l'automne de cette même année 1671 on le voit partir de Québec avec instruction d'examiner la route de la rivière Pentagoët, où il rencontra plusieurs établissements anglais qui le reçurent à bras ouverts. Les couronnes de France et d'Angleterre étaient dans une entente parfaite depuis le traité de Douvres du mois de mai 1670. Parti de Québec à la fin de septembre, Daumont y rentrait le 11 novembre "si abattu des fatigues de son voyage, écrit Talon à Colbert, et si affaibli par la faim qu'il a soufferte que je doute qu'il puisse aller en France, où je serais bien aise qu'il passât pour avoir l'honneur de vous informer lui-même de ce qu'il a vu dans les rivières Pemcuit et Kinibiki, toutes deux couvertes de belles habitations anglaises bien bâties." (*Documents de la Nouvelle-France*, I. 213, 217).

En dépit de la saison avancée, votre explorateur s'embarqua sur le *Saint Jean-Baptiste* et arriva à Dieppe, Normandie, le 10 janvier 1672, amenant "un orignal vivant âgé d'environ six mois, un renard et douze grandes outardes qu'il s'empressa d'aller présenter au roi. Le navire, qui était de trois cents tonneaux, portait dix mille livres de castor, valant alors quatre francs et demi la livre, quatre cents peaux d'orignal, diverses pierres, du bois, de la poix, et beaucoup d'autres productions du pays." (Faillon, III, 309).

Il est probable que Daumont revint au Canada puisqu'en 1672, il reçut une terre en seigneurie dans le bas du fleuve. (*Titres Seigneuriaux*, p. 316). Marié (en France, 1672?) avec Marguerite Bérin, de Paris, il fit baptiser (à Québec?) le 24 juin 1673, leur fils Jean-Baptiste et il a dû mourir peu après, puisque sa veuve épousa, à Québec, le 2 juillet 1675, Julien Boivin ou Bouin. (Tanguay I, 46, 62, 159).

Adrien Jolliet, qui signe l'acte du 14 juin 1671 au saut Sainte-Marie, était frère de Louis, fameux pour sa découverte du Mississipi deux ans plus tard. Adrien était marié au Cap de la Madeleine où il demeurait. Sa veuve se remaria en 1674. D'Adrien descendait Barthélemi Joliette qui fonda la ville de Joliette dans la province actuelle de Québec.

Jacques Maugras, né en France, 1639, se maria, aux Trois-Rivières, 1672, avec Jeanne Moral, née en ce lieu. Vers 1680, il s'établit à Saint-François-du-Lac et y vécut jusqu'à 1690 où il s'enrôla dans l'expédition militaire de François Hertel contre le New-Hampshire et périt dans la marche de retour avec cinq hommes qu'il commandait. Le nom de Maugras est resté par une de ses filles mariée à Gamelin.

Pierre Moreau Lataupine, Saintongeois, né vers 1643, eut une carrière de coureur de bois fort accidentée. On le rencontre, jusqu'à 1700 au moins, dans les affaires de l'ouest et du Haut-Canada. En 1716 il était gardien du port de Québec où il mourut en 1727.

Denis Massé, né à Sillery en 1645, se maria en 1672, avec Catherine Pinel, née à Québec, et mourut deux ou trois années plus tard.

François de Chavigny, né à Québec en 1648, se maria dans cette ville en 1675 avec Antoinette-Charlotte de l'Hôpital, native de Montpellier en Languedoc. Il vivait encore en 1711.

Jean Mézeray, né à Québec en 1650, se maria dans cette ville en 1673 avec Madeleine, sœur de Denis Massé ci-dessus. Il vécut au Cap-Rouge et fut inhumé à la Pointe-aux-Trembles en 1703.

Nicolas Dupuis paraît être le même que le dictionnaire Tanguay mentionne avec le sobriquet de Montarvin. Venu de Paris, il se fixa à Nicolet.

Robert Duprat est peut-être le même que Jean-Robert Duprac, né en 1647, notaire, marié en 1678 et qui a vécu longtemps à Beauport.

Vital Auriot ou Oriol, né en 1648, à Saint-Victor, diocèse du Puy, en Auvergne, était employé chez les Pères Jésuites, à Québec en 1666. On le retrouve à Laprairie en 1673. Il épousa, 1687, Anne Picard, née au Château-Richer.

Guillaume Bonhomme, né à Québec en 1643, marié en 1664 à Françoise Haché, de Paris, fut inhumé à Québec en 1699.

Jacques Joviel, dit Bergerac, armurier, venait du diocèse d'Aix en Provence et il exerçait son métier aux Trois-Rivières depuis 1660 au moins. En 1676 il épousa dans ce lieu Gertrude Moral et, peu après, alla demeurer aux environs de Sorel où lui et sa femme vivaient encore en 1696.

François Bibaud, natif de la Rochelle, est l'ancêtre de l'historien Michel Bibaud. Il a toujours vécu dans le district des Trois-Rivières, côté sud du fleuve.

Pierre Porteret et Jacques Largilliers, dit le Castor, étaient "donnés" à la Compagnie de Jésus. Largillier, avait reçu les ordres mineurs avec tolérance de porter le costume civil dans les missions. D'après le recensement de 1681 il serait né en 1644 et était alors employé aux missions de l'ouest. Il paraît avoir débuté au Canada comme coureur de bois, d'après un acte du 23 avril 1666, passé au Cap de la Madeleine par le notaire Jacques de Latouche. Dans ce contrat, fait chez Adrien Jolliet, ce même Jolliet devient l'associé de Denis Guyon "pour le voyage des Outaouacks" et leurs canotiers ou "voyageurs" ayant part d'associé dans les profits de l'entreprise, sont Laurent Philippe, François Collart, Antoine Serré, Benoit Boucher, Jacques Maugras et Jacques Largilliers. On le voit, en 1704, à l'Immaculée-Conception de Kaskakias, aux Illinois, et c'est là qu'il mourut le 4 novembre 1714, "âgé de près de quatre-vingts ans et ayant été cinquante ans au service des Jésuites," écrit le Père Mermet, alors missionnaire aux Illinois. Il n'avait probablement que soixante et dix ans et moins d'un demi-siècle chez les Jésuites.

Ces deux hommes, Largilliers et Porteret, furent les canotiers de Louis Jolliet et du Père Marquette sur le Mississipi, en 1673, et ils se sont trouvés les seuls témoins de la mort de ce dernier en 1675. D'après le Père Cholenec, c'étaient des gens pieux et aimables. (Gagnon: *Louis Jolliet*, pages 22, 23, 42, 107, 108).

C'est en 1671 que Perrot[1] sortit du rang de coureur de bois et rendit des services inappréciables comme employé du gouvernement. Depuis 1665 ils travaillait pour son compte et celui de ses associés ou bailleurs de fonds. De 1672 à 1683 il suivit son ancien régime, mais, en toute occasion, se rendit utile à la cause générale. A partir de 1684, il exerça un commandement officiel et se tint sur les lieux prescrits à sa surveillance, jusqu'à 1701.

[1] Voir: La Potherie, II, 87; Garneau, I, 221; Farland, II, 46.

Revenant de l'ouest, l'automne de 1671, il se maria avec Madeleine Raclos, dont une des sœurs, Marie, épousa (1673) René Baudoin, et l'autre Françoise épousa (1673) Michel David. Il n'y a aucun acte de mariage connu dans ces trois cas. Les trois familles s'établirent à Bécancour, où sont encore les Perrot, les Baudoin, les David. D'après l'enregistrement de sa sépulture en 1724, Madeleine serait née en 1650.[1] Il est fait mention d'assez fortes sommes d'argent que Madeleine et Marie reçurent comme héritières et nièces de Collette Raclos, veuve d'André d'Hoin, procureur en la cour du parlement de Paris.

D'après le recensement de 1681, voici les enfants de Perrot: 1672, François, 1674, Nicolas, 1676, Clémence, 1677, Michel, 1679, Marie. Le 25 juillet, 1681, fut baptisée Anne, puis nous plaçons Claude en 1683, Jean-Baptiste en 1688. Enfin Jean baptisée le 15 août 1690, dernier enfant.

IV.

Dans sa lettre de 1671 le Père Dablon résume admirablement l'état des connaissances acquises par les Français du lac Supérieur concernant les peuples qui les entouraient et nous observons que ni lui ni personne à cette époque ne fait allusion au centre du Wisconsin, sans doute parce que ce territoire étant réclamé par les Sioux, aucune tribu algonquine n'osait y demeurer, c'est à dire qu'il restait sans habitants, car les Sioux eux-mêmes n'y passaient que pour la chasse ou la guerre.

L'objet du présent article étant de donner une description des peuples de l'ouest et de la situation des choses en 1671, au moment où l'administration française y mettait la main pour la première fois, nous ne pouvons mieux faire que de découper des citations dans les écrits du temps rédigés par des témoins instruits et à tous égards croyables. Les historiens ne peuvent venir qu'après eux puisqu'ils tirent leurs renseignements de cette source même.

"Les Kilistinons sont répandus par toutes les terres du nord du lac Supérieur, sans avoir ni blé ni champ ni aucune demeure arrêtée, mais errant incessamment parmi ces grandes forêts pour y vivre de chasse, aussi bien que quelques autres nations de ces quartiers-là qu'on appelle pour ce sujet les Gens des Terres ou de la mer du Nord. (Relation, 1671, p. 34, 39, 47, 48).

On pensait que, du Saut jusqu'à l'océan Pacifique la distance ne dépassait pas trois cents lieues (Archives d'Ottawa, correspondance générale, F. 9, page 356).

Le lac Nipigon figure pour la première fois sur la carte des Jésuites, en 1671, mais sans nom. La carte de Jolliet donne (1674) le

[1] *Revue Canadienne* 1871, p. 935; *Mémoire* de Perrot, p. 301.

lac Supérieur, mais non Nipigon. Franquelin, 1682, met sur sa carte: Ameligon. Jolliet, en 1686, a sur sa carte: Alemenipigon. La Hontan, 1705, écrit: Nemipigon. Guillaume de l'Isle, 1722, lac Nipigon. Thomas Jeffreys, 1777, nomme le lac et la rivière Alempisarki.

"Poussant de Chagouamigon vers l'ouest, nord-ouest, dit le Père Dablon, il y a les Assinipoualac, qui font une grande ville (à ce que l'on rapporte) ou selon d'autres trente petits villages ramassés assez près de la mer du nord, à quinze journées de la mission du Saint Esprit (Chagouamigon).

"Vers le midi coule la grande rivière que les Sauvages appellent Mississipi, laquelle ne peut avoir sa décharge que vers la mer de la Floride à plus de quatre cents lieues du saut Sainte-Marie."

"Les Nadouessi se sont rendus redoutables à tous leurs voisins parce qu'ils sont naturellement belliqueux et, quoiqu'ils ne se servent que de l'arc et de la flèche, ils en usent néanmoins avec tant d'adresse et avec tant de promptitude qu'en un moment ils remplissent l'air (de leurs traits) surtout quand, à la façon des Parthes, ils tournent visage en fuyant, car c'est pour lors qu'ils décorchent leurs flèches si prestement qu'ils ne sont pas moins à craindre dans leur fuite que dans leurs attaques."

Perrot et les missionnaires nous font très bien comprendre que les Sioux n'étaient ni féroces ni conquérants. Le terme "belliqueux" dont se sert ici le Père Dablon n'est pas juste. Les Sioux se défendaient contre les incursions des pillards de leur voisinage et comme c'était un peuple organisé il était d'autant plus heureux à la guerre. En ce qui concerne la flèche ne nous trompons pas non plus: elle valait mieux que le fusil de ce temps-là, portant presqu'aussi loin, étant aussi pénétrante que la balle, se déchargeant dix fois plus vite et, avec l'arc, était d'un entretien infiniment plus facile. D'ailleurs les ennemis des Sioux avaient en main la même arme et leur faiblesse dans les combats provenait du manque de plan d'opération et de discipline. On ne voit pas que les Sauvages aient employé la pique ou la lance mais seulement la hache de pierre et le casse-tête dans les corps à corps.

"Les Nadouessi habitent sur les rivages et aux environs de cette grande rivière appelée Mississipi." Ils étaient surtout dans la région des mille petits lacs où prennent leurs sources la rivière Rouge[1] qui passe à Winnipeg, la rivière Saint-Louis qui tombe au lac Supérieur,

[1] Dite Rivière Rouge du Nord. Elle prend sa source dans le lac du Coude, tout près du lac Itasca, tourne au sud-ouest, puis au nord et va se perdre dans le lac Winnipeg en territoire Canadien.

origine du Saint-Laurent, et, dans la direction du sud, où commence à se former le Mississipi. Les villages Sioux ne s'étendaient pas beaucoup plus loin que les chutes Saint-Antoine (Mineapolis) un endroit du fleuve, large de quelques cents pieds. C'est devant l'Iowa, plus bas, que le Mississipi prend de l'importance.

"Ils ne sont pas moins de quinze bourgades assez peuplées et cependant ils ne savent ce que c'est de cultiver la terre[1] pour l'ensemencer, se contentant d'une espèce de seigle de marais que nous nommons folle-avoine que leur fournissent naturellement les prairies (et les petits lacs) qu'ils partagent entre eux pour y faire la récolte chacun à part, sans empiéter les uns sur les autres. C'est à soixante lieues du lac Supérieur, vers le soleil couchant, et comme au centre des nations de l'ouest, qu'ils ont toutes sur les bras, par une ligue générale, qui s'est faite contre eux comme l'ennemi commun." Leurs villages étant de beaucoup mieux construits et mieux pourvus que les campements des autres peuples, ceux-ci les jalousaient et cherchaient à les piller. De plus leur langage n'étant pas du tout semblable à aucun autre il s'en suivait une haîne de race qui attisait le désir de les écraser.

"Ils parlent une langue toute particulière, distincte de celles des Hurons et des Algonquins, qu'ils surpassent de beaucoup en générosité puisqu'ils se contentent souvent de la gloire d'avoir remporté la victoire et renvoyent libérés les prisonniers qu'ils font dans les combats sans les avoir endommagés."

Les Sioux se défendaient contre ceux qui leur voulaient du mal mais n'exerçaient point de vengeance. Les Hurons et les Algonquins attaquaient pour détruire, faire des prisonniers et les torturer.

"Les Nadouessi ayant été irrités par les Hurons et les Outaouacs, la guerre s'alluma entre eux." Les Sioux firent comprendre leur intention d'entrer en lutte par le renvoi au Père Marquette de quelques images dont il leur avait fait présent pour leur inspirer le goût des choses religieuses. (Relation, 1672, p. 36).

Le Père Dablon (Relation, 1671, p. 24, 39, 47, 48) explique la situation des Illinois, "au delà du Mississipi, comprenant huit bourgades, à cent lieues de la Pointe du Saint-Esprit (Chagouamigon).

"Plus loin se rencontre une autre nation, de langue inconnue, après laquelle est, dit-on, la mer du couchant (le Pacifique). La grande rivière nommée Mississipi semble faire comme une enceinte de tous nos lacs, prenant son origine dans les quartiers du nord et coulant vers le midi jusqu'à ce qu'elle se décharge dans la mer que nous jugeons être ou la mer Vermeille (Californie) ou celle de la Floride,

[1] Ils avaient des cultures assez bien conduites, comme toutes les tribus sédentaires.

puisqu'on n'a pas connaissance d'aucune grande rivière vers ces quartiers-là que celles qui se déchargent en ces deux mers. Quelques Sauvages nous ont assuré que cette rivière est si belle qu'à plus de trois cents lieues de son embouchure elle est plus considérable que celle (le Saint-Laurent) qui coule devant Québec puisqu'ils la font d'une lieue de large; de plus, que tout ce grand espace de pays n'est que de prairies sans arbres et sans bois, ce qui oblige les habitants de ces contrées de faire du feu de tourbe de terre et des excréments des animaux desséchés par le soleil, jusqu'à ce que s'approchant environ vingt lieues de la mer, les forêts commencent à renaître. Quelques guerriers de ce pays-ici, qui nous disent avoir poussé jusque là, assurent qu'ils y ont vu des hommes (Espagnols?) faits comme les Français, qui fendaient les arbres avec de longs couteaux et dont quelques-uns avaient leurs maisons sur l'eau—c'est ainsi qu'ils parlent des planches sciées et des navires. Ils disent, en outre, que tout le long de cette grande rivière sont diverses peuplades de nations, différentes de langue et de mœurs, et qui se font toutes la guerre les unes aux autres. On en voit qui sont placées sur le bord de l'eau, mais (il y en a) bien plus dans les terres, continuánt jusqu'à la nation des Nadouessi qui sont épars de plus de cent lieues de pays.

"Comme on a donné le nom d'Outaouacs à tous les Sauvages de ces contrées (baie Verte et lac Supérieur) quoique de différentes nations, à cause que les premiers qui ont paru chez les Français (à Montréal en 1654) ont été les Outaouacs, ainsi en est-il du nom des Illinois, fort nombreux et demeurant vers le sud (du lac Supérieur) parce que les premiers qui sont venus à la Pointe du Saint-Esprit pour le commerce s'appelaient Illinois."

Les autres Sauvages, voisins des Illinois, étaient des Sioux de l'Iowa, assez différents des Sioux du nord aux sources du Mississipi. Il pouvait y avoir aussi des Mandanes.

"C'est donc au delà de cette grande rivière que sont placés les Illinois et desquels se sont détachés[1] ceux (les Oumamis) qui habitent ici[2] avec la nation du Feu,[3] pour y faire comme une colonie transplantée[4], pour être, comme on espère, bientôt suivis des autres, et que le

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[1] Non pas. Ils étaient restés dans le pays d'origine, aux environs de Chicago, en 1657, et c'est le gros de la nation qui s'était alors détaché d'eux pour aller habiter l'Iowa.

[2] C'est à dire en haut de la rivière aux Renards, bien loin de Chagouamigon, dans la direction du sud.

[3] Voir Société Royale 1903, p. 31.

[4] Si vraiment les Oumamis étaient transplantés, c'est qu'ils étaient d'abord partis avec les autres tribus et qu'ensuite ils étaient retournés dans leur ancienne patrie, où Perrot les visita en 1665.

Saint-Esprit nous amène en ces lieux (la rivière aux Renards) pour pouvoir y être instruits, nous étant presqu'impossible de pouvoir aller jusque dans leur pays (l'Iowa). Et, de fait, plusieurs se sont déjà rendus avec les autres qui fournissent un beau champ aux ouvriers évangéliques."

D'après les textes de 1671 on pourrait croire que les Illinois, revenant de l'ouest cette année, se plaçaient à la baie Verte, toutefois quand la masse de la nation fut de retour elle rentra dans son ancien pays, beaucoup plus au sud et c'est plutôt par la rivière Illinois que par la Wisconsin qu'elle fit le voyage. Selon le Père Marquette il n'y avait encore sur la rivière Illinois, en 1674, que la tribu illinoise des Kaskaskias, forte de trois mille âmes. Les autres branches de la nation n'avaient pas quitté l'Iowa, empêchées par la crainte des Iroquois d'exécuter le projet du retour comme ils le désiraient depuis longtemps. En 1676, sept tribus, formant onze mille âmes, reprirent possession de la rivière Illinois à côté des Kaskaskias.

Le Père Dablon dit positivement que les Illinois avaient d'abord vécu "proche de la mer," ce qui suppose le lac Salé ou le Pacifique qu'ils furent chassés de là par des ennemis et se réfugièrent sur les bords du lac Michigan, où les Iroquois les attaquèrent (1656) et que de nouveau ils émigrèrent " à sept journées, au delà de la grande rivière Mississipi," dans l'Iowa.

Le même Père nous parle de la baie Verte: "Entre le lac des Illinois (Michigan) et le lac Supérieur on voit une longue baie appelée des Puants, au fond de laquelle est la mission de Saint-François-Xavier. A l'entrée de cette baie on rencontre les îles Huronnes parce que les Hurons, après la désolation (1649) de leur pays s'y sont retirés quelque temps. . . . Approchant du fond de la dite baie on voit la rivière des Oumaloumines (Malhomines et Maloumines) comme qui dirait la nation de la Folle-Avoine, laquelle est de la dépendance de la mission de Saint-François-Xavier, aussi bien que celle des Poutéouatami, des Ousaki et autres peuples, lesquels étant chassés (par les Iroquois) de leur pays, qui sont les terres du sud proche de Missilimakinac, se sont réfugiés dans le fond de cette baie—au delà de laquelle on peut apercevoir (de très loin!) dans les terres la nation du Feu ou Maskoutench, avec une de celles des Illinois dite Oumami et les Outagami. . . . Les autres nations plus éloignées vers le sud ou sud-ouest, ou bien commencent à s'approcher de nous, car les Illinois sont déjà arrivés dans cette baie, ou bien attendent qu'on puisse pousser jusque chez elles. La mission de Saint-François-Xavier embrasse huit nations différentes ou même davantage qui voudrait comprendre quelques peuples moins sédentaires qui ont rapport avec eux. Au fond de la baie quatre nations font leur résidence, à savoir: ceux qui portent le nom de Puants et qui y ont toujours demeuré comme en leur propre pays. D'un peuple très florissant et très nombreux qu'ils étaient, ils sont presque réduits à rien, ayant été exterminés[1] par les Illinois. Les Poutéouatamis, les Ousaki[2] et ceux de la Fourche y demeurent aussi mais comme étrangers—la crainte des Iroquois les ayant chassés de leurs terres qui sont entre le lac des Hurons et celui des Illinois."

Au fond de la baie, sur une rivière qui s'y décharge, mais à plus de quinze lieues vers l'ouest, étaient les Malhomines[3] ou Folle-Avoine.

Venant du sud et se débouchant aussi à la baie est la rivière des Renards et ce peuple (Outagamis)[4] se rencontrait le premier en remontant mais "on tourne à droite" pour le trouver, c'est-à-dire qu'il était du côté ouest de la rivière et un peu éloigné de ses bords. Le Père Dablon nous le représente comme "fier et arrogant." Il l'a prouvé par la suite.

"Assez proche des Renards sont les Mantoue,[5] puis, montant à gauche sur la même rivière, on trouve la nation des Maskoutench[6] et Oumamis,[7] peuples plus civiles et plus doux."

Les Outagamis, où était la mission de Saint-Marc, formaient le chef-lieu de toute la rivière. "Ils sont superbes (orgueilleux, hautains) parce qu'ils sont nombreux. On y compte plus de deux cents cabanes dans chacune desquelles cinq à six et même jusqu'à dix familles. Plusieurs autres nations grossissent celle-ci, ou plutôt en font une Babylone par la dissolution qui y règne. . . ." C'est le Père Allouez qui, vers la date où nous sommes dans cet exposé, y établit une mission stable. Les Renards sont le seul peuple algonquin qui a eu guerre contre les Français, mais cela n'eut lieu que quarante ans après 1670.

V.

Transportons-nous au lac Nipissing qui est à vingt-cinq lieues à peu près au nord-est de la baie Georgienne. La Potherie, II, 50, 59, raconte que les Sauvages habitants des bords du lac au temps de l'arrivée des Français avaient vécu, ou leurs ancêtres, sur le Saint-Laurent. "Pour aller sur les lacs et sur les rivières et pour faire plus

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[1] Société Royale, 1903, p. 5, 24.

[2] Société Royale, 1912, p. 27; 1913, p. 83.

[3] Société Royale, 1904, II, p. 228; 1912, p. 14-16; 1913, p. 83.

[4] Société Royale, 1911, p. 261; 1912, p. 14, 19, 21, 27; 1913, p. 83-85.

[5] Société Royale, 1903, p. 38.

[6] Societé Royale 1897, p. 72, 73; 1903, p. 22, 31, 33; 1911, p. 251; 1912, p 21, 23, 30; 1913, p. 85.

[7] Société Royale, 1912, p. 21, 26; 1913, p. 84.

commodément les portages, ils inventèrent les canots d'écorce de bouleau. . . . Ils s'abouchèrent avec les Algonquins (du voisinage) pour profiter du commerce des Français et ils envoyèrent de nation en nation des haches, couteaux, alènes, chaudières et autres marchandises qui les faisaient estimer et considérer, les priant même de descendre (à Montréal) chez les Français, pourvu qu'ils payassent le tribut du passage sur leurs terres." C'est ce que Champlain nous dit, en ajoutant que pareille taxe existait à l'île des Allumettes et que la politique du chef de cette île à l'égard du commerce consistait à empêcher les Français de se rendre au lac Nipissing. Cette situation dura jusqu'à 1650, c'est-à-dire tant que les Iroquois n'inquiètèrent point les Algonquins de la baie Georgienne et le peuple du Nipissing. Celui-ci parlait un langage bien différent, toutefois apparenté à l'algonquin. Le lac Nipissing entouré de rochers et de mauvaises terres n'offrait que peu de ressources pour vivre, mais le trafic aidait ses habitants à subsister tant bien que mal. Après 1654, le génie commercial des Outaouas remplaça, et sur une grande échelle, les opérations des gens du Nipissing, qui d'ailleurs étaient alors dispersés vers le nord. Vers 1670, il faut croire qu'un certain nombre de familles avaient repris possession du lac puisque Perrot en parle et mentionne leur prétention de faire payer le tribut.

Les petites nations de la côte d'Algoma dispersées dans le nord depuis 1650 revenaient chez elles vers 1670. Le Père Henri Nouvel, qui était au Saguenay depuis 1664, établit la mission volante des Apôtres pour les Amikoués, les gens de la Loutre et les Missisakis en 1671. Parti du Saut le 26 octobre il arriva à l'île Manitoualine et y rencontra des Outaouas ainsi que des Hurons Pétuneux qui venaient d'abandonner leur lieu de résidence sur la rive du lac Supérieur. Après cette visite, le missionnaire traversa au nord et arriva, le 18 novembre, parmi les Amikoués. En janvier, il retourna à Manitoualine et n'en repartit qu'au printemps pour aller chez les Missisagués, à la côte du nord encore une fois, puis il se rendit au Saut. (Relation, 1672, p. 31-34.)

"Les Missisakis sont sur le lac Huron (Algoma) dans une rivière dont ils tirent le nom car *missi* veut dire en leur langue "toute sorte" et *sakis* "sortie de rivière" et comme cette rivière ce dégorge dans ce lac par différents endroits cette nation en prend le nom. . . . Ils sont fiers, orgueilleux et fort méprisants, en un mot, c'est la moins sociale de toutes les nations." (La Potherie, II, 60).

"Les gens de la Loutre sont sur le lac Huron (Algoma) dans des rochers. Ils sont à couvert par un labyrinthe de petites îles et de peninsules. Ils vivent de blé-d'Inde, de chasse et de pêche. Ils sont simples et peu courageux et ont beaucoup de rapport (ressemblance) avec les gens du nord." (La Potherie II, 60).

A Michillimakinac la terre ferme avance entre les lacs Huron et Michigan. C'est la Pointe où est la ville actuelle. A une demi-lieue au large est "l'île fameuse de Michillimakinac aux environs de laquelle, comme du lieu le plus célèbre de tous ces quartiers pour l'abondance du poisson, divers peuples ont eu autrefois leur demeure, lesquels, s'ils voyent la paix bien affermie, prétendent bien y retourner. C'est pour cela que nous avons déjà jeté quelques fondements de la mission de Saint-Ignace, pendant l'hiver dernier (1670) que nous y avons passé."

L'île est une corbeille de verdure flottante sur les eaux. La mission fut transférée, par la suite, à un mille de la Pointe dans le fond de l'ellipse formé par le lac Michigan. Là est le monument du Père Marquette. Le fort militaire de 1780 était sur l'île.

Le Père Dablon écrivait en 1672 (Relation, p. 34) "Dieu a continué ses miséricordes sur la mission de Sainte-Marie-du-Saut qui compte, depuis un an, plus de cent quarante-cinq personnes baptisées dans une belle église bâtie depuis peu, et qui attire l'admiration non seulement des Sauvages mais aussi des Français qui la considèrent comme une chose assez surprenante, étant avancée de plus de quatre cents lieues (de Québec) dans les forêts." Le Père Druillette était chargé de cette mission, dont le siège était placé "à trois lieues au dessous de l'embouchure du lac Supérieur, dit le Père Dablon, sur le bord de la rivière dans laquelle ce grand lac se décharge par l'endroit qu'on nomme le Saut, lieu bien avantageux pour y faire les fonctions apostoliques puisqu'il est le grand abord de la plupart des Sauvages de ces quartiers et le passage presque ordinaire de tous ceux qui descendent aux habitations françaises (Montréal). Aussi est-ce en cet endroit que s'est faite la prise de possession au nom de Sa Majesté, en présence et avec le consentement de quatorze nations qui s'y sont rendues pour cet effet."

"Les Outaouaks[1] ont imité les mœurs et maximes des Hurons. Ils étaient auparavant fort grossiers mais ils sont devenus, par leur fréquentation, les plus intelligents. Ils ont imité leur valeur et ils se sont fait redouter de toutes les nations qui leur sont ennemies et considérer de celles qui leur sont alliées." (La Potherie II, 66).

"Vers l'autre extrémité (ouest) du lac Supérieur se découvre la mission du Saint-Esprit qui se fait en partie au lieu qui s'appelle la Pointe de Chagouamigon et en partie aux îles (des Apôtres) voisines, où les

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[1] Ceci paraît s'appliquer à la branche des Outaouas qui, guidée par le chef Sinagos, s'était fixée à Chagouamigon vers 1660, harcela les Sioux, et craignant les représailles de ceux-ci, quitta le lac Supérieur en 1670-1671.

Outaouacs, avec les Hurons de Tionnontaté (les Pétuneux) se retirent selon les saisons propres, ou par la pêche ou pour le blé-d'Inde." (Relation, 1671, p. 24, 39).

La Potherie disait des Hurons, en 1700: "Ils sont prévoyants, songent à l'avenir et soutiennent leurs familles. Comme ils sont sobres il est rare qu'ils se sentent de la misère. Cette nation est fort politique (rusée?), traîtresse dans ses mouvements, orgueilleuse dans toutes ses manières. Elle a plus d'esprit que tous les Sauvages. Les Hurons sont généreux, ont de la délicatesse dans leurs entretiens. Ils parlent avec justesse. Les autres tâchent de les imiter. Ils sont insinuants et ne sont guère dupes de qui que ce soit dans toutes leurs entreprises."

"Nos Outaouacs et nos Hurons de la Pointe du Saint-Esprit avaient jusqu'à présent entretenu[1] une espèce de paix avec les Nadouessi, mais les affaires s'étant brouillées pendant l'hiver dernier, et même quelques meurtres ayant été commis de part et d'autre, nos Sauvages eurent sujet d'appréhender que l'orage ne vint crever sur eux et jugèrent qu'il leur était plus sûr de quitter la place, comme ils firent de fait dès le printemps et ils se retirèrent dans le lac des Hurons: les Outaouacs dans l'île d'Ekaentouton (Manitoualine) avec ceux de leur nation qui, dès l'an passé, y avaient pris le devant et où nous avons ensuite établi la mission de Saint-Simon; et les Hurons en cette île fameuse de Missilimakinac où nous avons commencé, l'hiver dernier, la mission de Saint-Ignace." (Le Père Dablon: Relation, 1671, p. 39). Il ajoute que le Père Marquette suivit les Sauvages de Chagouamigon qui émigrèrent à Michillimakinac (voir Relation, 1671, p. 36-38; 1672, p. 36. Relation du Père Bressani, p. 315. Ernest Gagnon: *Louis Jolliet*, p. 33.)

Les Outaouacs et les Hurons voyant que les Sioux allaient prendre revanche de leurs agressions, avaient commencé, en 1669, à se diriger vers leur ancien pays. D'autres suivirent en 1670. La dernière bande abandonna le lac Supérieur au printemps de 1671. Nous avons vu plus haut que, le 14 juin, ces Sauvages avaient quitté Chagouamigon et que le Père Marquette qui les accompagnait arriva trop tard au Saut pour assister à la cérémonie de la prise de possession.

VI.

Maintenant, Perrot nous raconte la suite de ce changement de patrie, pages 102-103 de son *Mémoire*, et là, comme dans ce qu'il dit à une date antérieure, on voit que les Sioux étaient constamment en

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[1] Tout le contraire. Ils avaient commis des hostilités sans raisons contre les Sioux.

butte aux attaques des Hurons et des Outaouas, ce que le Père Dablon se garde bien d'expliquer.

A peine installé à Michillimakinac et à Manitoualine, les Hurons et les Outaouas descendirent (1671) à Montréal "et traitèrent leurs pelleteries pour fusils et munitions de guerre, dans le dessein de marcher contre les Sioux, de bâtir un fort et de leur faire la guerre pendant tout l'hiver.

"Après leur traite, étant de retour chez eux, ils firent la récolte de leurs grains à la hâte et partirent tous ensemble pour aller contre les Sioux. Ils augmentèrent leurs forces en chemin, car le chef Sinagos avait pour beau-frère celui des Sakis qui demeurait à la Baie, et dont les alliés étaient les Poutéouatamis et les Renards. Comme les Outaouas avaient apporté avec eux toutes les marchandises qu'ils avaient traitées avec les Français, ils en firent des présents aux Poutéouatamis, Sakis et Renards qui formèrent un corps de plus de mille hommes ayant tous des fusils ou autres armes de bonne défense.

"Aussitôt qu'ils furent arrivés dans le pays des Sioux, ils tombèrent sur quelques petits villages dont ils mirent les hommes en fuite et enlevèrent les femmes et les enfants qui s'y trouvèrent. Ce coup fut fait si vivement qu'ils (les Sioux) n'eurent pas le temps de se reconnaître et de se fortifier. Les fuyards ne tardèrent pas à porter l'alarme dans les villages voisins qui accoururent en foule pour donner sur les ennemis. Ils les chargèrent si vigoureusement qu'ils les mirent en fuite et abandonnèrent le fort qu'ils (les Outaouas) avaient commencé. Les Sioux les poursuivirent sans relâche et en tuèrent une grande quantité, car la terreur était si extraordinaire parmi eux qu'ils avaient jeté en fuyant leurs armes, et d'autres furent dépouillés tout nu. Il y en avait à qui il restait une mauvaise peau de chevreuil pour les couvrir. En un mot, les coups, la faim et la rigueur du temps les firent presque périr tous. Il n'y eut que les Renards, les Kikaouets (Kiskacons) et les Poutéouatamis, gens moins aguerris que les autres, qui ne perdirent pas tant dans cette occasion, parce qu'ils lâchèrent le pied dès le commencement du combat. Les Hurons, les Sinagos (Outaouas) et les Sakis se distinguèrent et favorisèrent beaucoup les fuyards en leur donnant le temps, par la courageuse résistance qu'ils firent, de prendre le devant. Le désordre fut enfin si grand parmi eux (les fuyards) qu'ils se mangèrent les uns les autres.

"Les deux chefs du parti furent fait prisonniers et celui des Sinagos fut reconnu pour celui auquel ils (les Sioux) avaient chanté le calumet. Ils lui reprochèrent sa perfidie d'avoir mangé (attaqué) celui qui l'avait fait enfant de sa nation. Ils ne voulurent pas, cependant, le faire brûler, non plus que son beau-frère, mais le faisaient venir dans les repas et lui coupaient des tranches de chair sur les cuisses et sur toutes les autres parties du corps, pour en faire des grillades et les lui donner à manger, lui faisant comprendre qu'ayant tant mangé de chair humaine dont il avait été si avide, il eut à se rassasier en mangeant la sienne. Son beau-frère eut le même traitement: c'est toute la nourriture qu'ils eurent jusqu'à la mort.

"A l'égard des prisonniers, on les fit tous mourir et passer par les flèches, excepté un Panis qui appartenait au chef des Sauvages, que l'on renvoya dans son pays afin de rapporter fidèlement ce qu'il avait vu et la justice qu'on s'était rendue."

Le désir des Sioux était de s'entendre avec les Français pour les avantages du trafic, mais une partie des Outaouas et des Hurons, réputés amis des Français, empêchaient les Sioux de fréquenter le lac Supérieur.

Le partage de l'immigration canadienne depuis 1900.

Par M. GEORGES PELLETIER.

Présenté par M. ANTONIO PERRAULT, M.S.R.C.

(Lu à la réunion de mai 1918.)

De 1897 à 1911, il est entré au Canada des centaines de mille immigrants venus de tous les pays d'Europe, ainsi que des États-Unis et de certaines régions d'Asie. De 1911 à 1914, ce mouvement s'est accru. À partir de 1914, il a très sensiblement fléchi et l'immigration européenne et asiatique à destination du Canada a subi un ralentissement considérable. Le courant d'origine européenne et asiatique ne devra pas recommencer avant la signature de la paix; il est douteux qu'il reprenne même dès la fin des hostilités européennes. L'apport américain se poursuit, mais plus lentement.

Toutes sortes de causes ont contribué à cette migration de millions vers le Canada. Ce mouvement a suivi une progression ascendante presque chaque année, de 1897 à 1914 exclusivement. Cette grande période d'immigration débutait avec 21,716 immigrants en 1897, atteignait et dépassait le nombre de cent mille (exactement 128,364) en 1902-1903, celui de 250,000 en 1907-1908 (exactement 262,469) et donnait en douze mois un maximum de 402,432, en 1912-1913. Pendant la dernière année de paix, il est entré au pays, tant par les ports océaniques que par les villes accessibles aux immigrants d'origine américaine, 384,878 hommes (31 mars 1913 au 31 mars 1914). Ce total est tombé à 144,789 pour les douze mois subséquents, par suite de la guerre qui bouleverse l'Europe.[1]

[1] En 1915-1916, notre immigration a atteint le chiffre de 48,537; en 1916-1917, celui de 75,374; en 1917-1918 (au 31 mars) celui de 79,074, soit un total de 202,985 pour les trois derniers exercices financiers. De ce nombre, 169,640 sont venus des Etats-Unis. (Discours du ministre intérimaire des finances, M. MacLean, 30 avril 1918, page 1,365 de l'édition française des Débats).

LE NOMBRE DES IMMIGRANTS, DU 1 JANVIER 1897 AU 31 MARS 1914.

Les statistiques officielles du 1er janvier 1897 au 31 mars 1915 enregistrent l'admission au pays de 3,172,865 étrangers. Voici comment cette immigration se répartit, chaque année:

Année civile 1897	21,716
Année civile 1898	31,900
Année civile 1899	44,543
Premier semestre 1900	23,895
Exercice financier 1900-1901	49,149
" " 1901-1902	67,379
" " 1902-1903	128,364
" " 1903-1904	130,331
" " 1904-1905	146,266
" " 1905-1906	189,064
Neuf mois (1 juillet 1906 au 31 mars 1907)	124,667
Exercice financier 1907-1908	262,469
" " 1908-1909	146,908
" " 1909-1910	208,794
" " 1910-1911	311,084
" " 1911-1912	354,237
" " 1912-1913	402,432
" " 1913-1914	384,878
" " 1914-1915	144,789
Total global.[1]	3,172,865

Il faut déduire de ce nombre 12,081 immigrants refusés à l'examen médical aux ports océaniques canadiens, puis 111,590 venus par les ports américains mais refusés aux frontières canadiennes, et, finalement, 10,475 déportés pour différentes causes, pendant cette même période, soit un total de 134,146. Il reste un nombre de 3,038,719 définitivement admis de 1897 au 31 mars 1914.

L'ORIGINE DES IMMIGRANTS, DE 1900 À 1915.

Les statistiques officielles complètes manquent sur l'origine de tous ces immigrants, de 1897 à 1900. Elles existent du 1 juillet 1900 au 31 mars 1915. Elles démontrent que, pendant cette période où il est entré au Canada au delà de 3 millions d'immigrants, plus d'un tiers sont d'origine britannique et plus d'un autre tiers, d'origine américaine, bien que de sources ethniques différentes. La troisième catégorie comprend entre autres des groupes austro-hongrois, italiens, russes, hébreux, allemands importants, venus de l'Europe continentale et des immigrés d'origine asiatique ou étrangère, en moins grand nombre. Ces trois grandes divisions se partagent ainsi: immigration du

[1] Si on ajoute à ce total les 202,985 immigrants entrés au pays du 31 mars 1915 au 31 mars 1918, on obtient un grand total de 3,375,850.

Royaume-Uni, 1,159,628; immigration américaine, 1,058,438; immigration de l'Europe continentale ou d'autres origines, 832,745. Voici comment se fractionnent ces trois grands contingents:

Anglais	833,982
Gallois	13,396
Ecossais	240,106
Irlandais	72,144
Américains	1,058,438
Sud-Africains	682
Australiens	2,096
Austro-Hongrois	200,000
Belges	15,810
Bulgares	18,170
Chinois	31,786
Hollandais	9,607
Français	24,974
Allemands	38,771
Habitants des Antilles	3,530
Grecs	8,329
Hébreux	75,743
Italiens	118,958
Japonais	16,065
Terre-Neuviens	17,964
Noé-Zélandais	679
Portugais	109
Polonais	36,165
Persans	189
Roumains	8,662
Russes	97,064
Finlandais	21,177
Doukhobors	417
Mennonites	101
Espagnols	2,790
Suisses	2,441
Serbes	1,258
Danois	6,116
Islandais	4,462
Suédois	27,571
Norvégiens	19,757
Turcs	4,078
Arméniens	1,808
Syriens	5,962
Arabes	469
Maltais	551
Nègres	1,200
Indous	5,296
Macédoniens	149
Divers (comprenant 1,562 sujets américains entrés au pays par les ports océaniques)	1,708
Grand total	3,050,730

COMMENT L'IMMIGRATION S'EST REPARTIE ENTRE LES PROVINCES.

Dès leur arrivée au Canada, ces immigrants se sont dirigés vers des destinations diverses. Une partie est restée dans l'est, une autre partie, s'en est allée dans le nouveau Canada,—les provinces de l'Ouest. Les vieilles provinces, du 1 juillet 1900 au 31 mars 1915, ont reçu 1,418,381 immigrants, tandis que 1,619,219 s'en allaient tout de suite dans l'Ouest. Pendant la même période, les nouveaux venus se sont divisés comme suit entre les différentes provinces.[1]

Dans l'Est.		Dans l'Ouest.	
Provinces Maritimes	137,114	Manitoba	451,749
Québec	485,678	Colombie	346,109
Ontario	795,589	Alberta et Saskatchewan	821,361
Totaux	1,418,381	Totaux	1,619,219

L'Ontario, de toutes les provinces, en a reçu le nombre le plus élevé; eu égard à leur population, toutefois, les quatre provinces de l'Ouest, vu leurs terres immenses, plus faciles à obtenir et d'abord inexploitées, en ont attiré la plus forte partie, dans l'ensemble.

L'IMMIGRATION RESTÉE AU CANADA.

La population totale du Canada, en 1901, était de 5,371,315 habitants. Au recensement de 1911, elle était de 7,206,643.[2] L'accroissement était de 1,835,328 habitants. Pendant cet intervalle, il arrivait dans les provinces canadiennes, d'après les statistiques officielles, plus d'un million sept cent mille immigrants. Si l'on tient compte de l'accroissement normal de la population du pays, de 1901 à 1911,[3] on doit conclure que bon nombre de ces immigrants n'ont fait que passer au Canada et en sont repartis soit pour les États-Unis, soit pour leur pays d'origine.

L'étude des statistiques du bureau de l'immigration canadienne, telles que les résument des publications officielles, démontre par exemple que, du 1 juillet 1901 au 31 mars 1911, il est entré au Canada 1,042,069 immigrants d'origine américaine ou non-britannique, répartis comme suit:

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[1] 13,211 immigrés, pendant cette période, n'ont pas indiqué leur destination finale et donc ne paraissent pas à ce tableau.

[2] Recensement du Canada 1911, volume II, page IV.

[3] Ainsi, dans tout le pays, le groupe ethnique canadien-français à lui seul a passé pendant cette décade et sans immigration française notable, de 1,649,371 (Recensement du Canada 1911, page VIII) à 2,054,890; c'est une augmentation, par le seul excédent des naissances sur les décès, de 405,519, soit environ 25 pour cent.

	Immigration étrangère.	Immigration américaine.
1901–1902	23,732	26,388
1902–1903	37,099	49,473
1903–1904	34,786	45,171
1904–1905	37,364	43,543
1905–1906	44,472	57,796
1906–1907	34,217	34,659
1907–1908	83,975	58,312
1908–1909	34,175	59,832
1909–1910	45,206	103,798
1910–1911	66,620	121,451
Totaux	441,646	600,423

Or, de ces 1,042,069 immigrants d'origine étrangère, qui eussent dû, s'ils fussent tous restés au pays, paraître pour la plupart au recensement de 1911, les recenseurs n'ont retracé guère plus que la moitié, soit exactement 528,066.[1] De ce nombre 167,542 sont arrivés au pays de 1901 à 1905 et 360,524, de 1906 à 1911. Donc, de mai 1901 à 1911, sur plus d'un million d'immigrants américains ou de races non-britanniques venus au Canada, la moitié à peine se sont fixés dans les différentes provinces canadiennes. Les statistiques suivantes[2] le font voir:

Provinces.	1901–1905	1906–1911
Colombie Anglaise	17,842	55,451
Alberta	35,836	80.509
Saskatchewan	44,105	83,560
Manitoba	27,920	35,040
Ontario	23,752	71,239
Québec	15,072	27,849
Nouveau-Brunswick	1,026	2,077
Nouvelle-Ecosse	1,819	4,435
Ile du Prince-Edouard	170	364
Totaux	167,542	360,524

Les 514,003 autres ont quitté le pays pour des destinations inconnues ou sont disparus dans l'intervalle.

Il est aussi entré au Canada, pendant la période 1901-1911, un total de 673,237 immigrants d'origine britannique (venus du Royaume-Uni). Le recensement décennal de 1901[3] accusait la présence au pays de 390,019 hommes nés dans le Royaume-Uni et celui de 1911 en inscrit en tout et partout 784,526 sous cette désignation. L'accroisse-

[1] Rapport spécial de la population née à l'étranger, publié par le bureau fédéral des recensements, Ottawa, 1915, page 7, tableau 2.

[2] Voir le même rapport fédéral, édition française.

[3] Recensement du Canada 1911, volume II, page 446.

ment réel de cette catégorie a donc été, pendant cette décade, par suite de l'immigration au Canada, de 394,507. Les statistiques de l'immigration indiquent par ailleurs que, pendant le même temps, il en est arrivé ici 673,237. Il en est donc retourné dans leur pays d'origine ou il en est disparu du pays dans l'intervalle le nombre de 278,720. Ceux des immigrants venus du Royaume-Uni qui sont restés au Canada se sont partagés entre les différentes provinces, d'après le recensement de 1911, comme suit:

Alberta	58,170
Colombie Anglaise	76,715
Manitoba	57,529
Nouvelle-Ecosse	4,974
Ontario	108,808
Québec	25,320
Saskatchewan	67,176
Total	398,692

Il faut déduire de ce nombre 1,497 immigrés d'origine britannique en moins, à la fin de cette même décade, au Nouveau-Brunswick, qu'en 1901, 1,479 en moins dans l'Île du Prince-Edouard et 1,209 en moins dans les Territoires du Nord-Ouest, soit un grand total de 4,185.[1] On constate en réalité que, de 673,237 immigrants d'origine britannique arrivés au pays depuis 1901, 394,517 seulement paraissent s'être fixés au Canada pendant la décade suivante.

LE DÉCHET DE L'IMMIGRATION.

Un étude d'ensemble de cette série de statistiques sur les immigrants établis au Canada pendant la période 1901-1911 conduit donc à cette conclusion que notre immigration y a subi un déchet remarquable.

Le Canada, en effet, a reçu pendant cette décade un total global de 1,715,328 personnes; il n'a pu en retracer, au recensement de 1911, que 922,573 soit guère plus que les cinq-neuvièmes de ceux qui y sont venus. Voici comment ce déchet s'est produit, dans quelles provinces:

[1] Recensement du Canada 1911, volume II, tableau XX.

Provinces.	Immigrants entrés de 1901 à 1911.	Immigrants retracés en 1911.
Provinces Maritimes	71,357	8,577
Québec	248,604	68,241
Ontario	397,691	207,799
Manitoba	298,359	120,489
Saskatchewan et Alberta	522,690	369,356
Colombie Britannique	185,971	150,008
Totaux	1,724,672	924,470[1]

Les Provinces Maritimes ont donc gardé à peu près 11 pour cent de leurs immigrants arrivés de 1901 à 1911, le Québec, 27 pour cent, l'Ontario, 52 pour cent, le Manitoba, 40 pour cent, la Saskatchewan et l'Alberta, 70 pour cent et la Colombie Anglaise, 81 pour cent.

Moins de 55 pour cent des immigrants admis dans notre pays pendant cette période s'y retrouvaient donc en 1911; ce sont ceux qui s'en sont allés dans la Colombie Anglaise, dans l'Alberta et la Saskatchewan qui s'y sont établis définitivement en plus grand nombre.

Le Québec, pour sa part, a à peine retenu le quart des immigrants qui, au débarquement, donnaient cette province comme leur destination finale au Canada.

GEORGES PELLETIER.

Nota—La plupart des statistiques relatives à l'immigration citées au cours de ce mémoire viennent des rapports annuels du surintendant de l'Immigration, Ministère de l'Intérieur, Ottawa. Elles sont résumées dans une brochurette intitulée *Immigration Facts and Figures*, publiée périodiquement par le ministère de l'Intérieur. L'auteur de ce travail s'est servi de ces statistiques officielles, tout en les groupant différemment.

G. P.

[1] Si l'on note que les Territoires du Nord-Ouest comptaient 1,209 immigrés de moins en 1911 qu'en 1901, on arrive au chiffre approximatif de 923,261, écart de moins de 700 du total donné par les statistiques fédérales citées jusqu'ici,—écart facile à expliquer par des erreurs de calculs possibles.

Le dernier effort de la France au Canada.

Par M. GUSTAVE LANCTÔT.

Présenté par M. MARIUS BARBEAU, M.S.R.C.

(Lu à la réunion de mai 1918).

(A la nouvelle de la prise de Québec, septembre 1759, le cabinet de Versailles resolut de tenter un suprême effort pour sauver le Canada. Au cours de l'hiver, on poussa les préparatifs afin de jeter de bonne heure au printemps dans la colonie des secours en hommes, en munitions et en provisions.)[1]

Le 10 avril 1760, le vent ayant tourné au nord-est, le convoi mit à la voile. Il comprenait la frégate *le Machault*, capitaine La Giraudais, lieutenant de frégate, chargé du commandement et de la protection de la petite flotte, et cinq vaisseaux marchands: *le Bienfaisant*, capitaine Grammont; *le Marquis de Malauze*, capitaine Lartigue; *la Fidélité*, capitaine Kanon le Jeune; *le Soleil*, capitaine Clémenceau; et *l'Aurore*, capitaine Desmortiers. A bord, dispersés sur les six navires, se trouvaient 400 hommes de troupe et, dans les cales s'entassaient des munitions et des provisions.[2]

Formé de soldats faits prisonniers et rapatriés de Louisbourg et de Québec,[3] le détachement de renfort se divisait en 8 compagnies composées chacune de 2 sergents, 3 caporaux, 1 cadet à l'aiguillette, 1 cadet-soldat, 2 tambours et 41 soldats. Elles étaient commandées par un capitaine et un lieutenant avec un enseigne en plus pour les quatre premières compagnies.[4] En cas de réunion, les troupes passaient sous le commandement du capitaine Dangeac, qui était le plus ancien officier.[5]

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[1] Faute d'espace, le présent article ne couvre que le voyage du dernier convoi français et sa défaite dans la rivière Ristigouche. Le travail de recherche en a été grandement facilité par la publication par le Dr. A. G. Doughty dans sa belle et savante édition du Journal de Knox, des principaux documents sur le sujet réunis par M. Placide Gaudet avec d'intéressantes notes biographiques. Ajoutons que tous les documents cités se trouvent aux Archives Canadiennes d'Ottawa. Enfin on a, dans les notes, fait usage des abréviations suivantes: An. Reg.—Annual Register 1760; Ar. Col.—Archives des Colonies; Ar. Mar.—Archives de la Marine; C.O.—Colonial Office; Nav. Trans.—Naval Transcripts.

[2] Archives des Colonies, B. 112-1, *à M. de Rostan*, 25 janvier 1760, p. 39.

[3] Archives de la Marine, B4, Vol. 98, *Journal de la Campagne du S. Giraudais sur le Machault*, p. 6.

[4] Ibid. B. 112-1, *à M. le Mal de Belle-Isle*, 2 février 1760, p. 49.

[5] Ibid. B. 112-1, *à M. de Rostan*, 18 mars 1760, p. 133.

Les munitions consistaient en poudre, balles, bombes et boulets, plus 1,000 fusils,[1] avec 2,000 pierres de rechange.[2]

Quant aux provisions, le convoi emportait, sans oublier les vins,[3] 6,000 quintaux de farine environ,[4] 4,000 quintaux de cochon salé et 400 quintaux de graisse.[5] Le chargement comprenait encore des bas, gilets et souliers pour les troupes,[6] ainsi que des étoffes, toiles et autres objets pour les Sauvages.[7] Ce fret était distribué à peu près par partie égales sur les six navires de façon à ce que chacun eut sa proportion des divers articles, munitions, provisions et marchandises.[8]

400 hommes avec une cargaison de vivres et de munitions, tels étaient l'armement et les secours destinés à sauver le Canada envahi par trois armées! Ces envois, le ministre devait lui-même en convenir, étaient plus que "modiques eu égard à leur objet." Il s'en excusait d'ailleurs en quelques lignes qui éclairent toute la situation: "Mon intention, écrit-il, est de ne pas dépenser au delà de ce qu'on peut payer, et de préférer un secours prompt, quoique médiocre, à un secours puissant dont les préparatifs annonceroient l'objet et en retarderoient l'expédition, j'ai cru ce parti préférable à tout autre."[9]

Au départ, le commandant La Giraudais avait reçu, sous pli, des instructions secrètes. Elles portaient qu'il était très important que son convoi atteignît le Canada et "qu'il ne saurait prendre trop de précaution." Dès qu'il le pourrait, il devait mettre à terre quelqu'un pour informer le gouverneur de son arrivée. Mais s'il lui était impossible de pénétrer dans le fleuve, il devait également, si faire se pouvait, en donner avis par messager, et se rendre ensuite à la Louisiane et à St. Domingue pour y opérer le déchargement des navires.[10]

Aux instructions était joint ce post-scriptum significatif de la main du roi: "Le S. De la Giraudais doit entendre que Ce n'est qu'En Cas de l'Impossibilité absolue et bien Constatée que Sa M^{té} lui permet d'aller à la Louisiane et ensuite à St. Domingue, l'objet essentiel et pour lequel il doit faire les plus grand Efforts étant d'arriver en Canada."[11]

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[1] Ibid. B. 111, *à MM. Bart et Elias*, 15 février 1760, p. 7.
[2] Ibid. B. 112-1, *à M. de Rostan*, 23 mars 1760, p. 137.
[3] Ibid. B. 111, *à MM. Bart et Elias*, 15 février 1760, p. 6.
[4] Ibid. B. 112-1, *à M. de Rostan*, 11 avril 1760, p. 158; 25 avril 1760, p. 165.
[5] Ibid. B. 112-1, *à M. de Rostan*, 22 janvier 1760, p. 32.
[6] Ibid. B. 111, *à M. Bigot*, 22 février 1760, p. 49.
[7] Ibid. B. 112-1, *à M. de Rostan*, 19 janvier 1760, p. 30.
[8] Ibid. B. 112-1, *à M. de Rostan*, 11 janvier 1760, pp. 19-20.
[9] Ibid. B. 110, *à Mr. Gradis*, 10 décembre 1760, p. 382.
[10] Ibid. B. 112-1. Instructions sur la Campagne que le Sr de la Giraudais va faire en Canada, 15 février 1760, pp. 77-8-9.
[11] Ibid. B. 112-1, p. 81.

Sorti de la Gironde, dans l'avant-midi du 10 avril, le convoi rencontrait le lendemain matin deux voiles ennemies, qui se mirent à sa poursuite. La Giraudais arbora le signal de sauve-qui-peut, et traînant à l'arrière, tout en se maintenant hors de portée de canon, il se donna l'"agrément" de les faire poursuivre en vain sa frégate, pendant que les vaisseaux marchands s'échappaient à pleines voiles.[1]

Le lendemain, *le Marquis de Malauze* se rallia au *Machault* et le *Bienfaisant* se joignit à eux quelques jours plus tard, le 17.[2] Les trois navires continuèrent leur voyage de compagnie sans incident. Des trois autres, l'un se perdit corps et biens, seize personnes seulement échappant au naufrage, et les deux qui restaient furent interceptés par les Anglais avant d'entrer dans le fleuve St. Laurent.[3]

Le 15 mai, *le Machault, le Marquis de Malauze* et *le Bienfaisant*, voguaient dans le golfe St. Laurent. Près des îles aux Oiseaux, au nord des îles de la Madeleine, la frégate captura un bateau ennemi en route pour Québec. A son bord, La Giraudais trouva des lettres qui lui apprirent que cinq ou six vaisseaux de guerre anglais, escortés d'un nombre égal de frégates, l'avaient précédé dans le St. Laurent depuis six jours. Aussitôt on tint conseil de guerre, à bord du *Machault*; il y fut décidé d'aller mouiller dans la Baie des Chaleurs hors de toute atteinte, d'envoyer de là un messager à Vaudreuil et d'attendre ses ordres.[4]

En conséquence, les matelots orientèrent la voile vers le sud. Le 16, à la vue de Bonaventure, le *Machault* s'empara de quatre bateaux anglais et le lendemain, en dedans des pointes de la baie, il captura une autre prise. Après avoir passé la nuit à l'ancre au Petit Bonaventure, La Giraudais fit voile vers le fond de la baie et le 19, il remontait la rivière Ristigouche jusqu'à six lieues des rapides, près de la Pointe de la Batterie et y faisait mouiller toute sa flotte dans un endroit fort commode.[5]

Ainsi La Giraudais arrivait trop tard. Envisageant la possibilité de secours français au début de la saison suivante, le vice-amiral Saunders, en quittant Québec, au mois d'octobre 1759, avait confié à lord Colville le commandement d'une escadre de cinq vaisseaux de

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[1] Ar. Mar. B^4, Vol. 98. Journal . . . , pp. 6-7. Relations depuis notre départ de Royant jusqu'au jour de notre Combat avec les Anglais le huit juillet mil sept cent soixante, p. 17.

[2] Ibid. B^4 Vol. 98. Journal . . . , p. 7; Relations . . . , pp. 17-18.

[3] Ibid. B^4 Vol. 98. Le 25 septembre 1760, p. 5. Annual Register, 1760, p. 134.

[4] Ar. Mar. B^4 Vol. 98. Journal . . . , p. 7. Relations, p. 18. Annual Register, 1760, p. 134. Journal of Vice Admiral Alexander Lord Colville, p. 47.

[5] Ibid. B^4 Vol. 98. Journal . . . , pp. 7-8. Relations . . . , p. 18.

ligne, de 3 frégates et 3 corvettes avec ordre d'hiverner à Halifax, et de se rendre à Québec "aussitôt que possible au printemps."[1]

Dès le 20 mars, ces vaisseaux étaient prêts à prendre la mer, mais comme il était trop à bonne heure pour naviguer le golfe, Colville fixa le jour du départ au 14 avril. Dans l'intervalle, afin de se protéger contre toute surprise, il envoyait en patrouille sur la route canadienne deux frégates, le Richmond et l'Ebrus.[2] Par suite de vents contraires, le départ de l'escadre n'eut lieu que le 22 avril. Ainsi quand le petit convoi français n'était encore qu'à mi-distance de sa destination, la flotte anglaise, forte de cinq vaisseaux de guerre, et de trois frégates, avec un convoi de bateaux marchands, était aux portes du Canada.[3] Retardée par les brouillards et les glaces, elle jetait, le 18 mai, l'ancre devant Québec, où elle avait été précédée par *le Vanguard* et *le Diana*, dont l'arrivée avait, la veille, forcé Lévis à lever le siège.[4]

A cette même date, comme nous l'avons vu, La Giraudais entrait dans la rivière Ristigouche et, le lendemain, y jetait l'ancre avec toute sa petite flotte. Son premier soin fut d'expédier à Montréal le Sieur de St. Simon avec les dépêches adressées aux autorités de la colonie. Cela fait, comme il leur fallait attendre les ordres de Vaudreuil, le commandant fit mettre à terre, pour les rafraîchir, les troupes se trouvant à bord, 200 hommes en tout, et les équipages des trois navires. Comme il restait très peu de biscuits, on employa une partie des hommes à bâtir des fours pour cuire du pain, pendant que les autres furent mis à construire une batterie sur une pointe qui commandait le chenal. En même temps, les navires faisaient eaux et provisions afin d'être prêts à sortir au premier ordre. Une des goélettes, prise en route, fut déchargée de sa cargaison et envoyée à la découverte avec un équipage sous les ordres du Sr. Lavary LeRoy. Sortie de la rivière, le 12 juin, elle croisa jusqu'au 22 sans rencontrer aucun navire ennemi.[5]

A Ristigouche, les Français trouvèrent un petit poste, commandé par M. Bourdon,[6] et un village acadien de plus de 1,500 personnes, exténuées de privations, "mourant de faim ayant été obligés de mangé des peaux de castor pendant tout l'hiver" ainsi que "des peaux de

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[1] Naval Transcripts, Vol. 21. Saunders to Cleveland to Clevland, 24 novembre 1759, p. 10. Account to the Disposition of all his Majesty's Ships and Vessels, p. 16.

[2] Ibid. Vol. 21. Colville to Clevland, 20 April, 1760, p. 53.

[3] Ibid. Vol. 21, p. 53. Colville to Clevland, 24 May, 1760, p. 57.

[4] Ibid. Vol. 21. Colville to Clevland, 24 May, 1760, p. 57.

[5] Ar. Mar. B^4, Vol. 98, Journal . . . , p. 8. Relations . . . , p. 18.

[6] Ibid. Ar. Col. C^{11}, I. 105-2, Bourdon au Ministre, 11 octobre 1760, p. 404.

bœuf et des chiens." On leur fit sur le champ des distributions, continuées dans la suite, de viande et de farine.[1]

Plus haut que le village, existait une mission de Micmacs dépendante du poste et comptant 150 familles.[2]

La nouvelle d'une flotte française dans le Ristigouche fit affluer au camp de nombreux Acadiens poussés par l'espoir de secours au milleu de leur misère. Ils arrivaient journellement en goélettes, bateaux et esquifs de tout genre.[3]

Toujours en garde contre un secours de France, les Anglais restaient continuellement sur le qui vive. Le 9 juin, en croisière sur les côtes de Gaspé, un détachement sous les ordres du capitaine Adlam apprit à Richibouctou, du chef indien de l'endroit, la présence à Ristigouche de plusieurs vaisseaux de guerre français. Le lendemain cette nouvelle lui était confirmée par le chef sauvage de Miramichi.[4]

Le renseignement fut aussitôt transmis au gouverneur Whitmore de Louisbourg qui le fit tenir le même jour, 17 juin, au capitaine Byron, commandant des forces navales de la station. Sans perdre un moment, ce dernier fit ses préparatifs et partit le lendemain à la recherche de l'ennemi.[5] Il prit avec lui trois vaisseaux de guerre, *le Fame*, qu'il montait, le *Dorsetshire*, capitaine Campbell, *l'Achille*, capitaine Samuel Barrington, et deux frégates, le *Repulse*, capitaine Allen, et le *Scarborough*, capitaine Scott.[6]

Dès la première nuit, le mauvais temps sépara les vaisseaux et le *Fame* prit les devants.[7] Le 21 juin, Leblanc, un corsaire acadien, qui sans doute avait aperçu le vaisseau anglais, vint de Miramichi se refugier à Ristigouche avec neuf bateaux retournant d'une croisière avantageuse contre les bâtiments marchands ennemis.[8] Le lendemain, au matin, les Français apprirent l'arrivée du *Fame* à la hauteur de l'île aux Hérons. Le même jour, la goélette de reconnaissance, sous les ordres de LeRoy, fut attaquée par quatre berges du navire anglais. Avec ses "canons sur affûts" et ses dix pierriers, le lieutenant se voyant incapable de résister aux grosses pièces du *Fame*, échoua son bateau à la pointe Magouacha, gagna la rive avec tout son équipage de 47

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[1] Ibid. C[11], I. 105-2, Bourdon au Ministre, 11 octobre 1760, p. 402. Ar. Mar. B[4], Vol. 98, Relations . . . , p. 18.

[2] Ar. Col. C[11], I, 105-2, Etat précis du monde de la dépendance de ce poste, p. 416.

[3] Ar. Mar. B[4], Vol. 98. Journal . . . , p. 8.

[4] C.O. Vol. 59, Hill to Witmore, 14 June, 1760, pp. 34-35.

[5] Ibid. Vol. 59, Witmore to Amherst, 1st July, 1760, p. 32.

[3] An. Reg. p. 54. Nav. Trans. Vol. 21, Byron to Colville, 14 July, 1760, p. 78.

[7] Nav. Trans. Vol. 21, Byron to Colville, 14 July, 1760, p. 77.

[8] Ibid. p. 79.

hommes et prit la direction de Ristigouche.[1] Les Anglais s'emparèrent de la goélette. A bord d'une des berges Byron partit à la découverte des vaisseaux français. Après avoir fait 4 ou 5 lieues, il les découvrit au loin dans la rivière. Il revint à bord et envoya sonder le chenal qu'il trouva extrêmement étroit et difficile. Cependant, il réussit à faire monter son vaisseau dans la rivière jusqu'à trois lieues des Français ancrés à la Pointe à la Batterie.[2] Le lendemain, 23 juin, en voulant s'avancer plus loin, le *Fame* s'échoua et parut un moment devoir y rester. Les Français songèrent, paraît-il, à monter à l'abordage, mais changèrent prudemment d'idée. Grâce à la goélette et à dix heures de travail, Byron réussit à se mettre à flot.[3]

Vers le même temps, LeRoy et ses hommes rejoignaient le poste français. Apprenant la force de l'ennemi, La Giraudais fit aussitôt mettre à terre quatre canons de 12 livres et un de 6 et poursuivre activement la construction de la batterie sur la pointe qui porte ce nom et commande le passage de la rivière. Il faisait aussi pour le bloquer, couler dans le chenal plusieurs petits bâtiments à une demi portée de canon de la batterie. Enfin il donnait ordre à tous les bateaux de remonter la rivière le plus haut qu'il serait possible et de décharger les vivres et autres effets.[4] Par mesure de prudence, comme aussi pour leur protection contre les Sauvages, on réunit sur une des goélettes les prisonniers, 60 hommes et 7 femmes, qu'on avait capturés à bord des prises anglaises, et on les fit descendre dans la cale, sous la garde d'un petit détachement de soldats.[5]

Le 24, le reste de l'escadre de Byron arrivait à l'embouchure du Ristigouche. Les deux frégates, le *Repulse* et le *Scarborough*, rejoignirent le *Fame*, pendant que l'*Achille* et le *Dorsetshire* restaient à 4 ou 5 lieues plus bas.[6]

Les forces étaient maintenant en présence: du côté anglais, 3 vaisseaux de ligne, le *Fame* de 74 canons, le *Dorsetshire* de 70, et l'*Achille* de 60; et deux frégates, le *Repulse*, de 32, et le *Scarborough*, de 29 canons,[7] plus la goélette de 4 canons reprise le 22,[8] escadre portant environ 1,700 hommes d'équipage;[9] du côté français, une seule frégate,

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[1] Ibid. p. 77. Ar. Mar. B[4], Vol. 98, Journal . . . , p. 9; Relations . . , p. 19.

[2] Na. Trans. Vol. 21, Byron to Colville, 14 July, 1760, p. 77.

[3] Ibid. pp. 77-78.

[4] Ar. Mar. B[4], Vol. 98, Journal . . . , p. 9; relations . . . , p. 19.

[5] An. Reg. p. 136.

[6] Nav. Trans. Vol. 21, Byron to Colville, 14 July, 1760, p. 78.

[7] An. Reg. p. 135.

[8] Ar. Mar. B[4], Vol. 98. Journal . . . , p. 10.

[9] Nav. Trans. Vol. 21. The State and condition of his Majesty's Ships and Vessels, p. 93.

le *Machault* de 20 canons[1] et deux vaisseaux marchands, le *Marquis de Malauze* de 16, et le *Bienfaisant* de 12. La frégate portait 150 hommes d'équipage et les autres probablement 100 chacun.[2] Avec eux, mais sans aucune utilité pour le combat, se trouvait une flottille de goélettes et de petits bateaux, une vingtaine environ, la plupart pris aux Anglais.[3] Sous les ordres de M. Dangeac se groupaient 207 officiers et soldats.[4] Il avait encore à sa disposition, tirés de Ristigouche et des équipages des petits bâtiments, probablement 200 à 300 Acadiens, et de la mission indienne un nombre égal de Micmacs. Mais ces renforts, importants sur terre, devenaient à peu près inutiles contre une force navale.[5] En somme, les forces françaises variaient de 12 à 1,500 hommes.

Une fois l'escadre réunie, les Anglais cherchèrent à se rapprocher de la batterie, mais, par suite du peu de profondeur du chenal, il leur fallut trois jours à couvrir la distance de 9 milles, qui les en séparaient, les navires s'échouant à tour de rôle une dizaine de fois.[6]

Les Français mettaient à profit ces heures de retard. Les équipages s'occupaient à faire remonter leurs vaisseaux dans la rivière et à les décharger pour les allégir. La Giraudais avait d'abord décidé de faire stationner son vaisseau près de la batterie pour l'aider et la couvrir de ses canons, mais quand parurent les frégates, il remonta avec le *Machault* qui rejoignit les autres le 28 juin. A terre, on poussait activement les travaux de la batterie. Elle était prête dans la nuit du 26 au 27, et Dangeac y plaçait un détachement de 60 soldats, de 100 Acadiens et de quelques Indiens sous le capitaine de la Vallière, en cas d'une descente de l'ennemi.[7]

Il était temps: le 27, le *Fame* et les deux frégates réussissaient enfin à mouiller avec la goélette juste en dehors de la chaîne des bâtiments coulés. Aussitôt la batterie qui défendait le chenal du nord, sous les ordres du Sieur Donat de la Garde, second de La Giraudias, ouvrit le feu sur les ennemis qui répondirent vigoureusement. On se bombarda jusqu'à l'entrée de la nuit, alors que Byron fit retirer ses vaisseaux dans le chenal du sud. Le lendemain sur une nouvelle

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[1] Ar. Mar. B^4, Vol. 98, Journal . . . , p. 6.

[2] An .Reg. p. 135.

[3] Journal of Vice Admiral Alexander lord Colville, p. 47. London Magazine, 1760, p. 489.

[4] Ar. Col. Série D^2 Vol. 48-2—Extrait de la Revue faite en ce poste, p. 537.

[5] Il y avait 1,500 personnes résidentes et réfugiées à Ristigouche. Ar. Mar. B^4 Vol. 98. Relations . . . , p. 18. A la mission on comptait 250 familles indiennes Ar. Col. C^{11}, I. 105-2. Etat précis . . . , p. 416. Dangeac mentionne qu'une centaine d'Acadiens prirent part au combat. Relations, p. 18.

[6] Nav. Trans. Vol. 21, Byron to Colville, 14 July, 1760, p. 78.

[7] Ar. Mar. B^4, Vol. 98, Journal . . . , p. 9; Relations . . . , pp. 19-20.

avance anglaise, la canonnade reprit entre les frégates et la batterie. Plus bruyant qu'effectif, ce duel se répéta chaque jour, avec des intermittences diverses, du 28 juin au 3 juillet. Exposée à la pleine vue et au feu plongeant d'une artillerie supérieure en nombre et en calibre, les Français firent preuve d'une belle ténacité en face d'adversaires protégés par les flancs de leurs navires. Mais le 3 juillet, Byron fit passer le *Fame* dans le chenal du sud, le long duquel il remonta au delà du poste français. Ainsi placé, il prit, avec ses nombreuses pièces, la batterie à revers, la couvrit de ses boulets et força ses défenseurs à évacuer la position, qu'ils ne quittèrent cependant qu'après avoir crevé leurs canons, incapables de continuer la lutte contre une artillerie aussi puissante.[1] La Garde et ses hommes, avec les soldats de La Vallière, rejoignirent la flottille française, pendant que Byron débarquait un détachement qui détruisit la batterie et environ 200 maisons formant le village de Ristigouche.[2]

Au cours de l'engagenemt, allégés par le déchargement d'une grande partie de leurs cargaisons, les bateaux français avaient remonté la rivière à 3 lieues plus haut, mais non sans grandes difficultés, car ils s'échouèrent plusieurs fois en route. Résolus à les atteindre, les Anglais travaillèrent à se frayer un chemin en soulevant du chenal quelques-uns des bâtiments qui le bloquaient. La journée du 6 se passa à cette besogne. Le 7, imitant les tactiques de l'adversaire, comme il y avait à peine 2 à 2 brasses et demi d'eau, ils allégèrent autant que faire se put les deux frégates, et parvinrent au cours de la journée, après des peines infinies, à les pousser en amont à une courte distance de la flotille française.[3]

Constatant sa grande infériorité, La Giraudais cherchait avant tout, si possible, à arrêter ou, sinon, à retarder l'approche des ennemis, afin d'avoir le temps de mettre à terre ses munitions, vivres et effets. Grâce à sa connaissance du chenal et à la légèreté de ses bâteaux, il avait remonté plus vite et plus haut que les Anglais et, dans l'intervalle, les troupes de terre et une partie des équipages avaient établi deux nouvelles batteries, l'une sur une pointe de la côte nord, et l'autre sur une pointe de la côte sud, à l'endroit où la rivière se rétrécit considérablement entre Campbeltown et Cross Point d'aujourd'hui position favorable qui leur permettait de croiser leurs feux sur le chenal.[4]

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[1] Ar. Mar. B^4 Vol. 98, Journal . . . , p. 9; Relations . . , p. 20.
[2] Nav. Trans. Vol. 21, Byron to Colville, 14 July, 1760, p. 78.
[3] Ar. Mar. B^4, Vol. 98, Journal . . . , p. 10; Relations, p. 20. An. Reg. p. 135.
[4] An. Reg. p. 135. Ar. Mar. B^4 Vol. 98, Journal . . . , p. 10; Relations . . . p. 20.

Sous le commandement du Sr Gilbert, lieutenant du *Machault*, la batterie de la côte sud comprenait trois canons de 4 livres et réunissait des officiers et des matelots de la frégate, ainsi que du *Bienfaisant* et du *Marquis de Malauze*, avec quelques centaines d'Acadiens et des Sauvages.[1]

La batterie du nord alignait trois canons de 12 livres du *Machault*, et 2 de 6 du *Marquis de Malauze*. Le Sr Reboul, premier lieutenant de La Giraudais, qui la commandait, avait sous lui des matelots du *Machault*, renforcés par 30 soldats, sous les ordres du M. Dubois-Berthelot. A portée de la soutenir, le *Machault* s'était embossé au milieu du chenal, présentant à l'ennemi son babord garni de 10 canons de 12 livres, et d'un de 6, ne retenant à tribord que 3 pièces de 12. pour défense au cas d'un abordage par les berges anglaises. A son bors, La Giraudais avait gardé 70 matelots, et sous lui, Dangeac commandait un détachement de 45 soldats.

Quand au reste des équipages et de la troupe, non assigné aux batteries, il était occupé à hâler les petits bâtiments chargés des effets du roi, à portée de mousqueterie de la rive, où on avait à la hâte improvisé un second dépôt, en outre du premier établi dès l'approche des Anglais, plus loin à l'intérieur à l'abri de toute insulte. Pour prévenir toute tentative de l'ennemi de les capturer, Dangeac avait placé en garde à cet endroit un piquet de soldats sous les ordres du lieutenant Dupont-Duvivier, qui avait aussi avec lui des matelots et quelques Acadiens.[2]

Dans le chenal à la suite du *Machault* venait le *Bienfaisant*, suivi du *Marquis de Malauze*, à bord duquel on avait fait passer les prisonniers à fond de cale, afin de les soustraire à la fureur possible des Indiens. Un détachement de 25 hommes sous deux sergents leur servait de garde.[3]

Enfin, pour maintenir les vaisseaux anglais à distance, La Giraudais avait fait couler une seconde chaîne de bâtiments en dehors de la batterie du nord à demi portée de canon de cette dernière.[4]

Telle était la situation des adversaires quand le 7 juillet le *Repulse* et le *Scarborough* parvinrent avec la goélette à s'approcher à portée de canon de la batterie du sud. Ne pouvant faire pénétrer ces vaisseaux de guerre dans le Ristigouche, Byron en avait retiré l'élite des équipages et les avait distribué à bord des frégates. Il avait placé

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[1] Ar. Mar. B[4] Vol. 98, Journal . . . , p. 10; Relations . . . , p. 20. An. Reg. p. 135.

[2] Ibid. E[4] Vol. 98, Journal . . . , p. 10.

[3] An. Reg. p. 136. Ar. Mar. B[4]. Vol. 98, Journal . . . , p. 11; Relations . . p. 21.

[4] Ar. Mar. B[4], Vol. 98, Journal . . . , p. 10.

sous un de ses officiers un équipage de 100 hommes sur la goélette.[1] Ainsi montée, elle tenta de venir sonder le chenal et de réduire la batterie au silence, mais Gilbert fit ouvrir sur elle un tel feu qu'elle dût bientôt se retirer. Une seconde fois, elle revint à la charge mais les boulets français la forcèrent à abandonner l'entreprise.[2] Devant cet insuccès, les hommes descendirent dans les chaloupes, bravant le feu de la batterie, touèrent les frégattes en amont. Dès qu'elles furent à la hauteur du poste français, elles lui lâchèrent de furieuses bordées auxquelles la batterie riposta vigoureusement. Après un duel qui dura peu, le Sr Gilbert et ses hommes, écrasés par la force des canons anglais, durent battre en retraite, abandonnant leurs pièces.[3]

Débarrassé de la batterie qui lui barrait la route, ce qui lui avait pris la journée du 7, Byron tourna son attention vers les vaisseaux, objets de sa croisière. Au petit jour, le lendemain, 8 juillet, le *Scarborough* et le *Repulse* s'approchaient des navires français et de la côte nord jusqu'à la chaîne des bateaux coulés qui les maintenaient à demi portée de canon.[4]

Vers les cinq heures du matin, le combat commença, le *Repulse* et le *Scarborough* ouvrant un feu violent de bordée sur la frégate de La Giraudais et sur le poste de Reboul. Les canons du *Machault* et de la batterie ripostèrent énergiquement.[5] Le *Bienfaisant* et le *Marquis de Malauze*, dont les équipages étaient aux batteries ne prirent aucune part à l'action.[6] Avec, de part et d'autre, une égale bravoure et une ardeur égale, la canonnade continua avec violence une partie de la matinée. En face d'une artillerie supérieure, les Français montrèrent une fermeté remarquable. Ils tinrent tête aux frégates, rendant coup pour coup. La plus forte des deux, le *Repulse*, qui menait l'attaque, fut rudement canonnée. Les boulets hachèrent son gréement, abattirent sa mature et trouèrent sa coque en plusieurs endroits.[7] Atteinte dans sa ligne de flottaison, elle coula et toucha fond; mais grâce au peu de profondeur de la rivière, elle put aveugler ses voies d'eau, se relever et continuer le combat.[8] Du côté français, le *Machault*, embossé au milieu du chenal, essuya le fort de la canonnade ennemis. Frappé dans sa carène, l'eau envahit sa cale,

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[1] An. Reg. p. 135.

[2] Ar. Mar. B[4], Vol. 98, Journal . . . , p. 10; Relations . . . , p. 20.

[3] Ar. Reg. p. 135. Ar. Mar. B[4], Vol. 98, Journal . . . , p. 10; Relations . . p. 20.

[4] Ibid. B[4]. Vol. 98, Journal . . . , p. 10; Relations . . . , p. 20.

[5] An. Reg. p. 135.

[6] Ibid. p. 135. Ar. Mar. B[4], Vol. 98, Relations . . . , p. 23.

[7] Nav. Trans. Vol. 21. Byron to Colville, 14 July, 1760, p. 80.

[8] Ar. Mar. B[4], Vol. 98, Journal . . . , p. 11.

à une hauteur de 7 à 8 pieds. Mais, à part ces avaries, les pertes de chaque côté étaient légères.[1]

Soudain, après plusieurs heures d'un feu très vif, le tir du *Machault* se ralentit: il était sur le point de manquer de poudre. A son départ, il avait à bord 1,100 coups, mais comme il avait dû en fournir aux trois batteries, il ne lui en restait ce jour-là que 450. L'armateur en devait charger une plus grande quantité, mais il avait manqué à son contrat.[2] La Giraudais envoya sa chaloupe en chercher dans un bateau où on avait mis les munitions, mais quoique la poudre s'y trouvât, le patron du canot, sans doute pris d'une alarme quelconque, n'en rapporta pas au *Machault*.[3]

Réduit à l'impuissance sous le canon ennemi, La Giraudais tint conseil avec Dangeac. Ce dernier déclara qu'il ne quitterait la frégate que quand il faudrait le faire sauter. La situation était précaire: on allait manquer de poudre d'un moment à l'autre; plusieurs soldats et matelots avaient été tués ou blessés, y compris l'aide-major Loppinot; et l'eau montait dans la cale. De plus on était trop faible pour résister avec 100 hommes à un abordage qui ne pouvait manquer de se produire dès que le *Machault* cesserait de tirer. Ne pouvant se dérober en remontant la rivière, les navires français étaient inévitablement condamnés à la capture. Devant cette issue le commandant décida de sacrifier ses vaisseaux plutôt que de les voir tomber en mains ennemies. Il fit évacuer ses blessés et après avoir mis le feu au *Machault*, se rabattit sur la rive en parfait ordre avec son équipage et les soldats, poursuivi par les boulets ennemis. Le *Bienfaisant* suivit l'exemple, les hommes qui restaient à bord y mirent le feu et l'abandonnèrent. Sans encombre ni perte, toutes les chaloupes atteignirent le rivage.[4]

Restait le *Marquis de Malauze* sur qui se trouvaient à fond de cale les prisonniers anglais. On commença par en démonter les canons que l'on fit mettre à terre; ensuite ordre fut donné aux prisonniers de monter sur le pont et de s'embarquer sur un radeau; mais le trouvant trop faible pour tous les porter ils refusèrent de quitter le bateau, redoutant encore davantage de tomber aux mains des Indiens.[5] Devant cette situation, au lieu de l'incendier comme on l'avait fait pour les deux autres, La Giraudais et Dangeac décidèrent,

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[1] Ibid. B^4, Vol. 98, Journal . . . , p. 11; Relations . . . , p. 22. An. Reg. 1760, p. 135.

[2] Ibid. B^4, Vol. 98, Relations . . . , p. 24.

[3] Ibid. p. 24.

[4] Ibid. B^4 Vol. 98, Journal . . . , p. 22; Relations . . . , p. 22. An. Reg. p. 135.

[5] An. Reg. p. 136.

pour ne pas risquer la vie des prisonniers, ni surtout les exposer aux furies indiennes, de leur abandonner le *Marquis de Malauze.* On leur annonça cette décision en leur disant que le vaisseau leur appartenait et qu'ils avaient à courir leur chance. La garde les fit descendre dans la cale, ferma les écoutilles et quitta le bord. Laissée seuls, les prisonniers s'alarmèrent. Redoutant une explosion, ils défoncèrent une cloison, forcèrent les écoutilles, et se trouvèrent libres. Ils visitèrent le bateau pour voir si on y avait mis le feu. Trouvant un vieux pavillon anglais, ils le hissèrent au mât, en guise de signal à leurs compatriotes; mais la fumée du *Machault* et du *Bienfaisant* qui brulaient à pleins ponts leur en cachait la vue.[1] Anxieux de s'échapper dans la crainte d'une attaque nocturne par les Indiens, attaque qu'accompagnerait le scalp, ils fouillèrent le bateau pour y découvrir des armes; ils n'y trouvèrent qu'un tonneau de couteaux à scalper dont ils s'armèrent ainsi que de bâtons et de mitraille, résolus à vendre chèrement leur vie. Ils agrandirent le radeau et y fixèrent une voile, dans le dessein de descendre jusqu'aux frégates anglaises, mais un jeune homme d'entre eux, excellent nageur, se jeta à l'eau, et réussit à gagner le *Repulse* une lieue plus loin. Mis au courant, le commandant envoya le capitaine Wood à la repousse avec un détachement de 9 berges. Elles passèrent bravement sous le feu des canons français pendant que les frégates bombardaient la batterie, atteignirent les prisonniers et les ramenèrent sains et saufs.[2] Avant de se retirer, les Anglais mirent le feu au *Marquis de Malauze,* mais ils perdurent 6 hommes dans l'incendie.[3]

Une fois à terre, La Giraudais alla se joindre au piquet de Duvivier avec une partie des équipages et quelques Acadiens pour défendre les petits bâtiments montés plus haut dans la rivière et dont le déchargement n'était pas terminé. Quant à la batterie elle continuait de se canonner avec les frégates. Dès que les vaisseaux furent brûlés, Byron détacha la goélette et 17 berges portant 25 hommes chacune afin de capturer et de détruire le reste de la flottille française. Elles franchirent le feu des batteries et se portèrent à l'attaque. N'ayant à leur opposer que les balles de ses fusils, La Giraudais plutôt que de les voir s'emparer des bâtiments qui étaient trop loin de terre, en incendia quatre, qui étaient des prises anglaises. Assisté par Duvivier et sa troupe, il défendit énergiquement les autress, une dizaine, qui étaient à portée de fusil, maintint l'ennemi à distance,

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[1] L'auteur dit que les Indiens tirèrent sur eux, ce qui est fort douteux puisqu'ils étaient hors de portée de fusil. An. Reg. p. 136.

[2] An. Reg. pp. 136-7.

[3] Ar. Mar. B^4, Vol. 98, Journal . . . , p. 12; Relations . . . , pp. 22-23. Nav. Trans. Vol. 21, Byron to Colville, 14 July, 1760, p. 79.

l'empêcha de débarquer et le força à se retirer vers les 11 heures du soir, sans avoir fait aucun butin.[1]

Le lendemain 9 juillet les frégates anglaises et la goélette descendirent le Ristigouche et rejoignirent les vaisseaux de guerre. Pendant que le *Repulse* qui était fortement endommagé prenait la route d'Halifax afin de se ragréer et de se radouber, le reste de l'escadre demeura ancré dans la rivière.[2] L'ennemi parti, les Français s'employèrent à organiser un établissement pour se mettre à l'abri d'attaque et placer à couvert les vivres et effets sauvés, car ils étaient en pleine forêt, "dans un bois debout."[3]

Ainsi se termina la bataille du 8 juillet 1760, qui ne fut en somme qu'une canonnade prolongée de plusieurs jours. Les pertes en hommes s'équilibrèrent: les Français ayant 30 tués et blessés, dont plusieurs officiers, et les Anglais 12 tués et 12 blessés.[4]

Avec des pertes égales, la bataille n'en restait pas moins nettement une décisive victoire anglaise. Inévitable à cause de la disproportion des forces, elle faisait quand même honneur aux Français. Pendant 17 jours, avec une faible frégate et 2 vaisseaux marchands, ils avaient tenu en échec une escadre de 5 navires pouvant mettre en ligne 256 pièces. Pendant 17 jours, ils avaient tenu l'ennemi sous le feu de leurs canons, les empêchant, sur une distance de cinq lieues, d'opérer un débarquement. Ils avaient courageusement tenu tête, des jours entiers, à une artillerie supérieure et n'avaient, comme dernière ressource, incendié leurs navires, que lorsque la poudre vint à manquer. Finalement ils avaient sauvé la majeure partie de leurs effets et de leurs canons, plusieurs bateaux[5] et tous leurs équipages et leurs troupes. Sans doute leur connaissance du chenal et son peu de profondeur les avaient grandement favorisés, mais les chefs avaient su tirer excellent parti des lieux, opéré un coulage judicieux de bâtiments inutiles, et les officiers et les soldats, aussi bien que les équipages avaient fait preuve de grand courage et de ténacité remarquables.[6]

D'autre part, les Anglais atteignaient pleinement le but de leur croisière: les trois vaisseaux français étaient complètement détruits,

[1] Ar. Mar. B4, Vol. 98, Journal . . . , pp. 11, 12; Relations . . . , p. 21. Ar. Col. C11, I. Etat de la situation du poste de Ristigouche, p. 257.

[2] Ar. Mar. B4 Vol. 98. Journal . . . , p. 12. Nav. Trans. Vol. 21, Byron to Colville, 14 July, 1760, p.

[3] Ar. Mar. B4, Vol. 98, Relations . . . , p. 23.

[4] Ar. Mar. B4, Vol. 98. Journal . . . , p. 11; An. Reg. 1760, p. 136. Byron dit 10 tués et 9 ou 10 blessés. Nav. Trans. Vol. 21, Byron to Colville, 14 July, 1760, p. 79.

[5] Ar. Col. C11 I. 105—2 Bâtiments restant aux particuliers le 13 septembre, 1760, p. 417.

[6] Ar. Mar. B4, Vol. 98. Journal . . . , p. 12. Relations . . . , p. 21, p. 23.

et quatre autres, des prises, partageaient le même sort, sans compter les bâtiments coulés dans le chenal.[1] Avec eux, avaient péri d'importantes cargaisons non encore déchargées, se chiffrant à 200,000 livres. Enfin, ils avaient ruiné le village de Ristigouche. Ces résultats considérables ne leur avaient coûté, à part la perte de quelques hommes, que de fortes avaries au *Repulse*. Bien dirigés par leurs chefs, les équipages avaient déployé autant de bravoure que d'endurance.[2]

L'expédition française était ruinée. Le 17 juillet, l'escadre anglaise quitta la rivière pour rentrer à Louisbourg. Le même jour, M. de St. Simon apportait de Montréal à la Giraudais l'ordre de passer en France avec les dépêches du gouverneur, ce qu'il fit le 10 août sur une goélette acadienne.[3]

Le reste des troupes et des équipages demeura sous Dangeac à Ristigouche. A la fin de septembre, l'ordre lui arriva de Vaudreuil de retourner en France avec son monde.[4] Mais, à la sortie de la rivière, le 15 octobre, sa flottille rencontra, envoyée par Amherst, une escadre anglaise qui le força à rebrousser chemin.[5] Le commandant, le major Elliot, lui remit une lettre de Vaudreuil lui enjoignant de se rendre aux termes de la capitulation de Montréal. Le 30 octobre les troupes mirent bas les armes et s'embarquèrent pour la France.[6] Tel fut l'épilogue du dernier convoi français envoyé au Canada.

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[1] Ar. Col. C^{11} I. Etat de la situation du poste de Ristigouche, p. 257. Bâtiment restant aux particuliers le 13 septembre, p. 417.

[2] An. Reg. p. 136. Ar. Mar. B^4, Vol. 98, Journal . . . , p. 12; Relations . . . p. 23.

[3] Ar. Mar. B^4, Vol. 98. Journal . . . , p. 12.

[4] Ar. Col. C^{11} I, 105-2. Etat de la Situation du poste de Ristigouche, pp. 569-570.

[5] Ibid. p. 570.

[6] Ibid. p. 570. C.O. 5, Vol. 61-1 Elliot to Amherst, 24 January, 1761, p. 316.

Le portage du Témiscouata.

Notes critiques et documents pour servir à l'histoire d'une vieille route coloniale.

Par le FR. MARIE-VICTORIN, des E. C.

Présenté par M. C.-MARIUS BARBEAU, M.S.R.C.

(Lu à la réunion de mai, 1918.)

"La route crée la civilisation." Le développement de pays neufs comme le Canada, par le moyen des chemins de fer, donne à cette proposition de nos économistes un air d'axiome; et il devient intéressant de rechercher, à la lumière de cette évidence historique, les origines de nos antiques routes coloniales, premières trouées dans la forêt immense, fils essentiels de la trame sur quoi nos ancêtres tissèrent la vigoureuse étoffe de la patrie canadienne. Elles virent défiler tour à tour nos découvreurs, nos missionnaires, nos soldats, beaux grenadiers ou humbles miliciens. Les charrettes primitives des colons, nos pères, durcirent leurs ornières, et, une génération poussant l'autre, elles ont porté dans un perpétuel va-et-vient toute la vie de notre peuple. A ces divers titres, leur histoire mérite d'arrêter l'attention de l'économiste et de l'historien.

I.

Les documents à notre disposition ne nous permettent pas de prétendre esquisser complètement l'histoire du Portage du Témiscouata. Nous pouvons tout au plus poser quelques jalons, réunir des textes et les analyser. Il s'attache à cette région un parfum de légende dont tous les voyageurs ont respiré la vigoureuse poésie et auquel nous nous arrêterons volontiers, car, dirons-nous avec Vallet de Viriville, "partout où l'on voit une légende, on peut être sûr, en allant au fond des choses, de trouver une histoire."

Pour les géologues, engeance austère, le plus beau paysage est une ruine, et la période historique tout entière un épisode insignifiant de la grande histoire du monde. Malgré leurs manies fâcheuses, eux seuls, cependant, sont en état de nous renseigner sur les causes qui ont déterminé ou modifié le relief d'un pays. En ce qui concerne proprement la région du Témiscouata, ils nous diront que c'est aux plissements parallèles des sédiments cambro-siluriens que la rive sud du Saint-Laurent doit sa topographie particulière, et que cette topographie modifiée par l'érosion, et surtout par le passage des glaciers pléistocènes a déterminé le régime actuel des eaux. Dans ses traits essentiels, ce régime se définit ainsi: la ligne de partage, grossièrement parallèle au Saint-Laurent, rejette une partie des eaux dans ce fleuve par les rivières du Loup, Verte et des Trois-Pistoles, tandis qu'au sud, de petites rivières drainent tout vers le grand lac Témiscouata qui, par la Madawaska et le Saint-Jean, se déverse dans la Baie de Fundy.

Le lac Témiscouata a une telle importance au point de vue qui nous occupe que nous nous y arrêterons un peu. Penchez-vous sur la carte et voyez cette longue nappe d'eau, toute d'une venue, nettement coupée aux extrémités, paraissant être plutôt l'ouvrage de l'homme que l'œuvre de la nature. Ne dirait-on pas un tronçon de grand fleuve égaré au milieu des terres? Il mesure 24 milles de longueur sur une largeur variant de un à deux milles. Sa forme générale est celle d'un L, le bras le plus long étant irrégulièrement sigmoïde et orienté du N.O. au S.-E. Une partie du bras en question a la même direction que la Madawaska et qu'une partie considérable du fleuve Saint-Jean, tandis qu'une ligne menée suivant l'autre et prolongée sur une distance de 46 milles coïnciderait avec la gorge profonde où coule le Saguenay. La profondeur du lac est d'environ 200 pieds dans toute l'étendue du long bras, justifiant ainsi l'étymologie du mot sauvage Témiscouata: "*C'est profond partout.*"

Quelle est donc la signification de cette fosse gigantesque? Ici encore, la géologie va nous répondre. Constatons d'abord quelques faits. Le lac Témiscouata n'a pour ainsi dire pas de vallée. Des collines s'élèvent brusquement des rives et descendent de la même façon à de grandes profondeurs sous les eaux. A la montagne Wissick ou Grosse-Montagne, située vis-à-vis de Cabano, les collines montent presque à pic jusqu'à la hauteur de 550 pieds et, à environ 100 pieds de la rive, la profondeur dépasse 200 pieds. D'autre part, la Madawaska qui reçoit les eaux du lac n'a guère plus de 200 pieds de largeur, tandis que sa vallée, généralement unie et plate, a rarement moins d'un mille de largeur. Ces faits et quelques autres, comme la direction des stries glaciaires sur les rochers d'alentour et la nature des matériaux déposés dans la vallée de Témiscouata - Madawaska donnent à penser que cette vallée tout entière est un grand sillon creusé par les glaces et qui, à une certaine époque, avait une profondeur au moins égale à celle du lac. Ce qui est aujourd'hui la fertile vallée de la Madawaska aurait été formé par l'accumulation des débris abandonnés lors du recul des glaces.

Le fond plat et presque égal du lac, la pente presque insensible qui remonte vers son extrémité méridionale et les importants dépôts d'argile qui remplissent à divers intervalles la vallée de la Madawaska corroborent cette opinion. Remarquons encore la forme carrée bien caractéristique de l'extrémité du lac. C'est bien l'indication du barrage glaciaire (*glacial damming*) auquel ce lac, comme beaucoup d'autres dans la même région, doit son origine. Les glaces ont d'ailleurs écrit sur le rivage les traces de leur passage. Les surfaces des roches schisteuses sont partout polies, arrondies, sillonnées ou striées. Celles de ces stries qui ont été observées à un niveau que les glaces contemporaines n'atteignent jamais, ne peuvent avoir été produites que par un glacier remplissant toute la vallée et dont la surface s'élevait beaucoup plus haut que le niveau actuel des eaux, tandis qu'il creusait profondément la dépression où gît aujourd'hui le lac. La partie supérieure, le bras court, de profondeur beaucoup moindre, a la même direction que les collines riveraines, et présente un phénomène très curieux. En effet, à en juger par la position des blocs erratiques, le glacier se dirigeait vers le nord et le nord-est au lieu de couler vers le sud. La présence d'un autre barrage glaciaire à l'entrée du lac confirme cette hypothèse. De sorte que nous aurions ici les vestiges d'un centre de glaciation et d'un régime hydrographique aujourd'hui complètement bouleversé.[1]

Le retrait des glaces et les modifications corrélatives de la température permirent l'établissement de la forêt climatique: sapin—épinette—bouleau, et le pays prit dès lors la physionomie qu'il a gardée jusqu'aujourd'hui. En effet, le comté de Témiscouata, si l'on en excepte la zone côtière, est encore essentiellement couvert de forêts.

Ces forêts recèlent une flore admirable dont l'aspect change d'un versant à l'autre de la chaîne apalachienne. Tandis que le littoral et la zone avoisinante présentent une flore plutôt boréale et apparentée à celle du Labrador, les rivages du lac Témiscouata sont égayés des plus jolis éléments de la flore du Saint-Jean. Sur les pointes rocheuses qui plongent à pic sous les eaux noires, s'épanouissent en abondance les fleurs d'or de la potentille arborescente, les liliales inflorescences de la castillégie pâle et de l'anémone des rivages, au travers desquelles passent et dominent les innombrables rosaces des églantiers. En

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[1] Cf. a. Bailey, L. W., et McInnes, W., *Rapport sur les explorations et reconnaissances faites dans certaines parties du nord du Nouveau-Brunswick et dans les régions avoisinantes de la province de Québec et de l'état du Maine, Etats-Unis.* Commission Géologique du Canada, 1887-1888.

b. Bailey, L. W. et McInnes, W., *Rapport sur certaines parties de la province de Québec et les régions adjacentes du Nouveau-Brunswick et du Maine, et traitant plus particulièrement des comtés de Témiscouata et de Rimouski, P.Q.* Commission Géologique du Canada, 1890-1891.

juillet, ainsi ceinturé de fleurs brillantes, le lac Témiscouata perd son air farouche et ses allures précipitueuses et c'est d'un œil assuré que l'on regarde toutes les nuances du vert se mirer dans ses eaux mortes sous lesquelles glissent silencieusement le *touladi* et le *pointu.*

A l'encontre de tant de régions neuves qui, chez nous, n'ont pas d'histoire, les forêts du Témiscouata, son lac, gardent le souvenir de la naissance de la civilisation chrétienne en Amérique. Ces échos que trouble maintenant le sifflet de la locomotive, ont répété le cri de guerre du Micmac et du Maléchite, "races fières qui, aujourd'hui, devant l'action énervante du commerce comme autrefois devant le casse-tête ennemi, savent mourir sans se rendre."[1] D'innombrables canots ont frôlé ces ondes éternellement assombries par l'image des forêts qu'elles réflètent, puisque le lac Témiscouata formait avec ses affluents et émissaires l'une des routes fluviales les plus fréquentées du continent, reliant la baie de Fundy au Saint-Laurent. Chargés de guerriers ou chargés de fourrures, les canots micmacs et maléchites remontaient le Saint-Jean—leur "Aloustouc"—jusqu'au portage du Grand-Saut—le "Kapskouk"—où les eaux puissantes du fleuve se précipitent d'une hauteur de 75 pieds à travers des encaissements de rochers d'aspect grandiose et terrible. Abandonnant le Saint-Jean au Petit-Saut, endroit où la rivière prend brusquement la direction de l'ouest, les voyageurs pénétraient dans la Madawaska qui les conduisait dans le lac Témiscouata. De là, deux chemins s'offraient pour traverser les chaînes de collines et arriver au Saint-Laurent. Ils pouvaient remonter le lac jusqu'à son extrémité, s'engager dans la rivière et la chaîne des lacs Acheberache, puis tomber après un court portage dans la grande rivière des Trois-Pistoles. La seconde route, plus longue, mais moins "portageuse" consistait à remonter par la rivière Touladi et le lac du même nom, la rivière des Aigles et le lac des Aigles. On traversait ce dernier lac en largeur pour pénétrer dans la rivière Petit-Saint-Jean qui décharge un lac du même nom. Un court portage et les canots flottaient sur la Bouabouscache, affluent de la rivière des Trois-Pistoles. Des traces relevées sur cette route semblent indiquer qu'elle était très fréquentée. Ces traces consistent surtout en amoncellements de pointes de silex taillés qui ne pouvaient provenir du voisinage. C'était donc un véritable sentier de guerre.

Nous avons tous lu dans notre enfance les *Trois légendes de mon pays* de J.-C. Taché. Dans "l'Ilet au Massacre" qui appartient autant à l'histoire qu'à la légende, c'est à travers ce dédale de rivières et de lacs que les partis micmacs et iroquois se font la terrible guerre d'embuscades. Et Taché décrit avec l'enthousiasme et le relief de

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[1] Taché, J.-C., *Trois légendes de mon pays.*

celui qui connaît et qui aime "ces paysages taillés profusément dans l'étoffe du globe."

On connait ce récit. Une cinquantaine de familles de Micmacs se sont arrêtés dans la baie du Bic pour y vivre quelques jours en commun avant de se disperser sur le littoral. Elles y mènent cette vie de lézard au soleil, chère aux races primitives, quand deux guerriers viennent jeter la nouvelle de l'approche, par la rivière Boisbouscache, d'un parti iroquois fort d'une centaine d'hommes. On se hâte d'expédier dans les cinq canots que possède la tribu: les femmes enceintes, les enfants à la mamelle et leurs mères qui iront rejoindre les frères de Matane. Puis, les Micmacs se préparent à la résistance, tout en députant cinq d'entre eux pour aller demander secours aux alliés maléchites de la Madawaska.

Après une lutte désespérée, la tribu entière, réfugiée dans une caverne de l'Ilet du Bic est massacrée par les Iroquois. Mais les messagers ont accompli leur mission et reviennent bientôt suivis de vingt-cinq guerriers maléchites. La vengeance est terrible, patiente, savourée! Le long des rivières Boisbouscache et des Trois-Pistoles, la chasse à l'homme se poursuit, implacable, jusqu'à ce que le dernier Iroquois meure au poteau de torture, face à l'Ilet du Bic, appelé depuis l'*Ilet-au-Massacre.*

Il ne faudrait pas croire que les Trois-Pistoles fussent le seul lieu d'aboutissement des routes liquides venant de l'Acadie. Il est certain au contraire qu'il y en avait plusieurs autres et que l'embouchure de la rivière du Loup était l'un des points de départ ou d'arrivée les plus fréquentés.

Le savant archiviste du collège Sainte-Marie, de Montréal, feu le R. P. Jones, S. J., a exhumé il y a quelques années une très curieuse "relation" insérée depuis dans l'édition Thwaites des *Relations des Jésuites.*[1] C'est un mémoire du P. Loyard, S. J., intitulé: *Etat présent des Abénaquis.* Nous avons tenu l'original du précieux document et y avons relevé les lignes suivantes: ". . . Les trois autres villages sont du côté de l'Acadie et s'appellent Naňraňtz8ak sur la rivière de Cambekki, Pana8aniské sur la rivière de Pentagouet, et de Medoktek sur la rivière Saint-Jean. Le village de Naňraňtz8ak est le plus voisin de la Nouvelle-Angleterre, celui de Medoktek est le plus voisin de l'Acadie, et celui de Pana8aniské est à peu près au milieu. Ces trois villages ont leur route différente pour aller un peu de jours à Québec, *chacun par sa rivière.* C'est ce qui rend leur situation si importante par rapport au Canada dont ils sont les plus fortes barrières."

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[1] *The Jesuit Relations and allied documents.* Edited by Reuben Gold Thwaites. Vol. LXVII, p. 120.

C'est nous qui soulignons. Il semble d'après cela que la même loi tacite qui délimitait les territoires de chasse, réservait aussi les voies de communication.

Un intéressant document inédit communiqué par M. William Smith et intitulé: *Notes on the Portage between the St. Lawrence and the St. John, by Mercure*[1] nous apprend que de temps immémorial la route favorite des Indiens qui passaient du bassin du Saint-Jean à celui du Saint-Laurent était la rivière Madawaska et le lac Témiscouata. La carte de Champlain qui porte la date de 1612 contient des indications vagues à ce sujet. Mais il avait d'autres portages dont les principaux étaient:

Rivière Touladi et rivière des Trois-Pistoles.
Rivière Saint-François et rivière du Loup.
Rivière Noire et rivière Ouelle.
Rivière Saint-Jean (branche N.-O.) et rivière du Sud.
Rivière Saint-Jean et rivière Etchemin.

Toutes ces routes, sauf peut-être celle de la Touladi furent utilisées dès l'origine pour le transport des dépêches. Plus tard lorsque se forma l'établissement de la Madawaska, cette voie devint la seule employée pour les messages officiels.

Quels furent les premiers blancs qui se hasardèrent dans les solitudes du Témiscouata? Il est difficile de le savoir avec certitude. Tant de voyages et de voyageurs n'ont pas laissé de traces à cette époque, où plus encore qu'à la nôtre, la main qui maniait l'aviron ne savait pas toujours tenir la plume. En feuilletant attentivement nos annales nous relevons cependant ici ou là une phrase, une allusion, parfois un document plus étendu relatifs au Portage du Témiscouata.

Champlain, qui ouvrit en ce pays tant de routes ignorées, ne fit pas ce voyage, mais, dès 1604, il en connut la possibilité. "Ralleau apprit de Schoudon, chef d'une tribu indienne campée le long de ses rives (la rivière Saint-Jean), que les sauvages se rendaient à Tadoussac en suivant son cours, n'ayant à franchir qu'un petit espace de terrain. Remontant en effet la rivière Saint-Jean jusqu'au Petit-Saut, les sauvages pouvaient engager ensuite leurs embarcations dans la rivière Madawaska qui les conduisait au lac Témiscouata. Ils n'avaient plus à faire par terre que quelques lieues pour arriver au fleuve Saint-Laurent presque en face de Tadoussac."[2]

Leclerc écrit qu'en 1624 arrivèrent heureusement à Québec trois illustres missionnaires récollets de la province d'Aquitaine qui venaient en canot de l'Acadie à Québec, par la rivière Saint-François, avec deux français et quelques sauvages. Il y avait un mois qu'ils

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[1] Nous reparlerons plus loin de ce Mercure.

[2] Dionne, N.-E., *Samuel de Champlain*, I, p. 94.

étaient partis de la rivière Saint-Jean. Ces trois Pères à qui leur Provincial avait permis de se consacrer aux missions du Canada s'ils ne trouvaient rien à faire en Acadie étaient les PP. Jacques de la Foyer, Louis Fontimer et Jacques Cardon.[1] Ils sont probablement les premiers blancs qui aient fait par terre le voyage de l'Acadie.

La Relation du P. Paul le Jeune pour 1634 nous apprend que ce zélé missionnaire, dans le but d'apprendre la langue des montagnais, accompagna cet hiver-là un parti de sauvages à la chasse dans la région du Témiscouata. Le bon Père, avec cette abondance de détails si précieuse pour l'historien rapporte au long ce voyage et les misères sans nom qu'il y endura.

La lecture de ce document laisse néanmoins subsister bien des incertitudes au point de vue géographique. L'historien Roy[2] l'interprète ainsi: "Dans cette première expédition, c'est donc à la tête du lac Témiscouata au milieu des tribus des Etchemins et des Micmacs que le P. le Jeune passa l'hiver, suivant les aborigènes dans leurs courses à travers les bois, à la chasse du caribou, de l'orignal et du chevreuil."

Parkman devant le même document ne hasarde aucune conjecture au sujet des lieux exacts; "Nous retrouvons la troupe le 12 de novembre ayant abandonné les canots dans une île et traversant à gué les dunes pour aborder sur la rive sud du Saint-Laurent. . . . Laissant la rivière derrière eux, ils entraient dans cette contrée accidentée d'où s'échappent les sources du Saint-Jean, solitude formée de collines successives, revêtues d'épaisses forêts et ne contenant pas un être humain."[3]

Le texte même de la Relation vaut d'être cité et étudié. "Le trentième jour d'octobre, nous sortismes de cette malheureuse Islette, vinsmes aborder sur la nuit dans une autre isle qui porte un nom quasi aussi grand comme elle est, car elle n'a pas demy lieue de tour, et voici comme nos sauvages me dirent qu'elle se nommoit: *Ca pecoucachetchckhi chachagou achiganikhi, Ca pakhitaouananiouikhi;* je crois qu'ils forgent ces noms sur le champ. Cette isle n'est quasi qu'un grand rocher affreux; comme elle n'a point de fontaine d'eau douce, nous fusmes contraint de boire des eauës de pluyes fort sales que nous ramassions dans les fondrières et sur des rochers."[4]

"Le douziesme de Nouembre, nous commençasmes enfin d'entrer dedans les terres, laissans nos Chalouppes et nos Canots et quel-

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[1] Leclerc, Chrestien, *Premier établissement de la foi*, p. 288.

[2] Roy, J.-Edmond, *Histoire de la Seigneurie de Lauzon*, I, p. 15.

[3] Parkman, Francis, *Les Jésuites dans l'Amérique du Nord.* Traduction française de la comtesse de Clermont-Tonnerre.

[4] *Relations des Jésuites*, I, p. 62. Québec, 1858.

qu'autre baggage dans l'Isle au grand nom, de laquelle nous sortismes de mer basse, traversans une prairie qui la sépare du continent."[1]

Quelle est cette "Isle au grand nom" qui marque le point de départ du voyage du P. le Jeune dans les forêts du Témiscouata? Les familiers des grèves témiscouatiennes ne feront pas difficulté d'admettre qu'il s'agit de l'Ile de Cacouna ou Gros-Cacouna. A marée basse, en effet, elle est reliée à la rive par une prairie saumâtre couverte de varechs, de zostères et de spartines. On objectera peut-être que l'Ile Verte présente à peu près la même particularité, mais l'Ile Verte mesure environ cinq lieues de tour et n'est nullement désertique, ce qui ne cadre pas avec les expressions "une demy lieuë" et "rocher affreux" de la Relation.

"Nous avons fait dans ces bois, depuis le 12 Nouembre de l'an 1633 que nous y entrasmes, jusqu'au 22 d'avril de ceste année de 1634 que nous retournâmes aux riues du grand fleuue de Sainct Laurens, vingt-trois stations, tantost dans des vallées fort profondes, puis sur des montagnes fort releuées; quelque fois en plat pays et tousiours dans la neige. Ces forêts où j'ai esté sont peuplées de diuerses espèces d'arbres, notamment de Pins, de Cèdres et de Sapins. Nous auons traversé quantité de torrens d'eau, quelques fleuues, plusieurs beaux lacs et estangs marchans sur la glace. Mais descendons en particulier, et disons deux mots de chaque station; la crainte que j'ay d'estre long me fera retrancher quantité de choses que j'ay jugé assez légères quoy qu'elles puissent donner quelque iour à ces mémoires."[2]

Laissons de côté le récit circonstancié de chaque station et arrêtons-nous sur quelques passages qui peuvent nous guider.

"Nous quittasmes les riues du grand fleuue le 12 de nouembre comme j'ay desia dit, et vinsmes cabaner près d'vn torrent, faisans chemin à la façon que je viens de dire, chacun portant son fardeau."[3]

"Le 3 de décembre, nous commençasmes notre quatriesme station, ayans délogé sans trompette, mais non sans tambour, car le sorcier n'oubliait jamais le sien. Nous plantasmes nostre camp près d'vn fleuue large et rapide, mais peu profond; ils le nomment *Ca pititetchiouetz*, il va se dégorger dans le grand fleuue de Sainct Laurens, quasi vis à vis de Tadoussac."[4]

Essayons d'interpréter ces données très vagues. Nous avons d'abord à conjecturer la direction suivie par le parti de chasse. Il est naturel de penser qu'ayant atterri, les sauvages ne revinrent pas

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[1] loc. cit. p. 66.
[2] loc. cit. p. 66.
[3] loc. cit. p. 68.
[4] loc. cit. p. 72.

sur leurs pas, mais s'enfoncèrent droit dans les terres ou obliquèrent vers l'est. Les deux passages précités rendent plausible la dernière hypothèse. Dans ce cas le "torrent" serait la rivière Verte, et le "fleuue large et rapide, mais peu profond" la rivière des Trois-Pistoles qui était fort connue des sauvages à cause de la communication qu'elle établissait avec la vallée du fleuve Saint-Jean par le lac Témiscouata. Le fait que, de toutes les rivières de la région, le *Ca pititetchiouetz* seul fut désigné par un nom au P. le Jeune, rend cette opinion probable.

"Le trentiesme du même mois de décembre, nous décabanasmes. Faisans chemin nous passasmes sur deux beaux lacs tout glacés."[1]

"Le seiziesme du mesme mois nous battismes la campagne, et ne pouuant arriuer au lieu où nous prétendions, nous ne fismes que de gister dans une hostellerie que nous dressasmes à la haste et le lendemain nous poursuiuismes notre chemin, passans sur une montagne si haute qu'encore que nous ne montassions point jusqu'au sommet qui me paraissoit armé d'horribles rochers, néanmoins le sorcier me dit, qui si le ciel obscurcy d'un brouillard eust esté serein nous eussions veu en mesme temps Kébec et Tadoussac, esloignez l'un de l'autre de quarante lieuës pour le moins. Je voyais au-dessous de moy avec horreur des précipices qui me faisoient trembler; j'aperceuois des montagnes au milieu de quelques plaines qui me paraissoient comme de petites tours, ou plutost comme de petits chasteaux, quoy qu'en effect elles fussent fort grandes et fort hautes. . . . Le vingt-neufiesme, nous achevasmes de descendre cette montagne, portant notre maison sur la pente d'une autre où nous allasmes. Voilà le terme de notre pelerinage; nous commencerons doresnauant à tourner bride et à tirer vers l'Isle où nous auons laissé notre Chalouppe. Nous vismes ici les sources de deux petits fleuues, qui se vont rendre dans un fleuue aussi grand, au dire de nos sauuages que le fleuue de Sainct Laurens; ils l'appellent *Oueraouachticou*."[2]

"Le vingt-troisiesme de Mars nous repassasmes le fleuue *Ca pititetchiouetz* que nous auions passé le troisième de Décembre.

"Le trentiesme du même mois nous vinsmes cabaner sur un fort beau lac, en ayant passé un autre plus petit en notre chemin; ils étaient encore autant glacés qu'au milieu de l'hiver. . . .

"Le premier jour d'Auril, nous quittasmes ce beau lac et tirasmes à grande erre vers nostre rendez-vous. . . . Enfin j'arriuay après les autres sur les riues du grand fleuue, et trois jours après nostre arriuée, scauoir est le quatriesme du mesme mois d'Auril, nous fismes

[1] loc. cit. p. 78.

[2] loc. cit. pp. 80-81.

notre vingt-troisiesmes station, allans planter nostre cabané dans l'Isle où nous auions laissé notre Chalouppe."[1]

Reprenons l'étude des textes.

Quelle est cette montagne "si haute, au sommet armé d'énormes rochers?" Il n'y a pas de très hautes montagnes dans la partie de la chaîne apalachienne qui traverse le Témiscouata. S'agit-il de la montagne Wissick—appelée encore Lennox ou Grosse-Montagne—bourrelet calcaire qui s'élève au coude du lac Témiscouata, à la suture des formations cambriennes et siluriennes? Mais outre que cette colline, malgré son nom, n'a guère qu'une altitude de 500 pieds, comment admettre que le missionnaire, si méticuleux d'habitude n'ait pas mentionné sa situation sur la rive du lac? Nos recherches personnelles nous portent plutôt à croire qu'il s'agit d'une colline située quelque part aux environs du curieux carrefour d'eaux courantes que l'on observe dans le canton Robitaille. Pour préciser, il est fort probable que la montagne en question est le "Pain de sucre" situé sur la rive gauche du lac de ce nom, qui est lui-même l'un des lacs de la chaîne des Squatecks dont les eaux viennent du sud et se déchargent par la Touladi dans le lac Témiscouata. Le "Pain de sucre" qui n'est pas autrement baptisé, peut avoir environ 1,000 pieds d'altitude, mais en raison de sa situation isolée et de ses flancs abrupts, il paraît beaucoup plus élevé. Quant à la prétention d'apercevoir de là et simultanément Québec et Tadoussac, il faut y voir simplement un de ces mensonges énormes dont les sauvages étaient coutumiers.

Cette hypothèse rendrait compte d'une manière satisfaisante des détails suivants fournis par les textes:

1. Les deux lacs passés avant d'arriver à la montagne "si haute" seraient les deux premiers lacs des Squatecks.

2. Les deux petits fleuves qui vont se rendre dans le fleuve Oueraouachticou (Saint-Jean) seraient les rivières Touladi et des Squatecks qui se réunissent dans le canton Robitaille. Durant la saison d'hiver, le P. le Jeune ne pouvait se rendre compte du sens du courant. Le régime hydrographique de cette partie du comté de Témiscouata est d'ailleurs compliqué et anormal. La chaîne des lacs Squatecks coule vers le nord, tandis que le lac Témiscouata qui lui est exactement parallèle coule vers le sud. N'apercevant pas le confluent, le missionnaire pouvait croire à deux rivières distinctes coulant dans le même sens et se rendant au fleuve Saint-Jean.

3. Le second passage du fleuve *Ca pititetchiouetz* (des Trois-Pistoles) offre une difficulté. Peut-être les sauvages désignaient-ils par le même nom les deux rivières des Trois-Pistoles et Acheberache

[1] loc. cit. pp. 83-84.

qui se dirigent vers des bassins différents mais sont pratiquement le prolongement l'une de l'autre et ont une source commune. Nous savons par ailleurs que c'était là un sentier de chasse ou de guerre très fréquenté. La Relation nous indique d'autre part que le voyage des Montagnais se fait en zigzag, circonstance qui achève de trancher la difficulté.

4. Le "fort beau lac" atteint après en avoir passé un plus petit serait le lac Témiscouata atteint par le lac Touladi. Du "Pain de sucre," en effet, le plus court chemin au lac Témiscouata passe par le lac Touladi.

5. Du "fort beau lac" les sauvages reviennent vers le Saint-Laurent en trois journées de marche forcée. Le lac Témiscouata est à environ trente milles de la côte; par le temps employé pour en revenir, il paraît assez vraisemblable que c'est de lui qu'il s'agit.

Malgré donc la base hypothétique sur laquelle repose cet essai d'interprétation géographique de la Relation de 1634, certains détails s'y adaptent si exactement que nous ne croyons pas téméraire de conclure que le P. le Jeune est le premier blanc qui ait séjourné aux environs du lac Témiscouata, que le bon missionnaire a visité cette région du Touladi et des Squatecks qui, après trois siècles, est encore à peu près vierge.

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Nos annales sont muettes sur les voyageurs qui firent le Portage du Témiscouata durant les cinquante années qui suivirent l'hivernement du P. le Jeune. Mais à cette époque, 1685 et 1686, s'inscrivent plusieurs voyages célèbres à travers les divers portages de l'Acadie. Ainsi l'intendant de Meulles partit de Québec à l'automne de 1685 et ne fut de retour qu'au commencement de 1686.[1] Le document Mercure indique l'itinéraire qui aurait été la rivière du Loup et le lac Témiscouata. Mais ce dut être en revenant, car, d'après Rameau de Saint-Père,[2] M. de Meulles s'embarqua à Québec, traversa le golfe Saint-Laurent et descendit sur les côtes de l'isthme de Shédiac. Le même document Mercure mentionne aussi un voyage de M. de Denonville en Acadie par la branche N.-O. de la rivière du Sud. Mais nous avons de bonnes raisons de croire que c'est là une erreur. Il est impossible, en effet, de concilier cette affirmation avec ce que le même M. de Denonville écrit au ministre, à la date du 10 novembre 1686[3] au sujet du voyage de Mgr. de Saint-Valier dont nous parlerons plus loin. Citons, entre autres discordances: "Le chemin que l'on m'a proposé pour se rendre en Acadie en 8 jours de temps." . . . "Je

[1] Ferland, abbé A., *Histoire du Canada*, II, p. 152.

[2] Rameau de Saint-Père, *Une colonie féodale en Amérique*, I, p. 165.

[3] *Collection de documents relatifs à la Nouvelle-France*, I, 669-70.

vousdrais bien avoir de plus certaines connaissances que j'en ai au sujet des intérêts et avantages de l'Acadie." . . . "M. de Meulles qui en arrive en est fort contristé." Et dans une autre lettre de la même date:[1] "Quand nous serons en repos, il faudra bien que M. de Champigny et moi y allions faire un tour." Il faut croire que le repos ne vint pas et que l'expédition de Catarakoui fit oublier au gouverneur ce projet de voyage.

Vers cette même époque, 1685, un mandement de monseigneur de Saint-Valier nous fournit un récit précieux au point de vue qui nous occupe. Laissons la parole à l'évêque lui-même.[2]

"Le voyage le plus long et le plus fatiguant que j'aie fait est celui de l'Acadie et du Port-Royal qui est distant de Québec de près de 200 lieues. Je partis le mercredi d'après Pâques, second jour du mois d'avril, malgré les glaces qui nous mirent plusieurs fois en péril, et qui nous retardèrent extrêmement.

"La rivière du Loup est la dernière habitation du Canada et un endroit fort propre pour y assembler les sauvages; on y en attendait une centaine dont le nombre s'augmenterait beaucoup en peu de temps si on pouvait leur donner un missionnaire comme ils le désirent et comme nous l'espérons. C'est là qu'étant un peu affaiblis par plusieurs jours de navigation et de marche très pénible, nous nous préparâmes par huit ou dix autres jours de repos à en essuyer de nouvelles. Nous nous remîmes donc en chemin le 7 de mai; j'avais avec moi deux prêtres et cinq hommes, qui devaient me servir de canoteurs, c'est-à-dire de gens destinés à conduire les canots sur l'eau, et à les porter sur terre quand il faut passer à pied d'un lac à un autre; ce qui arrive fort souvent et qui rend cette manière de voyager très incommode.

"Comme nos guides, pour prendre le plus court chemin, nous menaient par une route non fréquentée, où il fallait tantôt naviguer, tantôt marcher, dans un pays où l'hiver durait encore, nous rompions quelquefois les glaces sur les rivières pour faire passage aux canots et quelquefois nous descendions des canots pour passer sur les neiges et dans les eaux qui étaient répandues dans les espaces de la terre qu'on appelle portages, parce qu'il faut porter le canot sur les épaules.

"Pour marquer mieux notre route, nous donnâmes des noms à tous ces portages, aussi bien aux lacs et aux fleuves qu'il a fallu traverser. Nous naviguâmes sur les quatre rivières du Loup, des Branches, de Saint-François et de Saint-Jean; on fait peu de chemin sur les deux premières, on est plus longtemps sur les deux autres. Celle de Saint-François est plutôt un torrent qu'une rivière; elle est formée

[1] *loc. cit.* p. 388.

[2] Mandements des Evêques de Québec, I, pp. 211-124.

par la chute de plusieurs ruisseaux qui tombent de deux chaînes de montagnes dont elle est bordée à gauche et à droite; elle n'est navigable que depuis le 10 ou le 12 de mai jusque vers la fin de juin; pour lors elle est si rapide qu'on y ferait sans peine vingt à vingt-cinq lieues par jour si elle n'était pas traversée en trois ou quatre endroits par quelques arbres qui en chaque endroit occupent environ quinze pieds d'espace, et qui laisseraient le passage libre si on les coupait, comme on peut le faire avec fort peu de dépense; car on ne croit pas qu'il en coûtât deux cents pistoles à débarrasser le canal de ces obstacles qui retardent beaucoup les voyageurs.

"La rivière Saint-Jean a bien plus d'étendue et de beauté que celle-là; on dit qu'elle a près de quatre cents lieues de course et l'on en compte cent soixante depuis le lieu où nous la prîmes jusqu'à son embouchure; son cours est toujours égal, et les terres qu'on voit sur ses bords paraissent bonnes. On y trouve plusieurs îles fort agréables et quantité d'autres rivières fort poissonneuses au nord et au sud, qui, venant à s'y décharger, entretiennent son canal. Il nous a semblé qu'on pourrait y faire de belles colonies entre Medogtek[1] et Gemesech, et surtout dans un certain lieu que nous avons nommé Sainte-Marie, où la rivière en s'élargissant est entrecoupée d'un grand nombre d'îles qui seraient apparemment fort fertiles si elles étaient défrichées. Une mission pour les sauvages serait bien là: le terrain n'a pas encore de maître particulier, le Roi ni le gouverneur n'en ayant fait jusqu'à présent de concession à personne."

Avant et après le grand évêque de Québec, bien d'autres, sans doute, missionnaires, officiers, traiteurs ont fait ce voyage de l'Acadie par le portage du Témiscouata. Certains documents des archives de la marine (France) nous laissent entrevoir qu'au moment de la lutte suprême entre la France et l'Angleterre pour la domination en Amérique, cette route fut souvent utilisée pour le transport des dépêches.

"Je n'ai plus d'occasion de mer pour faire passer à Québec les deux paquets que vous m'avez adressés pour Mrs Vaudreuil et Bigot, mais je vais user de tous les moyens praticables pour les y envoyer par terre, en les confiant à deux personnes sûres qui iront prendre des sauvages à Miramichi d'où ils passeront à la rivière du Loup et de là descendront entre le Bic et les Camouraska; c'est la seule route qu'on puisse tenir aujourd'hui. . . ."[2]

"J'ai reçu depuis peu les lettres dont vous avez chargé M. de Macarty, commandant de la frégate "La Valeur." M. de Drucourt

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[1] Aujourd'hui Hayes Creek.

[2] Archives de la marine, Prévost au ministre, datée de Louisbourg, 30 octobre 1755.

me les a fait passer par la rivière Saint-Jean. Je n'ai pas perdu un instant pour faire repartir les mêmes courriers. . . ."[1]

Ce courrier qui transporta les dépêches apportées par "La Valeur" était vraisemblablement Gauthier, que nous croyons être l'un des fils de ce richissime acadien, Nicolas Gauthier, tour à tour colon, traiteur, armateur, corsaire, et qui fut ruiné par la guerre avec les Anglais.

Le courrier Gauthier se nommait Pierre et devait être âgé d'environ 37 ans. Les archives de la marine contiennent un récit détaillé de ce voyage écrit sur sa déposition.[2] Rameau de Saint-Père qui cite ce document[3] en supprime des parties importantes. Nous reproduisons ici le texte original d'après la copie manuscrite déposée aux archives du Canada, à Ottawa.

Voyage en hyver et sur les Glaces, de Chédaïque à Québec. (En l'hyver de 1755-1756).

"La communication par mer étant pour l'ordinaire totalement interrompue à la fin d'octobre ou au plus tard le 15 novembre, les Gouverneurs du Canada et de l'Isle Royale s'envoient une fois pendant l'hyver (le plus communément à la fin de mars) des courriers pour informer de ce qui s'est passé d'intéressant dans leur pays depuis l'interruption de la navigation.

"Ces courriers vont et viennent, de façon que pour l'ordinaire ils s'en retournent à l'endroit d'où ils sont partis. Ils sont ordinairement trois, gens connus, pratiques de la route à tenir et faits au genre de fatigues à essuyer.

"En 1756 il fut question de faire passer des paquets de la Cour de l'Isle Royale à Québec. A cet effet, l'on jeta les yeux sur un nommé Gauthier, habitant de l'Isle Saint-Jean, qui se trouvait pour lors à Louisbourg. La proposition qu'on lui fit de ce voyage ne lui déplut point, quoiqu'il ne connut ni sentiers ni chemin sur la route à tenir. Il l'accepta dans la confiance d'engager, en passant chez luy, un Acadien à l'accompagner, de se rendre ensuite de l'Ile Saint-Jean en canot à Chédaïque où il se proposait de prendre des sauvages pour guides et pratiques de ce voyage.

"Son arrangement eut son effet. Parvenus à Chédaïque, établissement du Roy et des sauvages et où commandait M. de Boishébert, lieutenant des troupes du Canada, ils furent à la rivière de Pécoudiac. Chédaïque est située sur une rivière qui débouche des côtés de l'est

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[1] loc. cit., Vaudreuil au ministre, datée de Montréal, 8 février 1756.

[2] *Archives de la marine:* Amérique du Nord, Nouvelle-France. Règlement des limites, Vol. 4. (F. 113 C.; Vol. 50, p. 172).

[3] Rameau de Saint-Père, *Une colonie féodale en Amérique*, pièces justificatives, p. 373.

de la grande terre dans le golfe Saint-Laurent et vis-à-vis celles de l'ouest de l'Isle Saint-Jean. La rivière de Pécoudiac débouche des côtés de l'est de la Baie Française et s'y confond. C'est un portage de six lieues d'un conduit à l'autre et beau chemin; il y a à la dite rivière six à huit habitations françaises.

"Remonté la dite rivière environ deux lieues; fait ensuite le portage nommé Ouaigesmock aussi de six lieues, jusqu'à une autre rivière dont on ignore le nom; il y a apparence que c'est celle de Chiamanisti. Point d'habitations dans cette traversée. L'on suivit cette rivière sur la glace jusqu'à Gensec, village français de 30 à 40 habitations situé un peu en deça de son débouché dans celle de Saint-Jean et à vingt-cinq lieues du fort français établi au confluent de cette dernière rivière dans la Baie Française. On estime avoir fait vingt lieues sur cette rivière.

"Gensec est situé à la rive gauche de la rivière Saint-Jean. Traversé la dite rivière et marché le long de la rive droite jusqu'à Hautepack, autre village français et de sauvages amalécites (*sic*) et où se tient le père Germain, jésuite, missionnaire de cette nation. On estime dix lieues de Gensec à Hautepack.

"Du village d'Hautepack, marchant toujours sur les glaces de la rivière Saint-Jean, parvenus à celui de Médoctec, aussi d'Amalécites (*sic*) établi de même que le précédent à la rive droite. On estime la distance d'entre ces deux villages de trente lieues; on y a employé trois jours.

"De Médoctec passé au Grand Saut, partie sur les glaces et l'autre sur les terres, attendu que la rivière était débordée et non gelée; fait trente lieues et employé onze jours à cause des mauvais chemins. Le Grand Saut est une chûte des eaux de la rivière, de cinquante à soixante pieds de haut; il y a un poste français muni de vivres pour les voyageurs. Au dit Grand Saut fait un portage demi-lieue, rentrés en dessus dans la rivière et fait trente lieues sur les glaces en trois jours jusqu'au débouché de la rivière de Madaouésca. Remonté la dite rivière de Madaouésca toujours sur les glaces et fait dix lieues en dix jours.

"Entrés ensuite dans le lac du nom de cette rivière, fait quatre lieues, et mis à terre à la rive gauche où se trouve un autre poste français. De là suivi la rivière du Cap à l'original (*sic*) qui débouche dans le fleuve Saint-Laurent et fait vingt lieues. Parvenus à son confluent, entrés dans le grand chemin qui conduit d'habitation à autre et tout le long du fleuve à la pointe de Léry (*sic*), fait trente-trois lieues en carriole. Traversé ensuite le fleuve d'un quart de lieue de largeur pour arriver à la basse-ville de Québec; longueur totale: 171 lieues $\frac{3}{4}$.

"On ne peut constater les journées qu'on emploie pour l'ordinaire dans ce voyage; c'est le plus ou moins beau temps qui en décide, et suivant comme les courriers se trouvent fatigués. Il est dur en hyver, et obligé à cabaner plus souvent qu'en toute autre saison et à se munir de vivres assez abondamment pour ne pas en manquer aux contretems imprévus qui ne surviennent que trop souvent.

(Non signé).

Le document ci-dessus nous apprend une chose importante, à savoir que, dès 1756, il y avait au moins deux postes français florissants dans ces régions: l'un au Grand Saut, l'autre à l'embouchure de la Touladi sur le lac Témiscouata. Lors du voyage de monseigneur de Saint-Valier, il est certain qu'il n'y avait pas un blanc depuis le Saint-Laurent jusqu'à Sainte-Anne (Frédéricton). Le premier essai de colonisation en ces contrées paraît dater du 29 novembre 1683 lorsqu'un fief comprenant deux lieues de profondeur tout autour du lac Témiscouata fut accordé aux enfants d'Aubert de la Chesnaye, Antoine et Marguerite-Angélique, deux jumeaux qui n'étaient encore âgés que de cinq mois! Une maison de pierre fut érigée près du lac et d'autres s'élevèrent dans le voisinage. Le sieur de la Chesnaye, qui avait le véritable génie du commerce et qui portait son activité d'un bout à l'autre du pays, avait espéré par cette création établir un courant de traite considérable entre la Rivière du Loup et la Baie Française. Cependant, pour des raisons inconnues l'établissement n'eut pas de succès et quelques années plus tard, on l'abandonnait.[1]

Malgré l'importance capitale du Portage de Témiscouata pour le transport des dépêches durant une moitié de l'année, il ne paraît pas que, sous le régime français on ait songé à ouvrir une route permettant l'établissement de communications plus faciles et plus régulières. Nous connaissons trop les raisons de cette incurie: de ce côté de l'Atlantique la ruineuse administration de Bigot et de ses complices, les tiraillements intérieurs et les trahisons; en France, la Pompadour et les propos cyniques de Voltaire. On avait bien autre chose à faire qu'à ouvrir des routes dans les arpents de neige!

II.

L'écroulement de la puissance française en Amérique ouvrit un nouveau chapitre dans l'histoire du Portage. L'Angleterre, pratiquement maîtresse du continent, songea de suite à organiser sa nouvelle conquête, à tracer des routes postales et militaires qui permissent l'administration et la défense du pays. Nous voyons arriver à ce moment dans l'Amérique Britannique du Nord, comme député

[1] P.-G. Roy, *La famille Aubert de Gaspé*, p. 34 et seq.

du Maître Général des Postes de l'Empire, l'un des plus grands hommes que le Nouveau-Monde ait produits et dont la figure originale occupe une place à part dans l'histoire et dans la science; je veux parler de Benjamin Franklin. Il fut le créateur du service postal canadien. Malgré son grand âge, il voulut visiter la partie septentrionale de son district, se rendit à Québec et à Montréal, y établit des bureaux de poste et organisa un service de courriers entre ces deux villes et New-York.

Mais le Nouveau-Monde n'était pas pacifié pour longtemps, et dix années ne s'étaient pas écoulées qu'éclatait la guerre de l'Indépendance. En mai 1775, Ethan Allen capture Ticondéroga. De ce fait, les relations postales sont coupées et ne reprendront que lorsque les colonies révoltées auront proclamé et assuré leur indépendance.

Durant toute cette période de transition le sentier des Micmacs et des trappeurs à travers la contrée déserte du Témiscouata fut utilisé par l'autorité militaire pour communiquer avec les colonies maritimes, et, l'hiver, avec la métropole. Le Portage proprement dit, le lac Témiscouata, la Madawaska furent parcourus par des courriers acadiens et sauvages dont la physionomie pittoresque s'esquisse dans les documents de l'époque. Ce sont, entre bien d'autres sans doute, les Desgranges, les Durand, les Deschamps, les Dufour, les Duperré, Higginbothan l'indien, Assam, les quatre frères Martin et surtout les trois Mercure: Louis, Joseph et Michel.

Louis Mercure est incontestablement la figure dominante de cette caste d'hommes physiquement incomparables qui, raquettes aux pieds, un lourd sac de dépêches sur le dos, s'aventuraient pour des semaines dans les solitudes témiscouatiennes. Il était né le 11 mai 1753 du mariage de Joseph Mercure, capitaine d'infanterie résidant à l'Isle Saint-Jean et de dame Anne Gauthier. Les documents[1] le nomment généralement Mercure l'Acadien et le représentent brave, fidèle, mais âpre au gain. Le gouverneur de cette époque qui n'est autre que le général Haldimand ne peut terminer une lettre à son collègue du Nouveau-Brunswick sans s'en plaindre piteusement.

Mercure semblait exercer une sorte de suzeraineté sur le Portage du Témiscouata, à tel point, paraît-il, que les autres courriers lui versaient la moitié de leur salaire. Nous voyons par des lettres du temps[2] qu'en 1782 un certain nombre d'entre eux sont à Québec et qu'ils réclament $100.00 pour leur voyage. On trouve la note élevée et un officier témoigne qu'il les a entendu dire "*that they go halves with Mercure.*" On leur donne enfin $50.00 et Mercure reçoit $30.00 de plus. Le 26 novembre, Haldimand écrit que Mercure a reçu $100.00

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[1] *Archives du Canada*, Collection Haldimand, B. 150, p. 145 et seq.

[2] loc. cit.

pour son voyage et recommande à son correspondant à l'autre bout de ne pas le payer deux fois. Tous ces détails sont topiques et projettent une lumière crue sur certains petits côtés de la grande histoire.

Dans le voyage qu'il fit l'année suivante, 1784, Mercure eut une aventure assez curieuse. En remontant le fleuve Saint-Jean, il avait été suivi par des sauvages du Maine. Arrivé à l'embouchure de la rivière Saint-François, Mercure qui connaissait les superstitions des Indiens, s'avise d'un stratagème pour s'en débarrasser. Il y avait à cet endroit une hutte où les courriers avaient l'habitude de passer la nuit. Il y entra et fit ses préparatifs comme s'il avait voulu y dormir, mais entre le lit de branches de sapin et la couverture il glissa un morceau de bois de la taille d'un homme et se mit à l'affût à quelque distance. A la nuit tombante, les sauvages, comme l'avait prévu Mercure, se faufilèrent avec mille précautions dans la hutte et se mirent à frapper à coups redoublés sur le pseudo-courrier. Selon leur habitude ils mirent leur déconvenue sur le compte du Mauvais Esprit qui était intervenu en faveur de Mercure et le laissèrent tranquille.

Mercure habitait alors à Aukpaque[1] à six milles au-dessus de Frédéricton. Vers ce même temps le gouverneur Parr, du Nouveau-Brunswick lui fit présent de l'île Bagweet qu'il convoitait depuis longtemps.[2]

Louis Mercure partage avec Duperré et Lizotte l'honneur d'avoir fondé en 1785 la colonie acadienne de la Madawaska. Son crédit auprès du gouverneur lui fut d'un grand secours pour obtenir de Carleton une concession importante s'étendant de la Madawaska à la rivière Verte, des deux côtés de la rivière Saint-Jean. Chaque famille reçut deux cents acres avec un front de soixante perches. Ces gens dont Mercure avait pris en mains les intérêts étaient des Acadiens dépossédés en 1755, fixés sur la rivière Saint-Jean et dépossédés encore au profit de loyalistes américains et de soldats congédiés qui n'eurent, dit Casgrain[3] "qu'à s'asseoir à leurs tables pour manger leur pain et devenir du jour au lendemain rois et maîtres des propriétés arrosées par les sueurs de la race proscrite. Ces malheureuses familles, impuissantes contre la force, n'eurent qu'à reprendre le chemin des forêts. Elles remontèrent la rivière Saint-Jean, à trente lieues de toute habitation, et ouvrirent, la hache à la main, les plateaux de la Madawaska où elles se multiplièrent avec la fécondité qu'on leur connaît."

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[1] Variantes: Hautepaque, Hautepack, Ottopaque, etc. (Voir "Journal de Durand").

[2] Winslow papers.

[3] Casgrain, abbé H.-R., *Les Acadiens après leur dispersion*, Mem. Soc. Roy. Can. 1887. Sect. I, p. 15.

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Quelques mois après la signature du traité de Versailles, en 1783, le service régulier des paquebots (packet-boats) entre Falmouth, (Angleterre), et New-York, fut établi et les marchands de Québec et de Montréal réclamèrent de Hugh Finlay, député du Maître des Postes, l'établissement de courriers entre leurs villes respectives et Albany, pour leur permettre de profiter de cette voie de communication. Or, comme il n'y avait pas de service régulier entre Albany et New-York, Hugh Finlay crut devoir donner des instructions à ses courriers de continuer leur chemin jusqu'à cette dernière ville, ce à quoi les Etats-Unis s'objectèrent exigeant que les lettres ou dépêches fussent déposées par les courriers canadiens au bureau de poste d'Albany pour passer ensuite, moyennant finance, sous le contrôle du Maître des Postes des Etats-Unis. A force d'instances, Hugh Finlay obtint le passage pour ses courriers jusqu'à New-York, mais à la charge de payer à la poste américaine trois shellings sterling par once "*bag and all*" dit le très intéressant document que nous avons sous les yeux.[1] De plus, M. Hazard, Maître des Postes de l'Union, annonçait son intention d'établir un bureau de poste sur la ligne quarante-cinquième pour retirer le plus grand profit possible du passage des dépêches canadiennes, en chargeant au *pro rata* de la distance, même quand cette distance serait parcourue par des courriers canadiens.

Ces exigences grevaient lourdement le budget des postes canadiennes. Si l'on ajoute le danger d'exposer à la violation le secret des dépêches officielles, on comprend que dès 1783, on ait songé à se libérer de cette servitude, en essayant d'établir une communication permanente avec le Nouveau-Brunswick par le Portage du Témiscouata.

Le 29 mai 1783, le général Haldimand, apparemment de sa propre initiative, émettait un ordre à l'effet de faire ouvrir un chemin reliant le Saint-Laurent au lac Témiscouata, et confiait à M. Jean Renaud, grand-voyer, la conduite de cet ouvrage et celle des miliciens qui devaient y travailler. Des ordres furent donnés aux capitaines des milices des paroisses "d'en-bas" de fournir des gens de corvée à tour de rôle à la demande de M. Renaud. Ces corvéables furent payés six deniers par jour, nourris et fournis des outils nécessaires, avec des conducteurs qui furent payés à raison de dix shellings par jour.

Nous avons du sieur Jean Renaud[2] un rapport détaillé de ce travail. Nous le citerons en entier, car, outre qu'il est complètement

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[1] Smith, M. W., *Address to the Convention of N. Y. State Postmasters.* Proc. of the 5th Annual Convention of N. Y. Postmasters, June 4th and 5th, 1912.

[2] Archives du Canada.

inédit, il nous apprendra dans quelles conditions se faisaient les travaux publics il y a un siècle et demi.

"Rapport du Portage du lac Témiscouata."

En vertu d'un Ordre de Son Excellence le général Haldimand du 29 mars dernier portant ses instructions de faire ouvrir la communication qui conduit au lac Témiscouata et d'employer à cet ouvrage les habitants des paroisses voisines par corvée, leur allouant par voie d'encouragement un petit salaire et des vivres, et Son Excellence nous ayant confié la conduite des travaux ainsi que celle des miliciens; nous, Jean Renaud, grand-voyer du district de Québec, accompagné de l'Hon. Jean Collins, Ecr., député arpenteur-général, nous sommes exprès transportés à la rivière des Caps, en bas de Kamouraska, où, ayant engagé trois guides au fait et connaissant le Portage du dit lac, et commandé un parti de onze hommes, nous avons cherché en descendant le long du fleuve un endroit commode pour monter les côtes de la mer qui sont partout fort escarpées, et ayant trouvé un endroit qui nous a paru le plus favorable à environ six lieues plus bas que l'église de Kamouraska et près de l'endroit où l'ancien sentier était pratiqué, nous avons plaqué les dites côtes en les élongeant (*sic*) le long des Caps et nous avons continué de plaquer jusqu'à la rivière du Loup, environ une lieue et demie dans les terres, poursuivant en général la direction du sud-est. Là, laissant M. Collins avec le dit parti et les guides pour poursuivre jusqu'au lac et plaquer le chemin dans les plus beaux endroits possible, suivant toujours la même direction sud-est, nous sommes revenus sur nos pas à la rivière des Caps pour commander les miliciens, savoir: de la compagnie de la rivière des Caps, 21 hommes; de la seconde compagnie de Kamouraska, 21 hommes; de la première compagnie de dite, 41 hommes; de la rivière Ouelle, 51 hommes; de Sainte-Anne, 51 hommes, faisant en tout 185 hommes, pour travailler dix-huit jours. Après leur avoir livré des vivres, nous les avons mis à l'ouvrage le douze juin, ouvrant le chemin et les côtes de douze pieds de large, arrachant les arbres, ôtant les souches, roches, cailloux, abattant les buttes et remplissant les trous. Mais, ayant trouvé des bas-fonds de cédrières et épinettières fort longs et pleins d'eau sans beaucoup d'égoût, nous avons été obligé de ponter ces endroits avec des lambourdes hautes de deux pieds à deux pieds et demi et des pièces de six pieds à travers, et de distance en distance, de quinze pieds.

Ces travaux étaient si pénibles par la longueur des ponts dont l'un en particulier est de dix-huit arpents, et le transport du bois propre pour les faire à bras d'hommes que cette corvée n'a pu pénétrer que jusqu'à la dite rivière du Loup, laquelle a huit perches de large et où nous avons fait deux bons canots de bois pour la traverser. M. Collins retourna du lac avec son parti après quatorze jours de marche et travaux, ayant plaqué et chaîné le chemin et posé des poteaux chaque demi-lieue, marquant la distance qui s'est trouvée de douze lieues et seize arpents, depuis le fleuve Saint-Laurent jusqu'au dit lac Témiscouata.

Ayant d'avance envoyé des commandements aux capitaines des paroisses de Saint-Roch, Saint-Jean et l'Islet, pour fournir chacun 61 hommes faisant en tout 183 hommes, pour travailler pendant 21 jours, ils arrivèrent au Portage le 29 de juin et leur ayant délivré des vivres le 30, ils furent mis à l'ouvrage et relevèrent la première corvée d'hommes qui fut congédiée.

Nous continuâmes l'ouverture du dit chemin de douze pieds de large faisant des ponts sur les rivières et les ruisseaux, particulièrement un pont de 45 pieds d'ouverture et 100 pieds de pavé sur la rivière Verte, à 9 lieues en deçà du lac, et un autre pont de 36 pieds d'ouverture et 64 de pavé sur la rivière Saint-François, à 7 lieues du dit lac, et ainsi des autres sur de plus petites rivières et ruisseaux qui sont fort nombreux, ce qui augmenta beaucoup l'ouvrage et la saison étant déjà avancée par rapport aux travaux des habitants, il ne resta plus de temps pour ponter les bas-fonds de la même manière que nous les avons faits jusqu'à la rivière du Loup, mais seulement avec des pièces mises côte à côte sur la longueur du chemin; prévoyant que cette seconde corvée ne pouvait pas pénétrer jusqu'au lac, nous fîmes encore un commandement de 21 hommes de la rivière des Caps, 16 hommes de la seconde compagnie de Kamouraska, 26 hommes de la première compagnie de dite, 31 hommes de la rivière Ouelle, et 31 hommes de Sainte-Anne, en tout 125 hommes pour travailler 16 jours. Ils se rendirent le 4 juillet; ils furent mis à l'ouvrage, les étendant comme les autres par petits partis dans le bois, pour ouvrir le chemin toujours de douze pieds suivant en général les plaques faites par M. Collins. Le 20 juillet, ayant fini l'ouvrage du dit chemin jusqu'au lac tous les hommes furent congédiés et renvoyés chez eux.

Mais pour qu'on pût rouler en voiture sur toute la longueur de ce chemin il restait à faire un endroit près de la rivière Saint-François, appelé la lieue des Roches qui est plein de gros cailloux où il était nécessaire de miner, et, n'ayant ni mineurs ni outils propres à miner nous en fîmes à notre retour la représentation à Son Excellence à qui il a plu d'envoyer un parti de mineurs avec un assistant-ingénieur pour faire sauter ces roches et cailloux, et, par son ordre, nous avons commandé le 13 septembre 24 hommes de la rivière des Caps et Kamouraska pour servir les mineurs et faire cette partie du chemin.

Comme ce chemin conduit sur le travers du pays, il croise toutes les montagnes qui sont fort fréquentes et quelques-unes très hautes; et alternativement il se trouve des bas-fonds où les eaux séjournent n'y ayant pas beaucoup d'égoût et le soleil ne pouvant y pénétrer, à cause des bois touffus, il était donc nécessaire de ponter, mais si jamais cette partie du pays s'établit, ces pontages ou chaussées ne seront plus utiles parce que les terres se débarrassant, l'eau trouvera naturellement son cours et le soleil aidera à les assécher. Nous avons trouvé plusieurs endroits où la terre parait très bonne et propre à être cultivée.

Québec, le 26 janvier, 1784.

JEAN RENAUD,
Voyer du district.

Dès les premiers jours du mois de janvier de cette année de 1784, les courriers recommencèrent à circuler à travers le Portage et à utiliser la nouvelle route, bien imparfaite encore. Le courrier Durand fut désigné pour en faire l'essai. Rien ne donnera une meilleure idée des conditions de ce temps que le journal qu'il tint de ce long et dangereux voyage.[1] Nous le reproduisons en en modifiant l'orthographe pour le rendre intelligible.

JOURNAL COMMENCÉ DEPUIS MON DÉPART DE QUÉBEC POUR HALIFAX LE 11 JANVIER 1784 JUSQU'À MON ARRIVÉE LE 24 AVRIL DERNIER. (1784).

Janvier 12.—Au Cap Saint-Ignace (Ne pouvant faire plus de diligence) nous sommes arrivés n'y ayant aucune poste à régler, ayant perdu autant de temps pour attendre les voitures qu'il en faut pour faire la route.

Janvier 13.—Aux Kamouraska j'ai été obligé de rester trois jours pour attendre que le guide et nos vivres fussent prêts pour la route.

Janvier 17.—A l'entrée du Portage.

Janvier 18.—A six heures du matin, nous sommes entrés dans le Portage et nous avons été coucher dans les côteaux de la rivière Verte.

Janvier 19.—Nous avons eu une bordée de neige d'environ deux pieds et nous avons été coucher à la rivière Saint-François.

Janvier 20.—Sur la montagne de la Petite Fourche nous avons été obligé de laisser nos charges et d'aller battre le chemin pour pouvoir passer notre bagage.

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[1] Archives du Canada.

Janvier 21.—Au pied de la grande montagne du lac Timisquata. Nous n'avons point trouvé aucune bonne cabane tout le long du Portage. Et le 22ième, du lac qui a environ 5 lieues.

Janvier 23.—A l'éntrée de Madaouisqua, à deux lieues de distance la rivière aux Bouleaux; à cinq lieues de distance la rivière à la Truite, du côté du sud.

Janvier 24.—A environ la moitié de Madaouisqua les terres y sont un peu basses tout le long de la rivière et les montagnes sont environ trente arpents éloignées de la rivière.

Janvier 25.—A la rivière Saint-Jean, aux environs de deux lieues de distance de la rivière, et les montagnes sont environ trente arpents éloignées de la rivière Oroquoise portant canot aux environs de dix lieues, à deux lieues de distance.

Janvier 26.—A Marton, rivière portant canot environ trente lieues de distance; Moriagippis portant canot aux environs de quarante lieues à trois lieues de distance; la Grande Rivière portant canot pour aller à Miramichi; à deux lieues de distance une autre rivière dont je n'ai pu savoir le nom, portant canot; les rivières mentionnées ci-dessus sont toutes du côté du nord.

Janvier 27.—A quatre lieues de distance, le Grand Saut où l'on peut faire de beaux établissements; bonnes terres; le dessus des montagnes garni de beau bois franc, et bien planche; le bord de l'eau garni de sapinages; à deux lieues de distance, la rivière aux Saumons au nord.

Janvier 28.—A six lieues de distance à Jacques du Bell et grande rivière portant canot aux environs de soixante lieues du côté du sud, bonne terre garnie de bois franc et le bord de l'eau de sapinages et de pins; à deux lieues de distance la rivière à Gaubis portant canot aux environs de vingt lieues du côté du nord.

Janvier 29.—A quatre lieues de distance, la rivière de Moinriche portant canot aux environs de neuf lieues de distance, la rivière de Chûte, portant canot, aux environs de dix lieues du côté du sud; à deux lieues de distance la rivière de Manquate portant canot du côté du nord.

Janvier 30.—A deux lieues de distance, la rivière Chituac portant canot du côté du nord.

Janvier 31.—Dégradé deux jours par la pluie.

Février 3.—A six lieues de distance la rivière Madociquée, du sud, portant canot. Il fait un grand froid. La glace était comme un miroir. A trois lieues de distance la rivière aux Anguilles, au sud, portant canot; à cinq lieues de distance la rivière Fécontrande, portant canot, du sud.

Février 4.—A une lieue de distance la rivière Annataoise portant canot, au nord.

Février 5.—A six lieues de distance, Ottopacque, première habitation française. A huit heures du soir, nous avons eu un grand coup de vent, et il est tombé un pied de neige.

Février 7.—J'ai parti d'Ottopacque à six heures du matin en canot et ai été obligé de prendre beaucoup de précautions à cause des voleurs et ai mis mon argent dans mes souliers sauvages.

Février 8.—A Grintassé où j'ai eu le bonheur de rencontrer quatre hommes qui faisaient route pour le fort Howe; ils m'ont demandé compagnie, ce que nous avons fait et avons continué notre route tous les sept.

Février 9.—A la Pointe d'Herbe, environ dix heures du matin, distance d'un mille dans le Portage, nous avons rencontré cinq voleurs avec un traîneau sur lequel il y avait cinq fusils avec du butin, et nous ont passé sans nous attaquer, et à une lieue de là nous avons entré dans une auberge où on nous a demandé si nous avions rencontré cinq voleurs qui avaient volé la nuit d'avant dans une maison et avaient volé tout ce qu'ils avaient trouvé, et lié et amené ceux qui étaient dedans.

Février 10.—Arrivé au fort Howe à dix heures du matin.

Février 22.—Parti du fort Howe à dix heures du matin.

Février 23.—Arrivé à Annapolis Royal à quatre heures après-midi.

Février 24.—Parti d'Annapolis .Royal à huit heures du matin.

Février 25.—A Granville.

Février 26.—A Wilmot.

Février 27.—A Windsor.

Février 28.—A Presser.

Février 29.—J'ai arrivé à Halifax à cinq heures du soir.

Mars 11.—J'ai parti d'Halifax à cinq heures du soir.

Mars 12.—A Presser.

Mars 13.—A Windsor.

Mars 14.—A Cornwallis.

Mars 15.—A Wilmot.

Mars 16.—Les habitants n'ont pas pu me dire le nom de l'endroit.

Mars 17.—A Granville.

Mars 18.—J'ai arrivé à Annapolis Royal à cinq heures du soir.

Mars 19.—J'ai parti d'Annapolis Royal le matin.

Mars 23.—Arrivé au fort Howe à trois heures après-midi.

Mars 24.—J'ai parti du fort Howe à neuf heures du matin avec trois canadiens qui retardaient leur voyage depuis plusieurs jours pour avoir compagnie pour monter dans la rivière. Dans la baie du Portage, notre cheval et canot ont calé dans l'eau. Heureusement que nous étions plusieurs qui nous ont aidé à le retirer après une heure et quart de travail. Nous avons manqué de perdre deux hommes. J'ai aussi calé moi-même une fois jusque dessous les bras, et, malgré le secours, on n'a pu me retirer qu'à la troisième reprise, la glace recassait toujours sous moi; le trou était d'au moins trente pieds de long; par bonheur que le canot n'a point tourné, le paquet du roi a resté à flotte dedans. Je n'ai perdue que mes deux pistolets qui étaient à ma ceinture.

Mars 25.—J'ai couché à la Pointe d'Herbe.

Mars 26.—A Grintassé, la rivière brisée à plusieurs endroits par la chaleur continuelle.

Mars 27.—Arrivé à Autepaque à sept heures du soir.

Mars 28.—Il a mouillé et tonné toute la journée ce qui me donna espérance que nous aurions du froid pour nous rendre. Effectivement, le lendemain, il ventait nord-ouest, et il fit un grand froid.

Mars 29.—Parti de Autepaque à six heures du matin.

Mars 30.—A Madossique.

Mars 31.—Dégradé par la pluie; la rivière déprise; nous avons fait environ deux lieues dans le bois pour nous rendre à des cabanes sauvages, pour prendre un canot d'Ecosse (*sic*). Nous avons vu un peu plus loin que la rivière était déprise. J'ai dit au guide que nous avions quatre-vingt lieues à faire et que nous ne trouverions peut-être pas plus de dix lieues de dépris, qu'il ne serait pas possible de traîner notre canot si loin. Il m'a approuvé.

Avril 1.—Nous avons parti; il avait bien gelé dans la nuit; nous nous sommes rendus jusqu'à la Presqu'île; il y avait environ dix pouces d'eau sur la glace par endroits.

Avril 2.—Aux environs de trois lieues de la Presqu'île nous avons trouvé toutes les glaces refoulées de la rivière dans son entrée. Le guide me dit qu'il pensait que nous serions obligé de nous en retourner; je lui dit qu'il fallait toujours poursuivre notre chemin jusqu'à l'extrémité. Nous avons fait environ deux lieues et demi dessus toutes les glaces; les glaces étaient seulement collées l'une contre l'autre; en sondant, nos bâtons passaient au travers. Le guide me disait à chaque instant qu'il fallait gagner le bois, qu'il ne voulait pas périr. Je lui dis que j'allais poursuivre ma route avec mes chiens qui traînaient le bagage. Le guide pour lors me laissa et gagna le bois; il ne fut environ une lieue qu'il fut obligé de venir me rejoindre; il ne pouvait plus porter ses raquettes dans le bois tant il dégelait. Nous avons fait environ quatre lieues comme ça; nous avons trouvé la rivière nette comme dans l'été; alors nous avons gagné le bois. On nous avait dit qu'il y avait des Français à une lieue plus haut de Namequarte, qui étaient à la chasse; nous nous y sommes rendus, et, y étant arrivés on nous dit que toute la glace était partie depuis le Grand Saut jusqu'à Namequarte depuis le 16 mars; et il plut toute la journée.

Avril 3.—Il mouilla jusqu'à midi. Pour lors je demandai au guide quel parti prendre; il me répondit qu'il fallait nous en retourner, que les vivres allaient nous manquer. Je lui dis qu'il fallait faire l'impossible; il me dit pour lors que, si je voulais me mettre dans le péril, pour lui qu'il ne le voulait pas, et qu'il était impossible d'aller par terre parce que les rivières et les ruisseaux étaient inondés. Je lui dis qu'il fallait aller chercher un canot en quelque endroit; il me dit que je ne savais ce que je disais. Il avait raison.

Avril 5.—Il me proposa que si je voulais engager un de ces hommes pour venir avec nous qusqu'à la Témisquata, qu'il ferait un canot de bois. Je lui dis que je savais percher et nager; il me dit que je ne connaissais pas la rivière et que nous courrions plus de risques. J'engageai cet homme pour quatre louis et fis un canot. Quand il fallut embarquer, il ne voulait plus venir avec nous, me disant qu'il y avait trop de risque, que la rivière était trop mauvaise. Pour lors je pris une perche en disant: "Allons à la grâce de Dieu!"

Avril 7.—Nous avons parti et n'avons pu faire qu'aux environs d'une lieue que nos perches étaient si grosses de glace qu'on avait de la peine à les lever, et les glaces drivant (*sic*) ne nous permettaient pas de faire davantage.

Avril 8.—Dégradé par les glaces.

Avril 9.—A la rivière Monache.

Avril 10.—A la rivière Tobie, les battures de glaces étaient si au large qu'on ne trouvait pas de fond, l'on ne pouvait plus percher, et la rapide était si fort que l'on ne pouvait plus monter la rivière à l'aviron. Nous avons tiré notre canot sur la glace et nous n'avons pas pu en venir à bout; pour lors nous le mîmes dessus une traine sauvage, et nous avons attelé nos chiens dessus et nous avons fait environ trois-quarts de lieue. Si nous n'eussions pas eu de chiens nous ne nous serions jamais rendus, parce que je pensais que si nous eussions manqué de vivres nous les aurions mangés; c'est ce qui me fit entreprendre le voyage.

Avril 11.—Dégradé par les glaces drivantes.

Avril 12.—A la rivière aux Saumons où nous avons acheté un canot d'Ecosse (*sic*) aux sauvages.

Avril 13.—Au grand Saut.

Avril 14.—Quand nous eûmes fait notre portage en haut du Grand Saut nous avons trouvé la glace bien mauvaise qui nous a obligé de faire un grand traîneau et nous avons mis notre canot dessus, et attelé nos chiens qui ont mené notre canot et notre bagage quinze lieues. La pluie a prise à midi et nous avons couché à Moque Mequoiton.

Avril 15.—Au poste de Madaouesca toujours la pluie sur le corps. Aux environs de deux lieues de Madaouesca nous avons trouvé la rivière déprise et nous avons embarqué dans notre canot et avons été coucher au poste de Madaouesca.

Avril 16.—Dégradé par la neige et n'ayant plus de vivres. (Je devais être au poste de Témisquata).

Avril 17.—A la rivière à la Truite.

Avril 18.—Au Dégelé; nous avons eu des vivres des Français qui étaient là.

Avril 19.—A la Petite Fourche, dans le Portage.

Avril 20.—A la rivière des Caps.

Avril 21.—Au Kamouraska.

Avril 22.—A Saint-Roch.

Avril 23.—A Beaumont.

Avril 24.—A Québec.

J'ai examiné les places pour la facilité de la poste. Je prévois qu'il n'y a pas de meilleur moyen pour la diligence des postes, que d'établir une maison au bout du Portage, une au poste de Madaouesca et une au Grand Saut, parce qu'il ne sera jamais possible de courir la poste par terre à cause que les montagnes sont trop près de la rivière, à cause des coulées et de la quantité des rivières et des ruisseaux; cela causerait trop de difficultés et on y mettrait un temps considérable. Les voitures convenables pour ces endroits-là seraient la berge ou bateau, au lac, pour aller au poste de Madaouesca, d'autres aussi convenables pour aller au Grand Saut, pour se rendre au fort Howe. En quatre ou cinq jours on peut faire cette route; l'hiver il serait facile de faire tenir les paquets ou autre chose qui sera au bout du Portage. Sur le lac la glace est toujours bonne; il n'y a qu'à Madaouesca qu'elle n'est jamais bien bonne; on peut faire un chemin d'hiver qui ne coûterait pas beaucoup. Il n'y a que dix lieues pour se rendre au poste de Madaouesca qui est à l'entrée de la rivière Saint-Jean; pour aller au Grand Saut, il n'y a que quinze lieues; la glace y est toujours bonne. Il faudrait un chemin d'environ deux lieues par rapport à la chute que le rapide occasionne; la glace n'est jamais bien bonne. Je pense que ce serait assez d'un seul homme pour avoir la conduite sur ces trois postes-là, pour faire tenir le chemin en bon ordre."

Ici finit le journal de Durand, document de piètre valeur littéraire, comme on pouvait s'y attendre, mais qui nous renseigne exactement sur le régime postal vers 1784.

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L'ouverture du Portage du Témiscouata n'était encore le fait que de la propre initiative du gouverneur, et les minutes du Conseil ne commencent à le mentionner qu'à la date du 23 mai 1785, lorsque "Son Honneur le Lieutenant-Gouverneur dépose devant le Conseil une proposition de l'honorable Hugh Finlay, Ecuyer, Maître Général des Postes pour la Province, ayant pour objet l'ouverture d'une route de Kamouraska au lac Témiscouata, et accompagnée d'un calcul des dépenses."

Ce calcul qui ne manque pas d'intérêt se lisait ainsi:

	£	s	d
50 men will consume 1500 rations in a month, which suppose a sum for rations delivered of........	75 :	0 :	0
Wages for 50 men per month......................	93 :	15 :	0
Rum at ½ pt. per day, 120 gs......................	30 :	0 :	0
Overseer, a dollar per day........................	7 :	0 :	0
Expense per month......................	205 :	15 :	0
Say it will take 2 months....................	205 :	15 :	0
Utensils, implements, etc.........................	50 :	0 :	0
	461 :	10 :	0

Les opinions des membres du Conseil paraissent avoir été divisées. Comme il s'agissait d'une route dont le bénéfice allait surtout au gouvernement de Sa Majesté, on aurait voulu lui faire porter entièrement la dépense, et attendre l'opinion des ministres de la métropole. Néanmoins, vu l'urgence, on s'accorda à laisser provisoirement poursuivre les travaux. A une réunion du Conseil tenue l'année suivante, le 4 avril 1786, la question est encore posée, et le vote est pris; sept des conseillers votèrent la continuation des travaux: Holland, De Léry, Pownall, Collins, Lévesque, Finlay et le gouverneur. Les dissidents au nombre de cinq étaient: Baby, Saint-Ours, Caldwell, Mabane et Harrison.[1]

Un rapport du 31 octobre 1786 nous apprend que cette année-là l'on continua de travailler au chemin sur un autre plan; on l'élargit et les gens qu'on y employa furent sous la conduite des capitaines Dambourgès et Los.

En 1798, le grand-voyer d'alors, M. G. Taschereau, fait rapport que le chemin ne fut pas terminé et que, à partir de 1786, il s'était gâté en beaucoup d'endroits. Une déclaration d'un nommé Desgranges, "courrier depuis Québec jusqu'au Grand Saut," attira l'atten-

[1] Archives du Canada, B. 14.

tion sur cet état de choses. On n'était plus au temps d'Haldimand, et, comme il s'agissait en l'espèce d'une route pour le service spécial de Sa Majesté, on ne put appliquer facilement la loi de corvée. Dans une lettre datée du 15 novembre 1798, le grand-voyer expose le cas au gouverneur Prescott:

"Suivant les informations que le grand-voyer a prises tous les ans lors de ses tournées de l'état de ce chemin, il lui a été dit qu'il n'avait point été entièrement rachevé et que, depuis 1786, il s'est gâté en beaucoup d'endroits et qu'il était, dès avant la déclaration de Desgranges le courrier, dans un mauvais état; mais ce chemin n'étant pas autorisé suivant les lois de cette Province et n'étant pas, par conséquent, sous la direction du grand-voyer, il ne lui paraît point de sa compétence d'en ordonner les travaux et réparations, qu'il ne pourrait même ordonner en Loi (supposant qu'il fut requis de l'autoriser par un procès-verbal) qu'à ceux à qui il serait particulièrement utile; et comme il ne paraît point particulièrement utile aux habitants cultivateurs de cette Province, il ne serait pas légal au grand-voyer d'en faire une imposition sur une partie de ces Habitants, ce qui laisse croire que ce chemin n'étant encore nécessaire qu'au service particulier du gouvernement pour l'intérêt de cette province, devrait être un objet de la législation.

"Le grand-voyer observe très respectueusement à Votre Excellence qu'il ne lui paraît point qu'il y ait dans cette province d'autre loi qui autorise de prendre des corvées sur les habitants, que pour les objets qui concernent les bateaux et transport des troupes lorsqu'elles sont en marche (Ordonnance du Conseil Législatif du 23 avril 1787) de sorte qu'un habitant qui se refuse au commandement qui lui serait fait d'aller travailler dans un chemin où il ne serait point obligé par un procès-verbal du grand-voyer ne pourrait point être poursuivi pour sa désobéissance.

"Quant à l'état actuel du chemin, les déclarations de Desgranges et autres prouvent qu'il est absolument impraticable et que le courrier ayant été obligé de prendre une autre route s'est écarté pendant un jour et demi, ce qui pourra encore être le cas et peut-être avec des suites plus fâcheuses.

"Comme il est très difficile en cette saison de débarrasser ce chemin et qu'une bordée de neige pourrait en arrêter absolument les travaux, le grand-voyer pense que l'on pourrait envoyer des guides et des hommes avec eux pour plaquer et pour tracer pour le moment un nouveau sentier où l'on éviterait les embarras que les arbres abattus par le vent ont faits sur le chemin, et que, par ce moyen, le courrier pourrait passer avec sûreté."

Ce document permet de saisir sur le fait la différentiation qui commençait dès lors à s'opérer entre les administrations civiles et militaires. La solution de la difficulté est pour le moins curieuse. Elle vint du Nouveau-Brunswick, directement intéressé, à d'autres titres cependant que le gouvernement impérial, à la libre communication avec le Canada.

Le 11 octobre 1799, M. J. Odell, secrétaire de la province du Nouveau-Brunswick charge, au nom de Son Excellence le gouverneur, M. Augustin Duplessis, "proche de la rivière du Cap" de rendre commodément passable le chemin du Grand Portage; il ordonne en même temps à un nommé Martin de faire le même travail du côté de la Madawaska. Les entrepreneurs devaient recevoir une piastre gourde par jour, et les hommes une demi-piastre.

Sans qu'il soit facile de savoir pourquoi, le grand-voyer Taschereau nomma quelques jours plus tard, le 7 novembre 1799, le même Duplessis, "maître de poste à la rivière des Caps," pour faire les travaux sur le chemin du Portage. Le même jour il mande à Ryland qu'il croit bon de nommer le sieur Duplessis "car il est déjà, écrit-il en ouvrage sur ce chemin." Il ajoute que, lorsqu'il présentera son compte de dépenses, il verra s'il n'a pas été payé deux fois. Duplessis certifia par la suite avoir débarrassé le chemin du Portage du Lac Témiscouata de 12 à 20 pieds, et que le montant des dépenses se chiffrait à soixante-quatre louis; il ajoutait qu'il n'avait reçu la lettre du grand-voyer qu'à son retour chez lui, son ouvrage terminé. Les documents n'indiquent pas de quelle bourse sortirent les soixante-quatre louis. Il est à croire que le grand-voyer, voyant le Nouveau-Brunswick prendre les devants, et craignant d'être accusé de négligence, imagina cette petite manœuvre de nommer le sieur Duplessis "déjà en ouvrage sur le chemin." *Nihil novi sub sole!*

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Haldimand avait vu juste en ordonnant dès 1783 l'ouverture de la route du Témiscouata. Les guerres américaines allaient éclater de nouveau et le Portage était appelé à fournir entre les colonies de l'Angleterre une liaison d'une valeur incalculable. Ce qu'était cette voie militaire à l'époque de la guerre de 1812, il nous est possible de le savoir par un ouvrage du temps.

"A environ quatre milles trois quarts de la rivière des Caps commence le Portage de Timiscouata, et comme c'est la seule route par terre de Québec à Halifax, pendant une distance de 627 milles, elle est très importante et peut-être sera-t-on bien aise d'en avoir une description particulière. Elle fut ouverte pour la première fois en 1783, par le général Haldimand, alors gouverneur, mais bien des personnes la considérèrent alors comme si pleine d'obstacles et de difficultés qu'il serait impraticable d'y établir un passage régulier; cependant la persévérance, jointe aux attentions qu'on y a données de temps en temps, a clairement démontré le contraire, et elle forme à présent une communication susceptible à la vérité de très grandes améliorations, mais qui est ouverte toute l'année, et par où passe toujours la malle d'Angleterre, quand elle a débarqué par le paquebot à Halifax. Depuis la grande route du Saint-Laurent, où la route du Portage s'embranche, jusqu'à la Ferme de Long sur le bord du lac Timiscouata, la distance est de 37 milles; la route se dirige généralement à l'est, mais elle prend un grand nombre de détours pour éviter de monter plusieurs collines très hautes et très escarpées, ou de traverser des marais profonds; cependant elle passe pendant environ 24 milles de cette distance sur une suite de montagnes dont plusieurs sont rudes et très escarpées, mais il n'existe aucun de ces obstacles formidables qu'on croyait d'abord insurmontables, et même quelques efforts, joints à une dépense peu considérable, rendraient cette route aussi commode et aussi bonne pour voyager qu'on peut raisonnablement l'attendre dans un pays sauvage et inhabité. Depuis le bord du Saint-Laurent jusqu'au passage d'eau de Côté, sur la rivière du Loup, à la distance d'environ cinq milles, la route est aussi bonne qu'on peut le désirer et les voitures de charge peuvent y passer jusqu'au passage d'eau, ou jusqu'aux moulins de Ballentines un peu sur la gauche. Le reste du chemin jusqu'au lac Timiscouata a été beaucoup amélioré par les corvées de plusieurs centaines de miliciens qui ont été employés à le réparer, en 1813, sous la surveillance du grand-voyer, le capitaine Destimauville. Dans plusieurs endroits où le fond était mauvais et marécageux, on a formé des chaussées avec des troncs d'arbres; quoiqu'on y ait fait beaucoup de travail, il en reste cependant encore plus à faire pour terminer l'ouvrage: en faisant des seignées (*sic*) des deux côtés de la route, on parviendrait à faire écouler l'eau et à en rendre la base plus solide; on devrait construire des ponts sur les différents courants d'eau, au lieu de l'expédient incommode dont on se sert à présent, d'y placer trois troncs d'arbres, invention très maladroite et très peu sûre, pour faire passer un cheval, et qui laisse trop peu de place pour une charrette. Sous peu d'années on aura certainement remédié à ces défauts, puisque le gouvernement désire tenir ouverte cette ligne de communication, et la rendre aussi commode que les circonstances peuvent le permettre; et en conséquence des ordres donnés à cet effet, plusieurs soldats du dixième bataillon des Vétérans Royaux, avec leurs familles, ont été établis, en 1814, sur des terres qui leur ont été accordées, à des intervalles convenables, sous la direction personnelle de l'arpenteur-général de cette province. Cependant ce petit nombre de colonies n'est pas encore suffisant pour répondre au but qu'on se propose, et probablement qu'on en placera encore dans des lieux convenables, qui peuvent se trouver en grand nombre, dans les endroits où il y a de grandes pièces de bonne terre, et quelques vastes brûlés, qui peuvent bientôt être mis dans un état passable de fertilité: il n'y a à présent que quelques hangars à différents intervalles, où les voyageurs peuvent passer la nuit à l'abri du mauvais temps, mais comme ils sont inhabités, on n'y peut attendre rien de plus. Deux des soldats vétérans (Clifford et Gardner) qui sont établis sur la rivière Saint-François, à peu près à moitié chemin de la longueur du Portage, ont des chaumières bonnes et commodes, où ils sont toujours disposés à recevoir les voyageurs, et il arrive rarement que quelqu'un passe par là sans être bien aise d'accepter un logement.

"Les principales montagnes sur lesquelles la route passe sont le Saint-François, la côte de la Grande Fourche, Jean Paradis, la montagne de la rivière Verte, et du Buard; les rivières sont du Loup, rivière Verte et Trois-Pistoles qui tombent dans le Saint-Laurent, et la rivière Saint-François, qui tombe dans la rivière Saint-Jean.

"A la Ferme de Long, le voyageur jouit d'une vue agréable et pittoresque du lac Timiscouata, de 22 milles de longueur sur une largeur moyenne de $\frac{3}{4}$ de mille; entourée (*sic*) de tous côtés de hautes montagnes couvertes de bois épais presque jusqu'au bord de l'eau; plusieurs grandes rivières aident par leur courant considérable à remplir ce vaste bassin romantique et isolé. Sur ce point si écarté des habitations des hommes et des plaisirs de la société, la ferme, tout humble qu'elle est, devient un objet intéressant: elle consiste seulement en une chaumière, une grange et deux ou trois petits appentis, entourés de quelques champs cultivés et d'un jardin; dans l'été la vue des environs est variée et extrêmement agréable; mais elle ne peut guère dédommager de la solitude de l'hiver. Long, le propriétaire, a lui-même une grande famille et ses fils sont les bateliers du lac, et ils ont toujours des canots d'écorce prêts à passer les voyageurs d'un bord à l'autre. De cet endroit à l'entrée de la rivière Madawaska, la distance est de 15 milles, et 5 milles plus loin se trouve la rivière du Bouleau, où il y a deux autres colonies du bataillon des Vétérans (le sergent Smith et Simpson). A 23 milles au-delà de cet endroit se trouvent les petites chutes de Saint-Jean, et à environ un mille au-dessous de ces chutes, sur la rive occidentale de la rivière, il y a une maison où l'on peut trouver quelque chose de semblable aux convenances d'une auberge, et si elles ne sont pas des meilleures, cependant le voyageur est généralement trop content de pouvoir en profiter pour se plaindre de ce qui leur manque.

"En cet endroit commence l'établissement de la Madawaska, qui continue par intervalles de chaque côté de la rivière Saint-Jean, pendant environ 25 milles; il est composé d'à peu près 200 familles de Canadiens et d'Acadiens; les chaumières sont pour la plupart proprement bâties, et les champs et les jardins bien cultivés; sur la rive orientale de la rivière, au commencement de l'établissement, il y a une église et un presbytère; on y trouve aussi deux moulins à grain. Depuis la fin de cette petite colonie jusqu'aux grandes chutes de la rivière Saint-Jean, la distance est de 15 milles: alors, on trouve un poste militaire, ou pour parler plus proprement, quelques vieilles maisons occupées par un officier non-breveté et quelques simples soldats détachés des corps qui servent dans la province de New Brunswick; de ce poste jusqu'à la presqu'île, il y a 42 milles et l'on trouve un établissement semblable. De la maison de Long à la presqu'île la distance est de 135 milles, dont on peut dire qu'il n'y a que 35 milles de route qui soit déjà faite; pour rendre la communication libre et commode toute l'année, il faudra donc former encore 100 milles de route; mais sur cette distance, toute la longueur de l'établissement de Madawaska peut être considérée comme déjà presque faite; cette entreprise qui d'abord paraît pénible ne serait pas difficile à achever, et on pourrait la conduire sur la rive occidentale des rivières Saint-Jean et Madawaska, en suivant à peu près la route qu'ont prise le 8e et le 104e régiments qui, dans l'hiver de 1813 à 1814, ont marché depuis la presqu'île jusqu'à la Ferme de Long autour du lac Témiscouata, en neuf jours. Depuis la presqu'île jusqu'à Saint-Jean, dans la baie de Fundy, l'espace de 136 milles, les routes sont passablement bonnes des deux côtés de la rivière. Durant l'été la communication par eau depuis le lac Timiscouata jusqu'à Saint-Jean est aisée, n'étant interrompue que par la petite chute et la grande; à la première, il y a un portage d'environ 30 toises, et à la dernière un autre d'environ un quart de mille. Le paquebot traverse la baie de Fundy de Saint-Jean à Annapolis, et de là jusqu'à Halifax, l'espace de 136 milles, la route est très bonne, et les voyageurs peuvent y trouver des logements passables."[1]

On remarquera dans le texte de Joseph Bouchette, la mention du premier essai de colonisation à l'intérieur de la région témiscouatienne. Nous savons par un autre document que 22 soldats du 10e Vétérans avaient été placés avec leur famille sur le Portage du Témiscouata. Ils restaient aux soins de l'administration militaire et reçurent des rations jusqu'au 24 janvier 1819. Les courriers consta-

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[1] Bouchette, Joseph, *Description topographique de la Province du Bas-Canada, avec des remarques sur le Haut-Canada et sur les relations des deux Provinces avec les Etats-Unis de l'Amérique.* Londres, 1815. pp. 556-562.

tèrent-ils la désertion des Vétérans ? En firent-ils rapport au Gouverneur ? Toujours est-il que celui-ci qui était alors le comte de Dalhousie, chargea en 1823 le major Elliott d'aller les visiter. Elliott eut le désagrément de constater que sur les 22 familles 15 avaient déjà disparu et que les 7 autres se préparaient à plier bagage.[1] La rigueur du climat, le manque de terre cultivable et la suppression des rations avaient réduit ces pauvres gens à la dernière misère. Elliott voulut les engager à attendre en leur faisant espérer l'intervention du gouverneur en leur faveur, mais toutes ses belles paroles n'empêchèrent pas l'exode de se continuer jusqu'au dernier.

Nous touchons ici à la cause qui allait porter les autorités à abandonner l'ancien chemin et à chercher un nouveau tracé. L'expérience des Vétérans avait démontré que la route du Portage n'offrait que peu ou point de terre cultivables. D'autre part, le manque d'habitations exposait constamment les courriers qui avaient à traverser cette grande étendue de pays sauvage. C'est ainsi qu'en 1827, Sutherland, député du Maître Général des Postes, écrit au major Elliott pour lui représenter ce danger et lui signaler deux cas où les courriers ont failli perdre la vie. Si l'on veut bien considérer que durant la saison d'hiver, toutes les dépêches d'Angleterre passaient dans le Portage du Témiscouata, l'on comprendra que l'autorité militaire dût dès lors se préoccuper de rémédier à cet état de choses.

Deux ans plus tard, le gouverneur, sir James Kempt chargea le major J.-A. Wolff, demi-solde du 60e régiment, de chercher une meilleure route, et lui soumit un questionnaire très précis. Le 2 octobre, Wolff, faisant rapport de son voyage, soumit un nouveau tracé et répondit comme suit aux questions qui lui avaient été posées:

"He will ascertain the practicability of making a Road."	A Good road could be made, in every respect preferable to the present one.
"Its probable expense."	About £3000 : 0 : 0 Currency.
"Whether the country through which it will pass is of good quality and fit for settlement."	Very good, and several of the labourers have expressed their wish at the opening of the Road to apply for grants of land thereon.

[1] Archives du Canada. Q. 183, pp. 235-239.

"Whether it will be longer than the present Road."	The present Portage Road is 36 miles, and the intended Road that is, from Cacouna to the Lake, 30 miles; but following the main road from St. Andrew to the Village de la Plaine is about 12 miles, which will make it six miles longer from Quebec to the Lake, but the advantages which the intended road will possess over the present (should it be opened) will far surpass this distance.
"Whether its advantage is so great as to induce the Government to abandon the present line of Road and adopt it."	In my opinion, its advantage would be very great, as from the nature of its soil and timber, it is certain of its being shortly settled, and considering the sums the present Road cost from time to time, and it is supposed the intended Road would not require, and less after its being settled, and the advantages that would derive to travellers, that have to pass through it.

Si l'entretien et la sécurité de la route préoccupaient à bon droit l'autorité militaire, sa défense commençait aussi à s'imposer. Cette même année, 1829, le lieutenant Ingalls est envoyé sur le Lac, au pied du Portage, pour y construire un fortin de bois rond, ainsi que les locaux nécessaires pour le baraquement des troupes. Cet officier adresse à son chef, Charles Gore, un mémoire intitulé: *A Few Remarks on Lake Temiscouata*." J'en détache quelques passages.

"The only inhabitants at present on the Lake consist of four families at the foot of the Portage, and one, six miles lower. On the banks of the Madawaska are occasionnally seen a few settled clearances.

"A site has been fixed upon where log Barracks are now erecting on an elevated sandy flat, from 80 to 90 feet above the Lake, and about 100 yards north of the Portage Road. The view from this spot is remarkably beautiful commanding a considerable distance of the surrounding country and the largest portion of the Lake. It forms a tongue of land with an abrupt descent to the East and North overhanging the Lake and the Valley of the Little River. A spring of delicious water which never freezes in winter gushes out of the side of the hill below the Barracks.

"As the Portage is the only communication with the lower Provinces at present available, its importance as a military station is great; for whatever Power happened first to gain possession, it would be next to an impossibility in the present state of the country to dislodge them. From the settlements on the St. Lawrence to the Lake shores, the whole country is a dense forest intersected with lakes and rivers and steep ridges of mountain land.

"Through this tract runs the present Portage Road, crossing one very considerable stream, the River du Loup, which has a long wooden bridge. Some Americans came from the River St. John in canoes up to the River St. Francis, and landed within 1½ miles of the Portage Road. There are about 50 to 60 acres of land cleared on each side of the Portage Road at the Lake shores. A slightly elevated, sandy ridge bounds this clearance.

"At the period where the people of the State of Maine made an inroad into the disputed territory they were preparing to push along the lee of the Madawaska and take possession of the foot of the Portage on the Lake. An enemy once in possession of that point could easily send a force across the Portage; and, by holding the bridge over the River du Loup on the Portage, and the N.E. side of the village of River du Loup on the St. Lawrence, would effectually cut off not only the communication with Lake Temiscouata and the Madawaska, but also the communication with the Métis Portage and the Restigouche:—that is, in plain English—with England in the winter season. The only means of dislodging an enemy in such positions would be to cut them off from their communication with the Fish River on the River St. John;—at best, a doubtful experiment. But were a British force once in possession of the foot of the Portage with a supporting force at the River du Loup, the communication between Canada and the River Restigouche by the Métis Portage, would at all events be effectually secured.

"At the present moment about 60 armed Americans are at the junction of the Fish River with the St. John's—a few miles below the St. Francis. Their avowed object is to throw a boom across the Fish River, but make no secret that the clearance they are making is for the purpose of fortification. It has been already remarked that canoes can ascend the St. Francis within a mile and a half on the Portage, and, in the winter, this river would form an excellent road.

The banks of the St. John are tolerably well settled as high as the St. Francis, chiefly by American squatters."

L'endroit où le lieutenant Ingalls construisit son fortin de bois s'appelle aujourd'hui Cabano, mais on le trouve encore fréquemment désigné sur les cartes sous le nom de Fort Ingalls.

* * * * * *

Durant toute la première moitié du XIXe siècle, le chemin du Portage semble avoir été très négligé et très mal administré. Un factum adressé par un nommé Pouliot à L'hon. J. Chabot, M.P.P. à la date du 8 décembre 1852, contient des détails quelque peu amusants.

Pouliot se plaint amèrement de la mauvaise administration des syndics. Il doute même que des syndics aient été nommés, car dans plusieurs poursuites on n'a pu trouver que les prétendants à ce poste fussent nommés; "s'ils ont été nommés, quatre d'entre eux demeurent à Montréal et à Québec et ne se sont pas plus occupés de chemin que de ce qui est dans la lune! (*sic*) . . . Restait M. Jones ici qui a voulu poursuivre. Il n'a pu prouver qu'il était syndic! Alors, vu le discrédit des syndics, les infractions se multiplièrent et M. Jones, découragé, a déchargé le gardien et laissé la barrière ouverte" . . . Pouliot fair remarquer agréablement que M. Jones souffrait de cet état de choses pour son commerce car les autres marchands faisaient passer leurs voitures sans payer malgré le gardien, ce que M. Jones, étant syndic, ou croyant l'être, ne pouvait décemment faire! Les fraudeurs de barrière avaient, paraît-il, plus d'un prétexte pour justifier leur action. D'abord, l'impunité leur était assurée; puis, il était notoire que le gardien pratiquait le népotisme sur une vaste échelle et faisait un gaspillage inouï de l'argent recueilli.

Durant ce temps; l'arpenteur Fournier et son collègue J. F. MacDonald—reprenant le travail du major Wolff—cherchaient un tracé plus avantageux pour la route du Portage. La construction du nouveau chemin autorisé en vertu du chapitre 8, 4 Victoria, 1840, ne fut commencée que sous l'Union en 1856.

Le nouveau tracé s'étendait depuis la rivière du Loup jusqu'à la frontière du Nouveau-Brunswick, ayant 67 milles de longueur avec 14 ponts. Le chemin fut terminé en 1861, à l'exception de un mille et trois-quarts qui furent complétés en 1867. Le coût total du chemin jusqu'à cette date était de $204,376.01. Une longueur de 54 milles du chemin fut transportée, par proclamation, aux municipalités qu'il traversait. En 1881 le pont de la rivière du Loup, et en 1873, celui de la rivière Verte furent rebâtis ainsi que plusieurs petits ponts et ponceaux. De plus des réparations, au coût de $26,039.83 furent faites au chemin.

Le néfaste compromis d'Ashburton, signé en 1842, assurait aux Etats-Unis la possession d'un saillant prononcé dans le Bas-Canada. Cette circonstance retarda d'un quart de siècle la construction du chemin de fer Intercolonial qui devait relier pour toutes fins économiques et militaires, les provinces du centre à celles de la mer. Mais, l'Acte de l'Amérique Britannique du Nord était à peine en force depuis une semaine que l'ingénieur en chef recevait du Ministre des Travaux Publics l'ordre de reprendre les arpentages commencés autrefois, et de chercher le meilleur tracé possible pour cette voie ferrée—condition *sine qua non* de l'entrée des provinces maritimes dans la confédération.

Trois tracés furent proposés: celui du Nord ou de la baie des Chaleurs, celui du centre et celui de la frontière. Le tracé du centre, le plus naturel et le plus avantageux, coïncidait essentiellement avec le Portage du Témiscouata. Cependant, les autorités impériales, considérant que cette voie, malgré les raisons qui militaient en sa faveur, serait exposée à être coupée dès l'ouverture d'hostilités possibles avec les Etats-Unis, optèrent pour le tracé du nord qui fut définitivement adopté.[1]

L'inauguration de l'Intercolonial (1876) marque évidemment le commencement du déclin du Portage du Témiscouata comme voie de communication interprovinciale. Cependant, durant les vingt années qui suivirent son parachèvement, il se fit sur le nouveau chemin un trafic assez considérable pour que l'on songeât à l'établissement d'un chemin de fer régional.

Vers 1887, une compagnie se forma à l'effet de construire une ligne qui devait suivre à peu près le tracé du Portage. Les premiers directeurs de cette compagnie furent: A.-R. MacDonald, P.-E. Grandbois, D. Rossignol, G.-H. Deschênes, J.-J. MacDonald, A. Hamel, J.-I. Tarte et C. Bertrand.

Le 26 août de cette même année, 1887, il y avait 13 milles de terminés, et les travaux furent poussés avec tant de vigueur qu'au 10 janvier 1888, les constructeurs atteignaient Edmunston, dans le Nouveau-Brunswick. La ligne, ouverte au commerce le 22 novembre 1888, avait alors 81 milles de longueur. Depuis, la compagnie a obtenu de pousser un embranchement vers l'ouest pour atteindre le confluent des rivières Saint-Jean et Saint-François. Cet embranchement, long de 32 milles et qui atteint Connor's, est ouvert au trafic depuis le 10 novembre 1891.

[1] Fleming, Sanford, *The Intercolonial*, Montreal, 1876, p. 85.

Le chemin de fer du Témiscouata joint l'Intercolonial à la Rivière-du-Loup et fait de cette jolie ville un centre où afflue le commerce de plusieurs régions importantes. La gare terminus, la Rivière-du-Loup, est à environ 190 pieds au-dessus du niveau de la mer. La voie doit gravir les pentes de la chaîne apalachienne jusqu'à la hauteur des terres, entre les bassins du Saint-Laurent et du Saint-Jean. Au bout de 24 milles, dans la paroisse de Saint-Honoré, la ligne atteint une altitude de 1,197 pieds pour redescendre à 428 sur les bords du Lac Témiscouata. A Cabano, l'ancien fort Ingalls, se trouvent d'importantes scieries qui donnent à cet endroit perdu un air de petite ville. Traversant Notre-Dame-du-Lac, à Sainte-Rose-du-Dégelé, sont deux florissantes paroisses agricoles; le chemin de fer y suit les sinuosités de la berge du lac, traversant l'un des plus beaux paysages de la province de Québec.

Comme il fallait s'y attendre, le chemin de fer du Témiscouata a définitivement ouvert cette belle région à la colonisation. Le canton de Whitworth reçut les premiers colons qui devaient plus tard former les belles paroisses de Saint-Antonin et de Saint-Modeste. Le canton Armand fut ouvert en 1862; on y trouve aujourd'hui un centre prospère: Saint-Honoré. C'est en 1864 que quelques bûcherons se fixèrent à Cabano; la colonisation y est maintenant très active.[1]

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Nous arrêtons ici ces notes laborieusement rassemblées et qui pourront, espérons-nous, former une base de travail à celui qui—à l'aide de documents nouveaux—entreprendra d'écrire l'histoire complète du Portage du Témiscouata, tour à tour sentier de guerre et de traite, route postale et militaire, artère du commerce et de la colonisation. Cependant, avant de déposer la plume nous nous permettons de faire une suggestion à ceux qui ont un mot à dire au sujet des noms géographiques de cette région. Ne serait-il pas à propos de conserver, en l'attachant à quelque point de la carte du comté de Témiscouata, le nom de ces modestes et braves serviteurs de la civilisation que furent les Gauthier, les Durand, les Desgranges, les Dufour, les Duperré, les Mercure, courriers de Sa Majesté le Roi ?

FR. MARIE-VICTORIN,
des E. C.

Collège de Longueuil,
Qué.

[1] Pelland, A., *Le Témiscouata, ses ressources, son avenir*, Québec, 1910.

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SECTION II

SERIES III — JUNE AND SEPTEMBER 1918 — VOL. XII

The Genesis of the University of New Brunswick.

With a Sketch of the Life of WILLIAM BRYDONE-JACK, A.M., D.C.L.

President from 1861-1885.

By ARCHDEACON W. O. RAYMOND, LL.D., F.R.S.C.

(Read May Meeting, 1918)

There may be seen on the walls of the library of the University, in Fredericton, the original of a memorial to the first Governor of New Brunswick on the subject of the establishment at the provincial capital of "an Academy, or School of Liberal Arts and Sciences." The memorial reads as follows:—

To His Excellency Thomas Carleton, Esquire, Governor, Captain-General and Commander-in-Chief of the Province of New Brunswick and the territories thereunto belonging, Vice Admiral, Chancellor, etc., etc.:

Your memorialists, whose names are hereunto subscribed, beg leave to represent and state to your consideration the necessity and expediency of an early attention to the establishment in this Infant Province of an Academy, or School of Liberal Arts and Sciences.

Your Excellency need not be reminded of the many peculiarities attending the settlement of this country. The settlement of other Provinces has generally originated in the voluntary exertions of a few enterprising individuals, unincumbered and prosecuting their labour at their leisure and as they found it convenient and most for their advantage. Far different is the situation in which the loyal adventurers here find themselves. Many of them upon removing had sons, whose time of life and former hopes call for an immediate attention to their education. Many publick advantages and many conveniences would result to individuals could this be effected within this Province, the particulars of which it is unnecessary to enumerate.

Your memorialists do therefore most earnestly request your Excellency will be pleased to grant a Charter for the establishing and founding such an Academy—that proper persons be appointed Trustees, and duly authorized in a corporate capacity to superintend the establishment. That lands be granted to erect proper buildings, and other lands be granted and appropriated for the use of the Academy; particularly they pray for a part, or the whole, of the reserved lands in the neighbourhood of Fredericksburg [Fredericton].

Your memorialists will not trouble you with any scheme or plan of the Charter prayed for, but submit the whole to your judgment and discretion.

And as in duty bound, etc.

(Signed) WILLIAM PAINE, JOHN COFFIN, WILLIAM WANTON, WARD CHIPMAN, GEO. SPROULE, A. PADDOCK, ZEPH. KINGSLEY.

This memorial was laid before the Governor in Council on the 13th December, 1785, and it was ordered that Attorney-general Bliss and Solicitor-general Chipman be directed to prepare, with all convenient speed, the draft Charter of the said Institution.

The signers of the memorial were eminent men. Paine and Chipman were Harvard graduates. Wanton was a son of the Governor of Rhode Island and first collector of customs at St. John. Sproule was a native of Long Island, N.Y., and afterwards for many years Surveyor-general of New Brunswick. Kingsley was an eminent merchant of Charleston, S.C., a Quaker by religion. Coffin belonged to a well known Boston family, distinguished in the King's service during the war, and at the time of his death was a general in the army. Paddock was also a native of Boston and an eminent physician, as were several of his descendants. Ward Chipman was successively solicitor-general, judge of the Supreme Court, member of Council and, at the time of his death, administrator of the provincial government of New Brunswick.

The memorial was in Doctor Paine's handwriting, but it would seem, from his private correspondence, that "a woman was leader in the deed." Paine obtained from Governor Parr in 1783 a grant of Le Tète Island in Passamaquoddy Bay. Writing from thence in August, 1784, he says:—"My situation I like very much; my lands are certainly well located, and if Mrs. Paine could content herself I should be well pleased. Her objection is that the children cannot be properly *educated*. This Island will soon be a place of consequence, and ultimately *the principal port in British America*."

Paine's expectations were based upon the proximity of the fine harbor known as L'Etang, near the mouth of the Bay of Fundy. Mrs. Paine was a remarkably clever woman. It is said that at one of her dinner parties in Worcester, Mass., not very long before the outbreak of the Revolution, some of the Whigs demurred at drinking the King's health until John Adams advised them to do so, saying, *sotto voce*, "We shall be able to return the compliment." Accordingly after Dr. Paine had proposed the health of his Royal Majesty, Adams rose and proposed the health of his Satanic majesty! The doctor was extremely indignant, but his wife saved the situation by saying, "My dear, since the gentleman has been so polite as to drink the King's health, let us by no means refuse to drink to *his* friend!"

In 1785 Dr. Paine was elected a member of the first House of Assembly, for the County of Charlotte, and was also appointed Clerk of the House. The following year the Governor in Council set apart a tract of 2,000 acres at Fredericton for the maintenance of the proposed Academy of Arts and Sciences. In the session of 1793 the House of Assembly voted that an annual sum of £200 be allowed towards the erection of proper buildings for the Academy. A site was chosen near that of the present Christ Church Cathedral. The academy was at first little more than an old time Grammar school. In 1800, however, it was duly established by provincial charter as the "College of New Brunswick."

In 1811 the Rev. James Somerville, M.A., LL.D., a native of Scotland, became the "principal preceptor" of the Academy, and on the 25th March, 1820, the same gentleman became the first and only President of the "College of New Brunswick." He was succeeded at the Academy by the Rev. Geo. McCawley, B.A., of Windsor, N.S., and these two eminent teachers were associated in academic and collegiate work for the next sixteen years. The staff of the College proper consisted of Dr. Somerville alone, as we learn from his address to the first and only graduating class, delivered on the 21st February, 1828, in which he observes:—

> "To assert that one man, although his abilities and acquirements were greatly superior to mine, when thrown upon his own solitary resources, could perform what in similar institutions is the business of five or six, would savor more of the vain boastings and empty pretence of an emperick than the modesty and diffidence of a scholar, but I can confidently say I have done what I could."

In addition to the revenue from the rental of its lands, the annual grant from the legislature was by degrees increased though it was always small.

In 1823 the legislature passed an act to enable the governor and trustees to make a conditional surrender of their charter in order to obtain a Royal charter from the Crown. Soon after the arrival of Sir Howard Douglas in August, 1824, the site for the new college building was chosen and during the next few years the sound of the workman's hammer was heard in the construction of the nobler and more enduring building which still crowns the hill back of Fredericton. In 1828 the work was so far advanced as to permit the surrender of the provincial charter. The new College was constituted by Royal Charter, with the privileges of an University, under the name and title of "The Chancellor, President and Scholars of King's College at Fredericton in the Province of New Brunswick."

The college was publicly opened on January 1st, 1829, and Sir Howard Douglas installed as its first Chancellor.

As originally built the edifice was of the proportions and design represented in the Douglas gold medal, founded by His Excellency at this time. Its cost was only £11,300 currency, a very moderate sum considering the excellence of the work. In his opening address Sir Howard observes:—

"I shall ever rejoice that it has fallen to my lot to lay with my own hand the corner stone of this building, and that I have been spared to witness its completion. The architect of the material fabric has been careful to make his selections of the best qualities and of materials the least perishable and to put them together with a master hand."

The building was planned so as to admit of the addition of another story, and in 1876, through Dr. Jack's efforts supported by the University Senate, another story with a fine central dome was added, at a cost of $8,500.00. Again the sum seems very moderate in view of the wonderful improvement in the appearance of the building and the increased accommodation afforded.

The first and only President of King's College was the Rev. Edwin Jacob, D.D., who filled the position for thirty years. He was a native of Gloucestershire, England, and sometime Fellow of Corpus Christi College, Oxford. He entered on his duties at King's College, October 19, 1829. In the assignment of work Dr. Jacob took the chairs of Classics, History and Moral Philosophy: Rev. George McCawley took the chairs of Logic, Mathematics and Hebrew; and Dr. Somerville the chairs of Metaphysics and Divinity.

A very interesting account of the opening of King's College and the attendant ceremonies has been preserved.[1] From this it appears that next to His Excellency Sir Howard Douglas, the most prominent personage on the occasion was Dr. Somerville, who was not only eminent as a scholar but was an orator. He continued to fill the chair of Divinity until 1840. His portrait in oils may be seen in the University Library. It was presented to the College by a number of his old pupils including such men as Hon. L. A. Wilmot, Hon. Judge Fisher, Attorney-General John Ambrose Street, and William H. Odell as " a tribute of affection and gratitude." Dr. Somerville retired from his duties as a professor in King's College in 1840. Rev. Geo. McCawley resigned his professionahip in 1836 to become president of King's College, Windsor, a position which he held for thirty-nine years; his work at Fredericton and Windsor covering the long period of fifty-five years.

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[1] See Lawrence's "Judges of New Brunswick and their Times,"pp. 244-252.

Dr. Jacob at the time of his selection as President of King's College, in 1829, was in his thirty-sixth year. His policy as the head of the institution was very conservative, and is thus defined in his Encœnial address in 1851:—

"In a thinly peopled and comparatively uncultivated country, no means which could be employed would have the effect of filling the college with agricultural, manufacturing, mechanical or commercial students. The attempt could have no better effect than miserable, disheartening, self-destructive disappointment. Intellectual and moral culture should be our pursuit and occupation. Our peculiar province is to teach the principles and application of Truth."

Doctor Jacob's term of service included one year at the University of New Brunswick, but was practically co-extensive with the life of King's College, 1829-1859. He died in 1868 at the age of 74 years.

We come now to speak of one who left an abiding impress not only upon the University but upon the progress of higher education in general.

William Brydone-Jack, the subject of this sketch, was born in the Parish of Tinwald, Dumfriesshire in Scotland, on the 23rd of November, 1819. His father, a stone-mason and master builder, came of a Perthshire family, but removed to Dumfriesshire early in life, married and settled down there. Young Brydone-Jack received his elementary education in the parish schools of Tinwald. Later he attended Halton Hall Academy, Caerlaverock, where he was prepared for college. In 1835 he entered as a student at the University of Saint Andrews in Fifeshire. Here he came under the influence of the principal, Sir David Brewster, one of the most famous mathematicians and natural philosophers of his time. Brewster was distinguished for his contributions to scientific literature. His biography of Sir Isaac Newton, embodied the results of more than twenty years patient investigation of original manuscripts and all other sources of information. In 1802, at the age of twenty, he was editor of the Edinburgh Magazine. He contributed many articles to the Encyclopedia Britannica, and later was editor of the Edinburgh Encyclopedia. In 1831 he was one of the founders of the British Association for the Advancement of Science. He was knighted the same year, receiving also the decoration of the Guelphic order of Hanover. In 1838 he became the Principal of the United Colleges of Saint Salvador and Saint Leonard at Saint Andrews. He was president of the British Association in 1849, and from 1849 until his death, which occurred on Feb. 10, 1868, he was the vigorous president of the University of Edinburgh.

Brewster was famous for his original discoveries in optics. In 1816 he invented the Kaleidoscope, for which there was such an extraordinary demand in England and America that the supply could not be met. The lenticular stereoscope was also his invention. The dioptric apparatus used in lighthouses was so vastly improved by him that his successor at the University of Edinburgh wrote: "Every lighthouse that burns round the shores of the British Empire is a shining witness of the usefulness of Brewster's life." At the time of his death he had attained the ripe age of 87 years. Such was the man who left an indelible impress upon the mind of William Brydone-Jack, and which he fittingly acknowledges in his Encœnial address in 1870.

In his college course at St. Andrews, young Brydone-Jack was distinguished for proficiency in mathematics and physics, carrying off the highest prizes in those departments of study. He received his M.A. degree in 1840 and very shortly afterwards was offered the chair of physics in Manchester New College in succession to the celebrated Doctor Dalton. About the same time he was offered the position of professor of Mathematics, Natural Philosophy and Astronomy in King's College, Fredericton. Sir David Brewster and other friends, who took a warm interest in his welfare, advised him to take the latter position, as they considered him too young—not having then attained his twenty-first birthday—to safely risk his reputation in the wider and, as it was thought, more ardous field of study pursued at Manchester. Their counsels prevailed and he accepted the New Brunswick professorship.

Here we may pause to observe that New Brunswick, in common with other parts of Canada, has been greatly indebted to Scotland for many of her leading educationists. Among them we may include the founder of the old "College of New Brunswick," Dr. James Somerville, also Professors David Gray, Dr. James Robb and Dr. W. Brydone-Jack; also two of our Chief Superintendents of Education, Dr. John Bennet and Dr. William Crockett. All were men of marked ability, high ideals, energetic and progressive. Gray and Robb arrived in October, 1837, and their coming was the beginning of a more modern era in the history of the college.

Previous to the appointment of Professor Brydone-Jack the chair of Mathematics and Natural Philosophy at Fredericton had been filled by Professor David Gray, who resigned in 1839 to accept the principalship of the Royal Academy at Inverness, and it was upon Gray's recommendation that the council of King's College selected so young a man as Brydone-Jack for his successor.

Professor Jack reached Fredericton in the month of September, 1840, intending to remain not more than a year or two and then to return to his native land. Fortunately for the cause of higher education in New Brunswick, he was subsequently led to relinquish this intention and to become prominently identified with the struggles, and finally with the success of the College.

After Brydone-Jack's arrival some alterations were made in the College building by which he and Dr. Robb were accomodated with rooms therein. This marked the beginning of a very intimate friendship between the two men, and upon the death of Dr. Robb, some twenty years later, Dr. Jack in his Encœnial address observed:

> "The death of Dr. Robb has no doubt been keenly felt by many of you as the loss of a warm friend or valued instructor; to me it has been the removal of more than a brother. For upwards of twenty years we had been associated in kindred pursuits without the perfect harmony of our daily intercourse ever being disturbed."

Robb and Brydone-Jack may be regarded as pioneers in the field of practical science. The first modest addition to the original building on the College campus was the observatory built through Dr. Jack's efforts in 1851. Jack and Robb found in Sir Edmund Walker Head a staunch friend and patron. He came to the province as Lieut.-Governor in 1847 and no governor, unless it be Sir Howard Douglas, displayed greater concern for the welfare of New Brunswick. He had himself taken a distinguished course at the University of Oxford and was a Fellow of Merton College. He was a friend of Professor Geo. Ticknor, Longfellow's predecessor at Harvard, who said, "Sir Edmund Head was one of the most accurate and accomplished scholars I have ever known, and could repeat more poetry, Greek, Latin, German and Spanish, than any man I ever knew." Nevertheless the same Sir Edmund Head had a practical mind and under his patronage Dr. Robb and his friends organized the "New Brunswick Society for the encouragement of Agriculture, Home Manufactures and Commerce." The same year, 1849, Dr. Robb delivered a course of public lectures on agriculture which were highly appreciated and well attended. Sir Edmund Head also induced the College Council to provide systematic instruction in engineering by employing McMahon Cregan, an eminent engineer, working at that time in the province under the railway contractors, Messrs. Jackson and Co. Mr. Cregan, with Prof. Jack's assistance, gave special lectures in engineering during the winter. This was the first attempt to go outside the old arts course of the primary college in order to meet the wants of a special class of students. Dr. Jack strongly emphasized the value of abstract science. He speaks of the Great Exhibition held in London in 1851, and in a more modest way of the first Provincial Exhibition at Fredericton in 1852, as having impressed upon the minds of intelligent and thinking men the momentous fact that a competition in industry must be a competition in intellect—"Most of the grand discoveries, which have contributed so largely to the advancement of the age have been," he says, "the fruits of purely theoretical investigations. Theoretical science is in fact the basis of all progress. It is the life blood of practice, the prime mover, the fire which generates the steam."

When Robb, Gray and Brydone-Jack made a beginning along the lines of practical science it was indeed the day of small things at old King's College, but they made at least a beginning. And Dr. Jack was a man of vision. In one of his Encœnial addresses he observes:—

"To render the University popular and attractive it must be able to show that it is progressive. It must be provided with all the best modern appliances for rendering its course of study effective and interesting. Its apparatus, library, museum and laboratory must receive the additions which from time to time become necessary. Its course of study must also be made more varied and complete to keep pace with the requirements of the age. The grand object to be attained is the widening of the sphere of education imparted, the bringing within the scope of University instruction every branch of human knowledge, and the making of it more thorough, searching and progressive. It should be the ambition of every up-to-date University to make provision for the endowment of scientific research, so that men able and willing to devote their time and talents to original investigations and to the prosecution of fresh discoveries in the branches of study in which they have become famous may meet with due encouragement. I do not presume for an instant to compare this University with any of the wealthy and long-established institutions to which I have referred. With us it is still the day of small things, and for many years we must be content to follow afar off, humbly and laboriously in their footsteps. But from all that has been said, I think it will be evident that an endowment, liberal and ever-increasing with the requirements of the times, is an absolute necessity for the maintenance of even a moderately equipped institution for the higher education."

His ideal is to make the University a place of resort where men of learning and ability may be assisted in research by eminent teachers, extensive libraries, museums, laboratories, etc. He deems it a grave error needlessly to multiply degree-conferring institutions in a country comparatively poor and with a sparse and toiling population. The funds which would barely sustain one in a tolerable state of efficiency, and insure to it some degree of reputation, are liable to be frittered away among as many colleges as there are denominations seeking for aid until all are reduced to a condition of feebleness.

During the first twenty years of Dr. Brydone-Jack's residence in New Brunswick there was a protracted and bitter controversy between the college council and the provincial legislature. The origin of the controversy was identical in the cases of King's College, Nova Scotia; Kings College, Toronto, and King's College, Fredericton, namely the attempt to perpetuate an old-world charter in a new country, in which there is no established church and where the people are becoming daily more democratic in their ideals. The animus against King's College in the legislature and in the press was not entirely because it was a Church of England institution. It was further claimed that the discipline was very lax, the curriculum not suited to the needs of the people, and the cost of keeping up the college out of all proportion to the benefits conferred. It is at least certain that previous to the reorganization of the college in 1860, and the appointment of Brydone-Jack as President, the institution had an abundant share of trials and troubles and had even to undergo the throes of a death struggle. During this period the situation of the unfortunate professors was far from enviable. Harassed by suspense and filled with anxiety for the future of their families, it is not to be wondered at if their ardor was damped and even their vigor and health impaired so that several of them became prematurely aged. The college doubtless suffered from this impaired vigor, as well as from the fact that many people were unwilling to send their sons to an institution whose existence could not be depended on for a single year.

On the 9th of April, 1851, a leading St. John paper urged the legislature to "cut the head off of King's College"; "we mean," adds the editor, "the £1,100 per annum taken from the pockets of all denominations that the sons of a particular denomination may graduate."

This, says Professor Jack, was by no means the worst of the attacks made upon the college, and ere long its existence was trembling in the balance.

Governor Head at this time proved a staunch friend of the cause of higher education. He declined to accede to a request of the House of Assembly to withhold the warrant payable out of the provincial treasury towards the maintenance of the College, because the grant in question was secured by an act which up to that time was unrepealed. Next year His Excellency sent a lengthy communication to the College Council urging the necessity of doing something to popularise the institution, and pointing out what he conceived to be the best way of making it more generally useful and acceptable to the province at large. The agitation in the legislature, however, continued to grow in virulence, and in 1854 a bill was introduced into the House of Assembly to repeal the section of the Charter granting £1,100 per annum from the provincial trasury to the maintenance of the college. To this an amendment was moved by Hon. John Ambrose Street, the attorney-general, that a commission be appointed to inquire into the state of the college, its management and utility, with a view of improving the same and rendering the institution more generally useful; and should such commission deem a suspension of the charter desirable, then to suggest the best mode of applying its endowment for the educational needs of the province. This amendment was carried, and being concurred in by the Legislative Council, it received the assent of the Governor at the close of the session.

The Commissioners appointed were Hon. John H. Gray, Hon. John Simcoe Saunders, Hon. James Brown, Dr. Egerton Ryerson and Prof. J. William Dawson. The two gentlemen last named were at that time the Superintendents of Education of Upper Canada and of Nova Scotia respectively, and were evidently recommended by Sir Edmund Head as members of the commission. We are told by Dr. Dawson that when on a geological excursion with his friend Sir Charles Lyell in the year 1852, he was introduced to Sir Edmund Head, the Governor of New Brunswick, who was much occupied at the time with the state of education in that province, and in particular with that of its provincial university and in 1854, he says:—

"He invited me, along with the late Dr. Ryerson, to be a member of a commission which had been appointed to suggest means for the improvement of the provincial University. This work was scarcely finished when Sir Edmund was promoted Governor-General of Canada, where, under the new charter granted to McGill College in 1852, he became Visitor of that University. As he was known to be a man of pronounced literary and scientific tastes, and an active worker in the reforms then recently carried out in the English Universities, the Governors of McGill naturally counted on his aid in the arduous struggle upon which they had entered. Accordingly soon after Sir Edmund's arrival, a deputation of the Board waited upon him, and one of the subjects on which they asked his advice was the filling of the office of Principal of McGill, which was still vacant. Sir Edmund mentioned my name as that of a suitable person. At first, as one of them afterwards admitted to me, they were somewhat disconcerted. They were desirous to follow Sir Edmund's counsel, but with his knowledge of the available men in England, of some of whom they had already heard, they were somewhat surprised that he should name a comparatively unknown colonist."

The circumstance here recorded by Sir William Dawson,[1] links in a very interesting way the new era at McGill and that at the University of New Brunswick.

Doctor Brydone-Jack speaks very appreciatively of the work of the Commissioners of 1854. He specially mentions "the eminent educationists, Dr. Dawson and Dr. Ryerson" and quotes from their report to the legislature the following notable paragraph:—

"New Brunswick would be retrograding, and would stand out in unenviable contrast with every civilized country in both Europe and America did she not continue to provide an institution in which her own youth could acquire a collegiate education, such as would enable them to meet on equal terms, and hold intercourse with the liberally educated men of other countries. New Brunswick would cease to be regarded with affection and pride by her offspring should any of them be com-

[1] Sir William Dawson was the first president of the Royal Society of Canada.

pelled to go abroad in order to acquire a University education. The idea, therefore, of abolishing or suspending the endowment of King's College cannot be entertained by the Commissioners for a moment. On the contrary, we think there should be an advance rather than a retreat in this respect, and that the youth of New Brunswick, whether many or few, who aspire to the attainment of the best University Education, as preparatory to professional or active pursuits, should be able to secure that knowledge in their native land."

In spite of the able report of the Commission in its favor, the continuation of King's College, even in a modified way, was stoutly opposed in the General Assembly. To quote Dr. Jack:—

"Long opposition had roused feelings of bitterness and exasperation in the breasts of those unfriendly to the college. Strong passions and prejudices influenced their actions. Moreover an extreme party—always dangerous because fierce and vindictive—had at length arisen which declared that nothing less would satisfy them than the complete subversion of the college. In terms not always either chaste or truthful they inveighed against the uselessness of the institution, and the heavy expense at which it was maintained, and triumphantly asked whether all attempts to improve it had not invariably ended in signal failure? The same result, they asserted, was to be expected in future, and hence the only sure and effectual remedy was its total destruction. The cry now raised, if sadly wanting in stern dignity and patriotism, resembled in passionate and fanatical vindictiveness that of Cato of old, who at the close of every harangue against Carthage made the senate-house resound with the ominous and inexorable words, *delenda est Carthago*."

The recommendations of the Commissioners did not at all suit the views of many members of the House of Assembly who, blind to the importance of institutions for higher education and impatient for their prey, now almost within their reach, were determined that King's College, however changed in name and character, should cease to exist in New Brunswick.

In 1856 Hon. Charles Connell, a member for Carleton County, introduced in the Assembly a bill to suspend the grant to King's College, which was carried in the House but did not pass the Legislative Council. Two years later Mr. Connell, with dogged persistency, introduced a yet more summary bill, the first section of which read as follows:—"All sums of money payable to the Chancellor, President and Scholars of King's College, Fredericton, and their successors, by any law and usage, shall from the first day of November next be discontinued, and all acts relating thereto shall be repealed." This bill was strenuously opposed but was finally passed, was concurred in by the Council and assented to by the Lieut.-Governor on the 6th of April, 1858. Lieut.-Gov'r. Manners Sutton, however, following in the footsteps of Sir Edmund Head, sent to the Colonial Secretary a dispatch reviewing in masterly fashion all the circumstances of the case. In consequence Her Majesty, with the consent of her privy council, declared her disallowance of the bill on the ground that it annulled the pledged faith of the crown so far as regards the sum paid out of the Civil List to the College was concerned.

In 1859 came the climax in a memorable debate upon a bill to suspend the grant to the college so far as relates to the sum paid out of the provincial revenue and not included in the Civil List. To this bill the Attorney-general, Hon. Charles Fisher, moved the substitution of a bill which had been prepared in 1857 by Hon. L. A. Wilmot, to carry into effect the reorganization of King's College on the lines recommended by the Commission of 1854. This bill was vehemently opposed at every step and by every possible manœuvre. It was amended in several particulars, and it was only by hard fighting that its supporters were able to carry it safely through the House. In the ensuing debate William H. Needham of Fredericton, a member for the County of York, spoke with wonderful power and ability. His address made a deep impression on the House and it was afterwards stated by many of those present, "Billy Needham's speech saved the college." The bill readily passed the Legislative Council and finally received the Royal assent.

Under the act of the legislature the Lieut.-Governor became the visitor of the institution instead of the Bishop of the Diocese. The President was to be a layman and no longer an Anglican clergyman. The Professorship in Divinity was abolished as were also all denominational tests. The name was changed to that of the University of New Brunswick and a new governing body was created called the Senate. The first year was a period of transition but in June, 1861, William Brydone-Jack was duly installed as President and delivered the Encœnial address. The outlook was now greatly broadened and provision made for new departments of study. The institution now entered upon a new and progressive career. A few words must be added here with regard to the personality of the new President.

He was in many ways an admirable representative of the Scottish race. He had the strong moral fibre characteristic of his ancestry, the rugged tenacity of purpose and common sense, the courage and perseverance, the cheerful optimism and energy essential to successful leadership. As a young man he was endowed with an unusually fine physique. He was tall, rather more than six feet in height, strong and vigorous. He liked life in the open air, was an excellent walker, and almost as much at home in practical surveying as in the lecture-room or in the college observatory. He was fond of his garden, liked and drove spirited horses and enjoyed the game of curling. He was an entertaining companion, interesting in the affairs of the day and in the wellbeing of the community, patriotic in his sentiments and social in his instincts. He was perhaps at his best on the occasion of any public function, and even those students who had little love for mathematics and stood in awe of the Doctor in the class-room were proud of him when he presided at the Encœnial festival. He was a brilliant mathematician, quick and accurate in his work and exceedingly neat in his diagrams both on paper and at the blackboard. It was always a surprise to the assembled class to see the ease with which the Doctor with graceful freearm movement would draw upon the blackboard a perfect *ellipse*. He had the gift of sarcasm and was not always patient with the dull boys. In the curriculum of those days, unfortunately, there were no options, and there were always certain students with whom the pass-mark in Analytics and Calculus was a veritable nightmare. But to the "mathematicians" in the various classes there was a never to be forgotten charm in the Doctor's manner in the lecture-room. While pre-eminent in mathematics, he was an all-round scholar and of this we have ample proof in his Encœnial addresses. It may be also noted that upon the sudden death of the classical professor, Geo. Montgomery-Campbell, in April, 1871, Dr. Jack himself took the subject of classics with the seniors for the balance of the year.

Previous to a serious attack of congestion of the lungs in the winter of 1869-70, from the effects of which he never entirely recovered, the Doctor did much valuable work in the observatory. This modest little building was built in 1851. Its fine equatorial telescope, by the famous Merz and Son, was for some time the best in British America, and the other accessories were then regarded as quite up to date. The many hundreds of careful observations that the Doctor took show that astronomical work was to him a labour of love. Soon after the observatory was built he made practical use of the lately established lines of electric telegraph, and by exchange of signals with Professor Bond of Harvard University he established the true longitude of Fredericton. He afterwards ascertained the exact longitude of Saint John and of Quebec. Finally in 1856, as discrepancies were found to exist in the longitude of places on the international boundary between Maine and New Brunswick, as taken by the British and United States surveyors, it was deemed important to settle the question by the electric telegraph and Dr. Jack accordingly determined the longitude of Grand Falls and Little Falls on the upper St. John.

During the decade that followed his appointment as president, Dr. Jack probably did his best work. It was his privilege to see in his lifetime the realization of many of his hopes. Grammar schools and High schools lately established were presided over by graduates of his own University, and to-day his pupils include such men as

Hon. Wm. Pugsley, lieutenant-governor of New Brunswick, Sir Geo. E. Foster, George R. Parkin, Chief Justice Hazen, Chief Justice Sir Frederick Barker, Chief Justice E. L. Wetmore, lieutenant-governor G. H. V. Bulyea, of Alberta, together with the Superintendent of Education for N.B., the Principal of the Normal School, all the County school inspectors, and even Chancellor Jones of the University, are distinguished graduates of the U.N.B.

Dr. Jack's long period of service extended over forty-five years, during which he enjoyed few holidays. In 1885 he retired on a well-earned pension and soon after, for the first time, re-visited the land of his birth. On his return he was made a member of the University Senate. But his life-work was done. He died at Fredericton on his sixty-seventh birthday, November 23, 1886, and was laid to rest in the cemetery in the heart of the town in which he had spent his working days. "*Nunc placida compôstus, pace quiescit.*"

Pre-Assembly Legislatures in British Canada.

By WILLIAM RENWICK RIDDELL LL.D., F.R.S.C.

CHAPTER I.

BEFORE THE FIRST COUNCIL OF 1764.

(Read May Meeting, 1918)

At the time of the Conquest of Canada in 1759-60, Britain had had much experience with Colonies on this side of the Atlantic and had a settled policy in their government. In Canada she derived little if any assistance from the methods of France, and the period of French rule may be neglected in the consideration of the history of Canadian Parliaments (1). In the Articles of Capitulation at Montreal between Amherst and Vaudreuil, Sept. 8, 1760, the free exercise of their religion was assured to the Canadians (Art. XXVII) but the request that they might not be called upon to bear arms against their former Sovereign met the curt reply "They become Subjects of the King:" and the request that they should continue to be governed according to the custom of Paris and the laws and usages established for Canada met the same fate. (Art. XLI, LXII) (2).

Not being embarrassed by stipulations entered into with the conquered people, the British Generals during the period of military rule (which lasted till after the Definitive Treaty of Paris, February 10, 1763) governed Canada on the ordinary principles of military rule (3). Nor did the Treaty of Paris change the situation: His Most Christian Majesty King Louis XV ceded to King George III, Canada with all its dependencies, in the most ample manner and form without restriction; while King George agreed to grant the liberty of the Catholic religion to the inhabitants of Canada (Art. V): but there was no provision as to law, government or language (4).

The time had now come for civil government; Canada was not only *de facto* but also *de jure* part of the British dominions.

Before 1696, supervision over His Majesty's possessions beyond the Seas had been exercised by the Privy Council or for a short time during the reign of Charles I by a Commission: in 1675 a Committee of the Privy Council had been entrusted with the control of trade and foreign plantations—"the Lords of Trade." In 1696, however, a new body was formed—the "Board of Trade"—by commission under the Privy Seal: some but not all of the members of the Board of

Trade—who now received the title "Lords of Trade"—were members of the Privy Council.

The powers of the Board were very extensive but not in all matters and at all times perfectly definite (5): at the time of the Conquest of Canada it was largely an administrative body, one of the most important of whose functions was the furnishing of information and advice to Parliament and the Great Officers of the Crown on colonial matters.

The Treaty of Paris having been concluded, Lord Egremont, Secretary of State, requested the Board of Trade to take under consideration and advise as to what new Governments should be formed in North America and what form should be adopted for such new Governments, suggesting that it might be a proper object of consideration how far it was expedient to retain or depart from the forms established by France in these Colonies. (6).

In an admirable report, the Board, June 8, 1763, recommended (*inter alia*) that a "Government" should be formed for Canada, with a Governor and Council under His Majesty's Commission with instructions adapted to the needs of the Country (7). The Board of Trade urged the settlement of Canada by encouraging those in the old North American Colonies to form new settlements and by giving land to Officers and Soldiers who had distinguished themselves during the war (7). This suggestion was also approved (8).

The Board by Message of July 14, 1763, were informed that James Murray had been selected as Governor of Canada and they were directed to draft a Commission and Instructions for him (9). Apparently it was when considering the Commission and Instructions, that the Board changed their views as to the proper form of Government for Canada: we find that in a Report, October 4, 1763, made to Halifax they say "It appears to us upon a Revision of the Report * * of the 8th of June last, that it will be expedient for His Majesty's Service and give Confidence and Encouragement to such persons as are inclined to become Settlers in the new Colonies that an immediate and public Declaration should be made of the intended permanent constitution and that the power of calling Assemblies should be inserted in the first Commissions" (10).

Having prepared the draft Commission and Instructions, they transmitted the documents with a Report in which they say that "they conceived it to be Your Majesty's Royal Intention that the Form and Constitution of Government in these new Colonies" (including Canada) "should be as near as may be similar to what has been established in those Colonies which are under Your Majesty's immediate Government:" and they accordingly prepared Commissions "by which the Governors were empower'd and directed so soon as the circumstances of the Colonies will admit thereof, to summon and call General Assemblys of the Freeholders * * * in such manner as is practised in Your Majesty's other Colonies" (11).

In the North American Colonies the government as prescribed by Commission and Instructions to the Governor consisted of a Governor, a Council selected by the Crown and an Assembly elected by the people. Both Assembly and Council took part in legislation and the Council also formed an Executive: the Governor gave or withheld the Royal consent in all legislation.

It did not seem advisable to call a House of Assembly immediately in Canada because it contained "within it a very great number of French Inhabitants and settlements and * * the Number of such Inhabitants must greatly exceed for a very long period of time that of Your Majesty's British and other Subjects even supposing the utmost efforts of Industry on their part either in making such new Settlements, by clearing of Lands or purchasing old ones from the ancient Inhabitants"—as the Board of Trade express it in their Report (10).

The object of promising an Assembly was plainly to induce settlement from the Old Land and the American Colonies, countries which enjoyed the advantage of a House elected by the people, not nominated by the Crown.

The Royal Proclamation of October 7, 1763, which divided the newly acquired territory, formed the "Government of Quebec" from old Canada (12) and stated that express power had been given to the Governors of the new Governments (including Quebec) "that so soon as the state and circumstances of the said Colonies will admit thereof, they shall with the Advice and Consent of our Council summon and call General Assemblies * * in such manner and form as is used and directed in those Colonies and Provinces in America which are under our immediate Government" (13).

In the Commission issued to General James Murray as Governor in Chief of the Province of Quebec, November 21, 1763, a Council was provided for, to be appointed by the Crown; and he was empowered "so soon as the situation and circumstances of our said Province under your Government will admit thereof and when and as often as need shall require to summon and call General Assemblies of the Freeholders and Planters within your Government"—and he was commanded to govern according to his Instructions or "according to such reasonable laws and statutes as shall hereafter be made and agreed upon by you with the advice and consent of the Council and Assembly of Our said Province." With the Council and Assembly or the major part of them, he was to "make, constitute and ordain, Laws, Statutes and ordinances for the public peace, welfare and good Government of our said Province and of the people and inhabitants thereof and such others as shall resort thereunto" (14).

The Royal Instructions, December 7, 1763, directed Murray to "nominate and establish a Council" for the Province to assist him in the administration of Government, i.e., an Executive Council: until the establishment of an Assembly he was "to make such Rules and Regulations by the Advice of Our said Council as shall appear to be necessary for the Peace, Order and good Government of Our said Province:" but he was "with the Advice of Our Council" to "summon and call a General Assembly of the Freeholders in Our said Province . . . as soon as the more pressing affairs of Government will allow—to give all possible attention to carrying this important object into Execution." After the establishment of an Assembly he was to legislate "with the Advice and Consent of Our said Council and Assembly" (15).

It is thus clear that it was intended that ultimately Quebec should be governed as the Royal Colonies to the south; but that for the time being there should be but one legislating house whose members were to be also Executive Councillors.

There is one provision in the Instructions worthy of note in this connection— after reciting that Members of several Assemblies in the Plantations had frequently assumed to themselves Privileges no ways belonging to them, amongst others that they had "taken upon them the sole framing of Money Bills refusing to let the Council alter or amend the same," the Instructions proceed "It is also Our further Pleasure that the Council have the like Power of framing Money Bills as the Assembly" (16). The difficulty experienced by many Colonial Governors in the American Colonies with Assemblies claiming the exclusive right to deal with money bills is well known—the story is a most interesting chapter in Constitutional History. Most of the Colonies in defiance of the Home Authorities, the Board of Trade and the Privy Council asserted and successfully asserted this right—perhaps the case of New York is the best known instance of Colonial self-assertion, but Massachusetts, New Jersey, North Carolina and other Colonies were equally firm and equally successful (17).

This provision was intended to prevent such an assertion by "the Commons" of Canada.

NOTES TO CHAPTER I.

(1) Those interested in the constitution of Canada under French rule may consult General Murray's Report on the State of the Government of Quebec, June 5, 1762; this is printed in convenient form in Shortt and Doughty's Documents

relating to the Constitutional History of Canada, 1759-1791, Canadian Archives 1907, Vol. III (Sessional Paper, No. 18), pp. 37 sqq.

Some account will also be found in my "Constitution of Canada," Yale University Press (the Dodge Lectures, Yale Univ. 1917) Lecture I.

(2) Shortt and Doughty *ut supra*, pp. 14, 17, 18, 25, 27.

(3) There has been much written of complaint against the military rule during the years from 1759 to 1763; and no doubt there were some incidents of a more or less harsh and arbitrary character: but taken as a whole, the administration was as considerate and as successful as could be expected under the circumstances. There was no act of apparent injustice or cruelty which could not be paralleled by a similar act about the same time in the British Isles, not to speak of France.

(4) Shortt and Doughty *ut supra* pp. 75, 85, 86.

(5) I have written a somewhat exhaustive note on the powers and functions of the Board of Trade (which may some day see the light); but since writing it, I have seen a sufficiently extensive, a very well-written and accurate account in Dr. Dickerson's American Colonial Government, Cleveland, The Arthur H. Clark Company 1912, which may be consulted with confidence by those interested.

(6) Shortt and Doughty *ut supra* p. 94.

(7) Shortt and Doughty, p. 111, Report of Aug. 5, 1763.

(8) Shortt and Doughty, p. 113, Halifax to Board of Trade, Sept. 19, 1763.

(9) Shortt and Doughty, p. 108.

(10) Shortt and Doughty, p. 114, Sir Charles Wyndham, Second Earl of Egremont, had died suddenly, Aug. 21, 1763, and had been temporarily succeeded by the Earl of Halifax as Secretary of State.

(11) Shortt and Doughty *ut supra* p. 116.

(12) This may not be literally accurate but it is substantially correct and is at all events near enough for our present purpose. The boundaries of the Government of Quebec are given in Shortt and Doughty *ut supra* p. 120.

(13) Shortt and Doughty *ut supra* p. 120.

(14) Shorty and Doughty *ut supra* pp. 127, 128.

(15) Shortt and Doughty *ut supra* pp. 133, 135.

(16) Shortt and Doughty *ut supra*, pp. 136, 137.

(17) I have written a note of some length on this subject; but sufficient will be found in Dr. Dickerson's Work mentioned in note (5). I give but one instance—in 1735 a serious clash occurred between the Council and the Assembly of South Carolina over the right of the Assembly to control money bills. The Council amended a money bill by adding an item and insisted that they would not pass the bill without this item.

The Assembly passed the following Resolution, February 8, 1735:

"*Resolved*, That His Majesty's Subjects in this Province are entitled to all the Libertys and Privileges of Englishmen,

"*Resolved*, That the Commons House of Assembly in this Province, by the Laws and Statutes of Great Britain made of force in this Province, and by the Acts of Assembly in this Province, and by Ancient Custom and Usage have the same Rights, Powers and Privileges in regard to introducing and passing Laws for the imposing of Taxes on the People of this Province as the House of Commons of Great Britain have in introducing and passing Laws on the People of England.

"*Resolved*, That after the Estimate is closed and added to any Tax Bill, that no additions can or ought to be made thereto, by any other Estate or Power whatsoever, but by and in the Commons House of Assembly."

The Council insisted (the salary of Chief Justice Wright, one of its members was in question); but there was the usual outcome—the Council was forced to give way.

An account of this dispute is given in "The Life of Henry Laurens," by Dr. Wallace, G. P. Putnam's Sons, New York and London, 1915, at pp. 37 sqq.—the learned author speaks of the House of Assembly's "arrogant and tyrannical exercise of power."

CHAPTER II.

1763-1774. The First Legislature.

It is now fitting that the composition of this Legislative Council should be considered.

In addition to the two persons selected by the Home Government as Lieuteant-Governors of the Districts of Montreal and Trois Rivières respectively, the Chief Justice of Quebec and the Surveyor General of Customs for the Northern District of North America (both also selected by the Home Administration) the Governor was to choose eight other persons "from amongst the most considerable of the Inhabitants of or Persons of Property in" the Province: those chosen were to take the oath of Supremacy and to sign the Declaration against Transubstantiation, etc., (1) as well as to take the oath of office; their names and characters were to be sent to the Board of Trade so that if any should not be approved by the Board, their place could be filled with others. The Governor might remove or suspend any Councillor for just cause and appoint others, until the will of the Crown should be known—but he was not to remove or suspend any Councillor who had been confirmed by the Crown, without good and sufficient cause and the consent of the majority of the Council after due examination of the charge against him and his answer. No member was to be absent from the Province more than six months without leave of the Governor or Commander in Chief; and not for a year without leave given under the Sign Manual of the King; if anyone wilfully absented himself, residing in the Province, he was to be admonished and if he persisted in his default after admonition he was to be suspended till the Royal pleasure should be known. In all cases of suspension for any cause, a full account of the proceedings and of the reasons for suspension was to be transmitted at once to the Board of Trade.

The Members of the Council were "to have and enjoy Freedom of Debate and Vote in all Affairs of Public Concern that may be debated in Council," and all Laws, Statutes and Ordinances passed were to be transmitted within three months of their passing to the Board of Trade (2).

The Province being under the immediate government of the King, and not that of the Parliament of the United Kingdom, of course it was for the King to give directions as to the legislative body in the colony. While by his Instructions, he directed the Governor to nominate and appoint Members of the Council he was not thereby deprived of the common-law power of himself appointing others to any desired number—those were appointed by a Mandamus issued to the Governor. There were then to be the two methods of appointment to the Council (1) by Summons from the Governor and (2) by Royal Mandamus—some of the Consequences of this dual system will be mentioned in the Memorandum added to this Chapter.

Governor Murray proceeded in June and July, 1764, to appoint Councillors; and at the first Council held Monday, August 13, 1764, there were present in addition to himself and Chief Justice William Gregory, seven persons "nominated Members of His Majesty's Honourable Council by His Said Excellency"—a mandamus had issued in July for another but he was not yet sworn in and is, of course, not noted as being present. Chief Justice Gregory was appointed President of the Council (3).

The Council with the successive Governors passed much useful legislation—of a purely local character of course; and seem to have been fairly efficient as legislators. But there was dissatisfaction in some quarters. It was not long before the English traders in Quebec began to press for an Assembly; and their request was backed up by a number of London merchants trading with Quebec—it was of course intended that the Members of the Assembly should be Protestants, as no others were considered qualified. There was no objection to Roman Catholics voting; and it was urged that there was a number more than sufficient of loyal and well-affected Protestants to form a competent and respectable House of Assembly. As early as September, 1765, the Board of Trade recommended the summoning of an Assembly, the Members to be Protestants, the voters of either religion. Opinions as to the expediency of an Assembly differed; e.g. Francis (afterwards Cursitor Baron) Masères (4) who became Attorney-General of Quebec in 1766 thought that such an Assembly would in truth be representative of only the 600 (5) new English Settlers and an instrument in their hands of domineering over 90,000 French—moreover he thought that the Canadian bigotted to the Popish religion should not be trusted with any power.

Masères afterwards in 1769, as Attorney General for the Province and on the order of Carleton the Governor, drew up a Report concerning the state of the Laws and the Administration of Justice in the Province in which he said that Murray's Commission did not justify legislation without an Assembly and that all the Ordinances theretofore made had been made without warrant or authority from the Commission and therefore might perhaps be justly contended to be null and void (6). This Report did not meet the approval of Carleton; and there does not seem to be any solid ground for Masères' doubts.

The London Merchants pressed a claim for a full Legislature, i.e., an Assembly and a Council; and in 1769 the Board of Trade took the matter into consideration. They suggested as an experiment and not as a fixed and permanent system, an Assembly of twenty-seven Members who should not be required to subscribe the declaration against Transubstantiation (except those elected for the two Cities of Quebec and Montreal and the Town of Trois Rivières) but only to take the oaths of Allegiance, Supremacy and Abjuration, thereby allowing Roman Catholics to be elected for the rural constituencies. It was expected by this means to assure nearly an equal number of Protestant and Catholic Members in the popular house (7). Nothing came of this scheme.

From time to time petitions were sent to the Home Governments by "Old Subjects" (i.e. those who did not become Subjects by the Conquest and Treaty of 1763, these being the "New Subjects") asking for an Assembly, claiming that there was a sufficient number of Protestant Subjects in the Province qualified to be Members. Occasionally but very rarely it was suggested that Roman Catholics and French Canadians might be admitted to Parliament; generally the monopoly of seats in Parliament was considered the right of Protestants. Solicitor General Wedderburn, indeed, thought it would be a dangerous experiment to admit a Canadian to a place in the Assembly but thought also that it would be impossible to exclude Canadians from voting—he was wholly opposed to an Assembly and thought that the power to make Laws must be vested in a Governor and a Council consisting of a certain number of persons not wholly dependent on the Governor (8).

The French Canadians did not much trouble themselves about an Assembly; what they were desirous of, was to recover their old laws of which they had been deprived by the Royal Proclamation of October, 1763.

But the incessant cry on the part of the "Old Subjects" (9) caused the question of the form of Parliament to be taken up by the Home Administration. "The Quebec Act" of 1774 was the result. The Royal Instructions to the Governor who followed Murray contained the same provisions as to calling a General Assembly as did the

Instructions to Murray (10) but the Quebec Act put an end to such a measure for nearly a score of years.

Before this period is left, mention should be made of the judicial powers of the Council.

The Royal Commission to Murray Nov. 21, 1763, gave him power with the advice and consent of the Council to "Erect, Constitute and Establish such and so many Courts of Judicature and Publick Justice . . . . . as you and they shall think fit and necessary . . ": and he was given power "to constitute and approve Judges &c". In pursuance of this power, an Ordinance was passed September 17, 1764, "by and with the Advice, Consent and Assistance of His Majesty's Council" establishing a Court of King's Bench to sit at Quebec twice a year with an Appeal to the Governor and Council where the matter in contest was above the value of £300 Sterling, and a further Appeal to the King in Council where the matter in contest was of the value of £500 Sterling or upward.

A Court of Common Pleas, an inferior Court, was also established to try cases above the value of £10 with an Appeal to the Court of King's Bench where the matter in contest was of the value of £20; where it was above the value of £300 Sterling the appeal might be taken immediately to the Governor and Council with a further Appeal to the King in Council if it was of the value of £500 Sterling or upward.

The Ordinance of February 1, 1770, establishing a separate Court of Common Pleas at Montreal did not modify this appellate jurisdiction which continued in effect during the remainder of this period.

There was a temporary ordinance, November 12, 1764, allowing an Appeal to the Governor and Council from "any Order, Judgment or Decree of the Military Council of Quebec or of any other Courts of Justice in the Said Government or of those of Montreal or Trois Rivières prior to the Establishment of Civil Government throughout this Province in August last, where the Value in Dispute exceeded the Sum of Three Hundred Pounds Sterling" with a further Appeal to the King in Council where the value was £500 or more.

Another temporary ordinance, September 1, 1773, was passed by reason of the absence of the Chief Justice (William Hey) from the Province: it constituted (during this absence) the Governor and Lieutenant Governor or in their absence the Eldest Member or President of the Council (not being a Judge of the Court of Common Pleas) together with every other Member of the Council, the Court of Appeal from the Courts of Common Pleas—no Judge of a Court of Common Pleas to sit in this Court. The Governor or Lieutenant-Governor or in their absence the Eldest Member or President with five other

Members were to be a quorum. In cases over £500 Sterling there was the further Appeal to the King in Council.

NOTES TO CHAPTER II.

(1) The Oath of Supremacy is prescribed by 1 Geo. I, St. 2, C. 13; the Declaration against Transubstantiation, &c., by 25 Car 11, C. 2. cf. Bláckstone's Commentaries, vol. 4, Chap. 4.

(2) The Royal Instructions to General Murray, December 7, 1763, are printed in Shortt and Doughty, *ut supra*, pp. 132 sqq.

(3) The first Legislative Council of the Province of Quebec met "At the Council Chamber in the Castle of St. Louis in the City of Quebec on Monday, the thirteenth day of August, 1764."

Those present were:—

"His Excellency the Honorable James Murry, Esq.

and

William Gregory
Paulus Emilius Irving
Hector Theophilus Cramahé
Samuel Holland
Walter Murray
Adam Mabane
Thomas Dunn
Francis Mounier.

Nominated members of His Majesty's Honorable Council by His said Excellency."

(Extract from the State Book "A," containing the Minutes of said Council from the 13th August, 1764, to 22nd May, 1765).

But it appears that there was a Royal Mandamus, July 20, 1764, appointing James Goldfrap (the Governor's Secretary) to the Council, and he received a Summons the same day (Index to State Book "A" pp. 72, 669): he was not sworn in, however, till Oct. 10, 1764, and therefore did not take part in the first meeting.

Benjamin Price took the oath on his appointment to the Council and took his seat October 31, 1764, thereby completing the number the Governor could appoint.

William Gregory was a English barrister who was in 1764 sent out by the Home Government to Quebec as Chief Justice of the Province. He was superseded, February, 1766, never having been of the slightest service to the country and leaving no mark on its jurisprudence. He was succeeded both as Chief Justice and as President of the Council, September, 1766, by William Hey, a much abler man.

Gregory is said to have "been let out of prison to preside on the bench, was ignorant alike of civil law and the language of the country," Garneau's History of Canada (translated by Bell), Montreal, John Lovell, 1862, Vol. 1, p. 91.

Lt.-Col. Paulus Aemilius Irving, an officer in the British Army, who for a few months in 1766 acted as Governor on Murray's recall by Conway; he was of the family of Irving of Bonshaw, Dumfriesshire, Scotland, had taken part in the Siege of Quebec under Wolfe and been wounded on the Plains of Abraham.

Hector Theophile Cramahé, a Protestant Swiss, who had been Civil Secretary for the District of Quebec during the military occupation from the time of Murray's appointment as Lieutenant-Governor of that District.

Murray had great confidence in him and in October, 1764, sent him to London to explain certain difficulties which had arisen. When in 1769 Sir Guy Carleton obtained leave of absence from his post as Governor in chief, Cramahé was appointed

Lieutenant-Governor and acted as such till Carleton's return in 1774. Being in command at Quebec on the approach of Arnold's expedition in 1775, he acted with promptness and prudence—removing all the sailing craft from the south side of the river, he delayed the invaders and probably saved Quebec. He continued to take a very prominent part in the affairs of the Province for many years and seems to have been a capable reliable and conscientious public servant. His Summons seems to be dated June 21, 1764.

Adam Mabane, a Scotsman, educated at Edinburgh for the medical profession who came to Quebec as a Surgeon (or Surgeon's mate) in the British Army. He was pushing and untiring in his efforts to advance himself, and obtained the confidence of successive Governors, especially Haldimand whom he almost entirely dominated. He was removed from the Council, 1766, by Carleton, appointed a Judge of the Court of Common Pleas under the Quebec Act of 1774, a member of the Legislative Council, and lastly a Judge of the Court of King's Bench. He acquired considerable property and played a great part in the history of Quebec during the early years of British rule.

Walter Murray, of whom Carleton says in a letter to Lord Shelburne October 26, 1766 (S. & D., pp. 192, 193), "Mr. Walter Murray who has acted as a strolling player in other Colonies, here as a Councellor"—otherwise unknown to fame.

Samuel Holland, Surveyor General. Dr. Scadding in his "Surveyor General Holland," Toronto, 1896, has an account of Holland; the following will be sufficient here. Holland seems to have been a native of Canada, a personal friend of General Wolfe who made him a present of a brace of fine pistols. He was engaged in making surveys at Louisbourg after its surrender in 1744 where he made the acquaintance of Capt. Simcoe father of John Graves Simcoe, afterwards Lieutenant-Governor of Upper Canada. He became the first Surveyor General of British North America, a position he filled for nearly fifty years. His residence at Quebec was near Spencer Wood and was known as Holland House. He died at Quebec in 1801, a member of the Executive and Legislative Councils. Holland River and Holland Landing are called after him.

Thomas Dunn, born in 1731 in Durham, England, Engaging in commercial life, he came to Canada very shortly after the Conquest in 1759–60 and carried on business as a merchant. So far as appears, he had no legal education but he was a man of great executive ability, and was "most enlightened, able minded and impartial." A member of the first Executive Council he became a member of the first Legislative Council in 1775, and the same year Judge of the Court of King's Bench, Quebec. He became Administrator of the Government in 1805 and again in 1811 and acted with promptness and energy. A Seigneur, he was very popular with the French-Canadian people and with no small number of the English population, but in those days it was impossible to please both factions.

Francois Mounier, a French-Canadian merchant, described by Carleton in his letter above mentioned as "an honest quiet trader who knows very little of our Language or Manners like most Canadians will sign without Examination whatever their Acquaintance urges them to." Gagnier says Vol. I, pp. 87, 88, "Only one native was admitted; the exceptional man being a person of no mark and his name added merely to complete the requisite number."

(4) Dr. Kingsford in his History of Canada, Vol. V, p. 165 n, gives a fairly full and accurate account of Masères; Masères' paper will be found in Shortt and Doughty, Const. Docs., pp. 179 sqq.

(5) Shortt and Doughty, p. 185.

(6) Shortt and Doughty, pp. 243 sqq.

(7) Shortt and Doughty, p. 267.

(8) Shortt and Doughty, pp. 297 sqq.

(9) Shortt and Doughty, pp. 263–352.

(10) Shortt and Doughty, pp. 210 sqq., Instructions to Sir Guy Carleton, 1768, as Governor in Chief: Paulus Aemilius Irving, Hector Theophile Cramahé and Sir Guy Carleton had acted as Lieutenant-Governor in the absence from the Province of the Governor-in-Chief; but the Royal Instructions issued only to the Governor-in-Chief. The only two Governors-in-Chief from the Royal Proclamation of 1763 to the Quebec Act were General James Murray and Sir Guy Carleton.

Memo.—I add here the references to Councillors extant in the Archives at Ottawa.

1764 July 20—James Goldfrap summoned to Council.
" " —Royal Mandamus appointing James Goldfrap to Council.
" Aug. 13—Meeting of Council, see *Note 3 supra*.
" Oct. 31—Benjamin Price sworn in and took his seat.
1765 June 27—Charles Stewart, Surveyor General, sat as a member of the Council at a meeting at the Castle of St. Louis.
" Sept. 25—Hugh Finlay received a Summons to Council.
1766 May 22—Thomas Dunn received a Summons.
" June 14—Charles Stewart, Surveyor-General, sat with Council (cf June 27, 1765).
" June 14—James Cuthbert Esq., sworn in and took his seat as Councillor.
" " 21—Hector Theophilus Cramahé received a Summons.
" " 30—Thomas Mills Esq., sworn in and took his seat as Councillor.
" Sept. 5—Chief Justice William Hey sworn in and and took his seat as Councillor.
1767 Jan. 2—Benjamin Price sat as Councillor.
1768 April 11—Mr. Colin Drummond sworn in and took his seat as Councillor.
1769 Jan. 1—Hugh Finlay appointed Councillor.
1772 April 4—Francis Levesque appointed Councillor in lieu of Hugh Finlay to embark for London.
1773 Jan. 9—John Collins and Edward Harrison appointed Councillors.
" Oct. 8—John Carden Esq., appointed Councillor.

A report made in 1766 shows the following as Members of the Council with the date of their admission:—

1764 Aug. 13—Paul Æmis Irving. Again swore in 24th Sept., 1766 by Mandamus.
Hector Theophilus Cramahé dated 21st June, 1766 (4?) swore in again 24th September, 1766, by Mandamus.
Samuel Holland.
Walter Murray again swore in 24th Sept., 1766.
Adam Mabane " "
Thomas Dunn " "
Francis Mounier.
1764 Oct. 10—James Goldfrap by Mandamus dated 20th July, 1764, again swore in 24th September, 1766.
" " 31—Benjamin Price.
1765 June 20—Charles Stewart S.G. by Mandamus.
1766 June 14—James Cuthbert.
" " 30—Thomas Mills R.C. by Mandamus.
" Sept. 25—William Hey C.J. by Mandamus.
(in the room of William Gregory Esq., late Chief Justice and struck out of the Council.)

Goldfrap being appointed by Mandamus from the King, the Council was complete when Benjamin Price became the eighth member appointed by the Governor. Charles Stewart was appointed by Mandamus.

How Hugh Finlay was appointed does not specifically appear but it must have been by Mandamus.

James Cuthbert was appointed by the Governor. I presume Col. Irving taking over the Governorship on Murray's leaving for England made a vacancy, "forced," Cuthbert told Carleton, "into the Council by Governor Murray on his departure much against his will." Shortt & Doughty, p. 193.

Thomas Mills was appointed by Mandamus.

Some of the members (who had been appointed by Murray) wrote about this time (October, 1766), to the new Governor, Sir Guy Carleton, of the practice of appointing by Mandamus. Carleton had assumed the reins of government September 24, 1766; they contended that while His Majesty might have an undoubted right to grant Mandamus where he pleased, that could not deprive the appointed members of their "Right to Procedure or to a Seat in Council." Carleton had called only certain members to Council Meetings and those left out supposed they were being excluded from the Board—they claimed that if the number of Members was limited by the Constitution or Custom, a Mandamus should be effective only if there was a vacancy.

Carleton's reply was not conciliatory—however, he informed them that the Council was composed of twelve members, "those named and appointed immediately by the King have the Preference next follow those appointed by Governor Murray till the Seats are all full." Shortt and Doughty, pp. 193–195.

He took occasion in his letter to make clear to the recalcitrants that he would "on all matters which do not require the Consent of Council call together such Councellors as I shall think best qualified to give me Information and further that I will ask the Advice and Opinion of such Persons tho' not of the Council as I shall find Men of Good Sense, Truth, Candor and Impartial Justice, persons who prefer their Duty to the King and the Tranquility of his Subjects to unjustifiable Attachment, Party Zeal and to all selfish mercenary views. After I have obtained such Advice I will still direct as to me shall seem best for His Majesty's Service, and the Good of the Province Committed to my Care."

In other words while recognizing that the "Advice and Consent" of the Council was necessary in legislation he declined their control in other regards, taking upon him the sole burden and responsibility of Administration. That he was justified in taking this position in law there can be no doubt, the time for Responsible Government had not come.

It may perhaps be of interest here to say that the Act of 1774 was fiercely opposed in the Imperial Parliament. I copy part of a paper read at the May meeting, 1917, of the Royal Society of Canada. (Trans. R.S.C. for 1917, pp. 81 sqq.) Some Origins of the British North America Act, 1867.

"There was some excuse for Thomas Townshend, M.P., saying that the government (1763-1770) was in fact despotic (Hansard, Vol. XVII, p. 1357).

A new period began when the Quebec Act of 1774 came into force (May 1st, 1775)—notwithstanding the vigorous efforts of the Opposition, Townshend, Dunning, Colonel Barre (who knew for a fact that the principal people of Canada "take a liking to assemblies" and "think they have as good a right to have assemblies as any other colony on the continent"), Sergeant Glynn, Charles James Fox (who urged that it was not right for Britain to originate and establish a constitution in which there is not a spark or semblance of liberty" and protested against the proposal to "establish a perfectly despotic government contrary to the genius and spirit of the British Constitution), and Burke (who objected to the "despotic Council"), the Bill was passed. The Attorney-General, thought it absurd that Canada should have her sovereignty divided between the Governor, Council and Assembly; that he thought, would be making Canada an Allied Kingdom totally out of the power of Britain, "to act as a federal union if they please and if they do not please to act as an independent country—a federal condition pretty much the condition of the States of Germany." Sir Guy Carleton, Governor-General of Canada, being examined before a Committee of the House of Commons said that the Canadian inhabitants were not desirous of having Assemblies in the Province—"Certainly not."

The Quebec Act provided for the government of Canada by Governor and Council without Assembly, and the British Constitution was ignored.

CHAPTER III.

Under the Quebec Act—1774-1791.

Whatever the theories of the American Colonies and their Successors, the United States, there can be no doubt (for a British Subject) that the Imperial Parliament had the power to legislate for Canada; the King being a part of Parliament, Parliament could take out of his hands any part of the government of the Colony.

The British Government took considerable pains with the proposed legislation—the fourth draft was made before it was decided to lay the matter before Parliament (1)—in none of these was it proposed to retain the provision for an Assembly. The Act as finally passed (1774, 14 George III c. 83. Imp.) provided, Sec. 12, for the appointment by the King by warrant under the Signet or Sign Manual with the advice of the Privy Council of a "Council for the Affairs of the Province of Quebec to consist of . . persons resident there not exceeding twenty-three nor less than seventeen . . . which Council . . . or the major part thereof shall have power and authority to make Ordinances for the peace, welfare and good government of the said Province with the Consent of "the Governor. This Act is generally known as "the Quebec Act" (2).

It is obvious that a change was made in the manner of appointing Members of the Council—from 1764 on, the Members were either (1) *ex officio* or (2) appointed under Mandamus of the King (both of these classes being selected by the Home Administration or (3) appointed by the Governor: now, all must be appointed by the Home Administration by Warrant.

Sir Guy Carleton being appointed "Captain General and Governor in Chief in and over Our Province of Quebec in America and all Our Territories thereunto belonging," his Instructions dated January 3, 1775, contained the names of the twenty-two persons appointed

Councillors (3). He was directed to notify the Secretary and the Board of Trade of all vacancies and to send to the Secretary the names and characters of those whom he thought best fitted to fill the vacancies.

The Quebec Act, Sec. 7, relieved all persons "professing the religion of the Church of Rome and residing in the . . . . Province" from the Oath of Supremacy &c; but the Instructions limited this relief to (French) Canadians professing the religion of the Church of Rome—no English, Scottish, Irish or American Catholic was privileged. (4).

Specific instructions were also given as to the Appellate jurisdiction; these were incorporated in an Ordinance of February 26, 1777, (5); an Appeal was given from the "Inferior courts of civil jurisdiction . . . in all cases where the matter in dispute should exceed the sum of £10 sterling or a duty payable to the Crown, or annual rents or other such like matter or thing where the rights in future might be bound." The Governor, Lieutenant Governor or Chief Justice with any five members of the Council were to be a quorum, Judges who had given the judgment appealed from to be excluded. Where the matter in dispute exceeded £500 a further appeal was given to the King-in-Council.

The Royal Instructions to Haldimand July 16, 1779, directed that the Court of Appeal "shall consist of four persons besides the Chief Justice to be nominated by the Governor or Commander in Chief . . . from among the Members of the Council . . . together with the Judges of the Court of that District from which the Appeal does not come, the Lieutenant Governor . . not to be one . . five to be a quorum . . . the Chief Justice (or acting Chief Justice) . . . to be one." This instruction, however, was not carried into execution by the enactment of an ordinance (6).

As we have seen, Carleton as early as 1766 tried to ignore some of his Councillors whenever possible. In the new state of the Constitution, he continued, perhaps aggravated, this practice: the Second Article of his Instructions (7) providing that "any five of the . . . Council shall constitute a Board of Council for transacting all Business in which their Advice and consent may be requisite, Acts of Legislation only excepted," he interpreted as authorizing him to select and appoint five Councillors by name to form such Quorum constituting thereby an Executive Council and to exclude the remainder from the deliberations except in case of desired legislation.

The excluded Councillors protested; and this dispute formed at least a part of the troubles of the Governor. Chief Justice Peter Levius (8) moved in the Council that an address should be presented to the Governor in the premises asking that the practice should cease. For this and other offences Carleton dismissed the Chief Justice who made his way to England and made complaint to the Home Authorities. The Board of Trade made full inquiry calling Carleton and Livius before them and ultimately decided against the position taken by the former (9). This led to Additional Instructions being sent to Haldimand who had succeeded Carleton (10) and had continued his practice. Accordingly the Governor received Instructions not to select and appoint five Councillors "terming the same a Privy Council" but to summon "to Council all such thereunto belonging as are within a convenient distance." (11).

When Sir Guy Carleton (now become Lord Dorchester) was again appointed Governor-in-Chief (12) care was taken in his Instructions to give a specific direction "you are however not to select or appoint any such Members of our said Council by Name to the Number of five as you may think fit to transact such Business or term any select Number of such Members by the Name of a Privy Council but you are on every Occasion where the Attendance of the Members is necessary or required to summon all such who may be within a convenient distance." (13).

Disputes between the Council and the Governor occasionally occurred thereafter; but we do not find any further attempt to exclude any Councillor from participation in all the business of the Council.

In 1787 an attempt was made to throw the deliberations of the Council open to the public but this failed owing to the opposition of the French Members (14). One of the Members (15) had the curious notion that every British subject had a right to hear the debates of the Legislature passing laws by which he was bound.

In the same year the Council as the Court of Appeal laid down the extraordinary doctrine that in cases in which the parties were English and no Canadian (i.e. French-Canadian) was in any way concerned, the English law should be applied. This was of course a misinterpretation of the Quebec Act which by sec. 8 declared that "in all matters of controversy relative to property and civil rights resort shall be had to the Laws of Canada as the rule for the decision of the same," (16). Those advancing this doctrine however received no encouragement at the hands of the Home Administration.

During all the period from the passing of the Quebec Act until 1791, there was an almost constant agitation for and against the erection of a House of Assembly elected by the people. While there were exceptions on both sides it may be said that in Canada, speaking generally, the English speaking (or old) subjects favoured while the French-speaking, "Canadian" (or new) subjects were opposed.

At length in 1791 the Constitutional Act or Canada Act was passed which for the first time gave Canada a bicameral legislature, and therefore a real Second House. (17).

The upper part of the Province was filling up, especially after the recognition in 1783 of the independence of the United States; this was of great influence in dividing the Province into two and of introducing an elective House of Assembly.

NOTES TO CHAPTER III.

(1) The Drafts are set out in Shortt and Doughty pp. 376–385.

(2) Shortt and Doughty pp. 401 sqq.

(3) Shortt and Doughty pp. 419, 420. The Councillors were:—

1. Hector Theophilus Cramahé or the Lieutenant-Governor for the time being.
2. The Chief Justice of Quebec for the time being. (This was at the time William Hey).
3. Hugh Finlay.
4. Thomas Dunn.
5. James Cuthbert.
6. Colin Drummond.
7. Francis LesVesques.
8. Edward Harrison.
9. John Collins.
10. Adam Mabean.
11. ——— DeLery.
12. ——— St. Ours.
13. Picodyde Contrecoeur.
14. The Secretary of the Province for the time being. (This was at the time George Pownall).
15. George Alsopp.
16. ——— De La Naudière.
17. La Corne St. Luc.
18. Alexander Johnstone.
19. Conrad Gugy.
20. ——— Bellestres.
21. ——— Rigauville.
22. John Fraser.

So the names appear in the Instructions: of these, Nos. 1, 2, 3, 4, 5, 6, 7 (Francis Levesque), 8, 9, 10 (Adam Mabane) had been Members of the previous Council—the others were new appointments—their names were—

11. Joseph Gaspard Chaussegour DeLery.
12. Roch de St. Ours.
13. Pecaudy de Contrecoeur.
14. George Pownall.
15. George Allsopp.
16. Charles François De La Naudiére.
17. LaCorne St. Luc.
18. Alexander Johnston.

19. Conrad Gugy.
20. Picothé de Bellestre.
21. Jean Baptiste Bergères de Rigauville.
22. John Fraser.

All appeared, were sworn in and took their seats at the first meeting of the Legislative Council held at the Castle of St. Louis, Quebec, 1777, July 9, Peter Livius the new Chief Justice was sworn in in the place of William Hey, the retiring Chief Justice (he had succeeded as Chief Justice in May of the same year), 1777, July 9, Henry Caldwell and John Drummond were sworn in, also.

1777 August 28, William Grant (afterwards Sir William Grant, Master of the Rolls in England) was sworn in.

1778 March 3, Paul Roch (de) St. Ours succeeded his father (No. 12 above).

Sir Frederick Haldimand succeeded Sir Guy Carleton in June, 1778; in his Royal Instructions, April 15, 1778, the Councillors named were Nos. 1, 2 (now Peter Livius) 3, 4, 5 (called "Cuthbert") 6, 7 (called L'evesque"), 8, 9, 10 (called "Mabeane"), 11 ("Chaussegros de Lery"), 14, 15, 17, 18, 19, 20 ("Picotte de Belestres"), 22 Henry Caldwell, John Drummond, William Grant, Rocque St. Ours Junior, Francis Baby and De Longueuil (this was Joseph de Longueuil). Shortt and Doughty, pp. 475, 590.

In Lord Dorchester's (Sir Guy Carleton's) Instructions, August 23, 1786, the Councillors named were Nos. 1 (now Henry Hope, Lieutenant-Governor), 2 (now William Smith, Chief Justice), 3, 4, 7, 8, 9, 10 (now called "Mabane"), 11 (as in the last list), 14, 20 (now named "Picotté de Bellestres"), 22, Henry Caldwell, William Grant, Rocque St. Ours Junr., Francis Baby, De Longueuil, Samuel Holland, George Davison, Sir John Johnson, Bart., "Charles de Lanaudiere" (16) ? de Boucherville, and "Compte de Pre;" "de Boucherville" was René Aimable (de) Boucherville and "Compte du Pré", Le Conte Dupré.

(4) Shortt and Doughty, pp. 403, 420.

(5) Shortt and Doughty, pp. 464, sqq.

(6) The Instructions are in Shortt and Doughty, p. 478. Haldimand took the advice of some of his Councillors as to the advisability of passing such an ordinance. Hugh Finlay, the Postmaster General appointed by the Home Administration, approved: George Allsopp, who had been Registrar and Clerk of the Council, also approved, but suggested an amendment. George Pownall, his successor in office, advised that the consideration of the matter should be "put off till the next year or some time of more tranquility and regularity." William Grant (afterwards Sir William Grant, Master of the Rolls), approved and said, "The Court appointed may not be ideally good but it is better than the one now existing and more in accordance with the British Constitution." He adds the interesting if not convincing argument "A Court with judges who know the law is better than one with judges who have only common sense."

The Council finally decided that "the passing of an ordinance in conformity thereto (i.e. to the Royal Instructions) would neither tend to the good of the people of this Province nor to a speedier or more impartial Administration of Justice." It is apparent that the chief objection was not to the proposed constitution of the Court of Appeal so much as to the proposition that the Chief Justice of the Province (always an English Barrister) should sit and preside in the Courts of Common Pleas which administered the French Canadian law and whose judges had had much experience in that law. The proposal was that the Chief Justice of the Province should not only sit in the Courts of Common Pleas but also in appeals from the Courts in which he presided.

Shortt and Doughty, pp. 478, 479, 480, 481, 487, 488,

(7) Shortt and Doughty, p. 420.

(8) Peter Livius was apparently not English. He is said to have been the son of a German and born at Lisbon. He came to America and was for some time a Judge of the Court of Common Pleas in the Colony of New Hampshire; taking the Loyalist side, he lost his position and went to England. Much to Carleton's disgust he was sent out in 1777 as Chief Justice of Quebec to replace William Hey who had been permitted to resign. Carleton said "He understands neither their laws, manners, customs, nor their language." They never agreed; Livius in his position as Councillor was a source of constant annoyance to Carleton who superseded him (1778) in almost the last official act of his first term as Governor. Livius appealed to the home authorities with success but never returned to Canada. He enjoyed his salary, however, until the last: he was succeeded in 1786 by a much abler man, William Smith.

(9) See Shortt and Doughty, p. 476, note 2.

(10) He succeeded Carleton June 27, 1778.

(11) Shortt and Doughty, p. 476.

(12) This was October 23, 1786; he became Lord Dorchester, August 21, 1786.

(13) Shortt and Doughty, p. 552.

(14) Shortt and Doughty, p. 586.

"At a session of the Legislative Council, January 22, 1787, some sixteen citizens presented a petition requesting permission to attend the debates of the Council when Col. (Henry) Caldwell moved that any Member of the Council shall have leave to introduce any Gentleman to hear the Debates at any time except when the House is ordered to be cleared. This motion, however, was defeated by 10 to 8 all the French Members voting against it."

(15) George Pownall.

(16) Shortt and Doughty, p. 404. Chief Justice Smith's Report to Nepean is pp. 569, 570, he says: "We had but one opinion with the exception of Messrs. St. Ours and Delery two Canadian Gentlemen to whom all I said by their Inexperience in the English Language must have been entirely unintelligible."

(17) As early as October 20th, 1789, we find Grenville writing to Dorchester with the draft of a proposed Bill and pointing out that "the general object of this plan is to assimilate the Constitution of the Province to that of Great Britain as nearly as the difference arising from the manners of the People and from the present Situation of the Province will admit." He asked for such observations upon the proposed Bill as Dorchester's experience and local knowledge might suggest; and meeting Dorchester's observations previously expressed to the formation of two Provinces pointed out that whatever weight the objection might have under the existing regime, it disappeared when "the resolution was taken of establishing a Provincial Legislature . . . to be chosen in part by the People," for then "every consideration of policy seemed to render it desirable that the great preponderance possessed in the Upper Districts by the King's antient subjects and in the Lower by the French Canadians should have their effect and operation in separate Legislatures."

I subjoin here an extract from my paper already mentioned supra p. 121.

"But many English-speaking immigrants came in from the United States after the Peace of 1783, and it was decided to divide the Province into two; this was done by Royal Prerogative, but the government and constitution of the two Provinces, Upper Canada and Lower Canada were prescribed by Act of Parliament, the Canada Act or Constitutional Act.

By this time there was a great change in the official view as to the proper form of government for Canada.

In moving for leave to introduce this Bill in the House of Commons, Pitt, with almost his first word, said that it was proposed to give the Colonists "all the advantages of the British constitution." In the extraordinary debate on the Bill lasting five days, Fox said that the Bill held out to Canadians something like the shadow of the British constitution, but denied them the substance. Burke could not keep away from his *bête noire*, the French Revolution, and had to be called to order more than once, but he urged that not the bare imitation of the British constitution should be given but the thing itself. He said that "it was usual in every Colony to form the government as nearly upon the model of the Mother Country as was consistent with the difference of local circumstance." With Fox he urged that the "constitution, deservedly the glory and happiness of those who lived under it, and the model and envy of the world should be extended . . . . as far as the local conditions of the Colony . . . should admit."

Seventeen years before, the Attorney-General Thurlow had thought it absurd to give Canada a Constitution at all like that of Britain—now every one believed that the Colony should have a Constitution as like that of the Mother Country as possible. Fox thought the new Constitution not democratic enough, but all thought it like that of Britain—as, indeed, it was on paper.

In the House of Lords Lord Grenville said "Our Constitution . . . the envy of every surrounding nation—they are now about to communicate the blessings of the English Constitution to the subjects of Canada because they (i.e., the Lords) were fully convinced that it was the best in the world"—and there was no dissent.

CHAPTER IV

Power of the Pre-Assembly Councils

As we have now reached the time when a constitution similar to that of Great Britain was intended to be granted to the Colony it may be of interest to examine what the legislative power was before this time.

In Governor Murray's Instructions December 3, 1763 (1) it was directed that "no Law or Ordinance respecting private Property be passed without a Clause suspending its execution until "the Royal pleasure should be known nor 'without a Saving of the Right of Us, Our Heirs and Successors and of all Bodies politic and corporate and of all other Persons except such as are mentioned in the said Law or Ordinance and those claiming by from and under them; and before such Law or Ordinance is Passed, Proof must be made before You in Council and entered in the Council Books that public Notification was made of the Party's Intention to apply for such Act in the several Parish Churches Where the Lands in Question lie for three Sundays at least, &c., &c."

This followed substantially the practice in the Mother Country in Private Bills legislation and the provisions were much the same as in the Royal Instructions to Governors in the English American

Colonies to the South. No instance of such an Act or Ordinance is recorded in Quebec but the Home Authorities disallowed many from the Thirteen Colonies, being inexorable in requiring the formalities, &c., to be strictly observed (2).

The Quebec Act by Sec. 12 gave the Council Power to make Ordinances for the peace, welfare and good government of the Province with the consent of the Governor; it contained no such provision concerning private bills as we have been considering, but the Royal Instructions to Carleton and Haldimand the subsequent Governors (3) have practically the same language in this regard as the Instructions to Murray.

In 1763, Murray's Instructions further provided that in all laws for raising money or imposing fines &c., express mention should be made that the same is granted to the King for the public uses of the Province and that the money so raised is to be accounted for to the Imperial Treasury and audited by the Auditor General of the Plantations or his Deputy.

It was of course part of the general policy of Britain not to make a direct profit out of her Colonies, being satisfied with the profits of commerce; as a consequence any money raised by the Colonies was to be applied to their use. Nevertheless Britain never until forced by arms in the American Revolution gave up her supreme power over the Colonies and their inhabitants and resources. This provision was a plain intimation that Responsible Government was not to have sway in Canada, the money raised in and by the new Colony was to be accounted for not to the Council of the Colony but to officers of the Imperial Government (4).

The Quebec Act is silent also on this matter but the Instructions to the Governors Carleton (1775 and 1786) and Haldimand (1778) contain the like clause (5). Murray's instructions further provided that no law which (a) might tend to affect the Commerce or Shipping of the Kingdom or (b) should in any way relate to the Royal Rights and Prerogatives or (c) the property or subjects or (d) should be of an unusual or extraordinary character should be approved without the signification of the Royal pleasure (6).

(a) It was the settled policy of the Board of Trade to look upon the Colonies primarily as markets for British manufactures and as suppliers of raw materials; sometimes indeed shipbuilding was encouraged in America but as a rule the American shipowner was not encouraged. Many disputes took place between American Colonies and the Board of Trade, the former looking to local profit the latter to advantage to British Commerce and shipping.

This was changed after the Quebec Act; in Carleton's Instructions it reads thus: "No Ordinance be passed relative to the Trade, Commerce or Fisheries of the said Province by which the Inhabitants thereof shall be put on a more advantageous footing than any other of His Subjects either of this Kingdom or the Plantations." Much trouble had been experienced from the American Colonies levying retaliatory duties on each other's products, making laws which laid a burden on English merchants and the like (8). This was to prevent such practices in Canada.

(b) The Royal Prerogative was an elastic term and convenient as elastic; scarcely anything could be done by the Colonies in the way of self-government but the High Tory might consider it an encroachment on the Royal Prerogative while scarcely anything could be such an assertion of independence that it might not by a complaisant monarch or his advisers be considered compatible with his Royal Rights (9). The clause does not call for particular attention.

(c) Interference with the rights of private persons is always a serious matter; no one can doubt the Power of the Imperial Parliament in the premises but this was forbidden the Colonial Legislatures (10).

(d) Laws of an unusual or extraordinary character were not uncommon in the American Colonies (11).

These provisions (b), (c) and (d) disappear after the Quebec Act but there is no reason to suppose that had any legislation of the kind been passed it would have received the Royal assent.

Murray's Instructions (1763) also recited difficulties arising from the enactment by the American Colonies of Laws for so short a time that they expired before the Royal Assent or Refusal could be obtained and he was directed to refuse assent to any law enacted for a less time than two years, except in case of imminent necessity or immediate temporary expediency; moreover he was not without express leave to permit a law to be reënacted which had failed of the Royal Assent, nor to permit a law to be repealed (which had once been approved) without a clause suspending its operation until the Royal pleasure should be known (11).

The temporary Act was a well known means of evading the directions of the Board of Trade (12) and equally well known were the re-enactment of laws already disallowed and the repeal of those which had been approved and confirmed (13). The same clause is found in the Royal Instructions after the Quebec Act (14).

We may pass over the purely directory clauses in Murray's Instructions, mentioning only that all Ordinances were to be transmitted in three months or sooner to the Board of Trade (15).

After the Quebec Act the time is extended to six months following section 16 of that Act and the Ordinances were to be sent not only to the Board of Trade but also to one of the Principal Secretaries of State (16).

The Council were still further restricted after The Quebec Act; Carleton's Instructions (1775) afterwards repeated to Haldimand (1778) and himself (1786, then become Lord Dorchester) prevented the Council from levying any taxes or duties, except such rates and taxes as the inhabitants of a Town or District might be authorized to assess for making roads, erecting public buildings or the like for the local convenience (17).

No such legislation had in fact been passed by the Council unless indeed the fees charged for licences to sell liquor could be so considered (68).

Carleton's Instructions (1775), also directed that "No Ordinance touching Religion or by which any Punishment may be inflicted greater than Fine or Imprisonment for three Months be made to take effect until the same shall have received our Approbation" (18) and that "no Ordinance be passed at any Meeting of the Council where less than a Majority or at any time except between the first day of January and the first day of May . . . unless upon some urgent Occasion; in which case every Member . . . resident at Quebec or within fifty miles thereof shall be personally summoned to attend . . ." The latter simply upheld the provisions of Section 16 of the Quebec Act, and the former, Section 15.

The Council were in Carleton's Instructions (1775), not to lose sight of the importance of personal liberty and were told that they could not follow a better example than the Writ of Habeas Corpus (19). Many of the petitions by the English-speaking inhabitants had bitterly complained of the absence of such a remedy and it was thought well to introduce it. But the troubles arising from the American Revolution prevented immediate effect being given to the recommendation. Haldimand imprisoned more than one person arbitrarily—(whether this was necessary or not we need not here enquire). The Instructions had been repeated when Haldimand succeeded Carleton in 1778 but it was not till April 29, 1784, that an Ordinance was passed bringing the Writ into force in Canada (20).

The Instructions to Dorchester in 1786 contained a clause directing him to "take effectual Care that the said Ordinance be duly enforced so that every Security to Personal Liberty . . may be fully enjoyed . . . in the Province" (21).

The Royal Assent was provided for from the beginning. In Murray's Instructions, there was a provision that until the calling of a General Assembly the Governor by the advice of the Council might make Rules and Regulations (22) for the Peace Order and Good Government of the Province which were to be forthwith transmitted for the Royal Approbation or Disallowance (these Rules and Regulations were in no case to affect the life, limb or liberty of the subject or to impose any tax or duty) (23).

After an Assembly should be called all Laws, Statutes and Ordinances were to be transmitted within three months to the Board of Trade (24). These provisions also appeared in the Instructions to Carleton (1768) (25).

The Quebec Act Sec. 14 provided that every ordinance should be transmitted within six months for the Royal Approbation and if it should be disallowed it should cease to be in effect from the promulgation in Quebec of the Order in Council disallowing it (26); this was included in the Royal Instructions to Carleton and Haldimand (27).

The number of Councillors was fixed in 1763 at eight in addition to the four who were Councillors *ex officio* (and also to any appointed immediately by Royal Warrant). The quorum was 5 (28).

In 1768 when Carleton succeeded Murray eleven persons are named in the Royal Instructions altogether including the Chief Justice; and provision was made for new appointments by Carleton so that there should always be at least seven within the Province (29). There is no provision for a quorum; the common law rule would therefore apply and the quorum would be a bare majority of the members.

After the Quebec Act, in Carleton's Instructions 1775 there are twenty two Councillors named; the Act Sec. 12 makes the major part of the Council a quorum for legislation but the Instructions prescribe five for all business except legislation and for legislation a majority of the whole (30).

When Haldimand succeeded Carleton in 1778 there are twenty three Councillors named and the provision is made for a quorum (31).

In 1786 Dorchester has twenty three Councillors named; the quorum as in 1778 (32).

Murray 1763 was given power to fix the time and place of meeting; Carleton in 1768 was confined to the Town of Quebec (which was appointed his place of residence). After the Quebec Act in 1775 Carleton received instructions authorizing him to call the Council together at such times and places as he should think proper except for purposes of legislation in which case the Town of Quebec was prescribed. Haldimand in 1778 and Dorchester in 1786 received the same Instructions (33).

In all cases after the Quebec Act the Instructions also provided that no Ordinance should be passed (except upon some urgent occasion) except between January 1 and May 1; in Dorchester's Instruction in 1786 there was a further provision that in the case of an urgent occasion every member resident at Quebec or within fifty miles thereof must be personally summoned (34).

NOTES TO CHAPTER IV.

(1) Shortt and Doughty, p. 132, sqq.

(2) Dr. Dickerson (in the work cited p. 113 ante note 5 to Chapter I), at pp. 256 sqq., gives many instances. Apparently the first instruction of the kind was in 1715 in Massachusetts which required a clause saving the rights of the Crown and of all persons not named in the Act: in 1723 a further instruction required the Act to be suspended until the Royal pleasure should be known. The learned author says p. 258, "The Board (of Trade) was quite inexorable when such a law failed to indicate that due notice had been given of the application for such a bill." See Instructions to Carleton 1768, Shortt and Doughty, pp. 210 sqq.

(3) Shortt and Doughty, pp. 419, 474, 552 sqq.

(4) See Instructions to Carleton 1768, Shortt and Doughty, p. 213.

(5) Shortt and Doughty, pp. 419, 474, 552, sqq.

(6) Shortt and Doughty, p. 136. The same provision is found in the Instructions to Carleton, 1768, Shortt and Doughty, p. 213.

(7) Shortt and Doughty, p. 422. This is repeated in the Instructions to Haldimand, 1778, and to Dorchester, 1786. Shortt and Doughty, pp. 475, 554.

(8) Dr. Dickerson, p. 248 sqq., gives a number of instances e.g. North Carolina levied a duty on Indian traders from Virginia by an Act which was repealed in 1709; Massachusetts in 1721 laid retaliatory duties on the products of New Hampshire; Virginia laid a high import duty on the tobacco of North Carolina; South Carolina taxed naval stores imported from the north. British merchants complained bitterly of Virginia and New York laying a heavy import duty on slaves, etc.

(9) Examples are laws tending to hamper the Home Government e.g. Acts by certain states to fix the period of their Assemblies thereby taking away from the Governor his power of proroguing and dissolving them. See Dickerson, pp. 228, 229.

(10) E.g., An Act of Pennsylvania in 1718 placing the property of a deceased in the hands of trustees for sale without safeguarding the rights of the minor heirs to whom it belonged, was vetoed, Dickerson "American Colonial Government," p. 259. New Jersey suspended civil actions from February to September, 1748. Virginia in 1729 limited liability on obligations for judgments, bonds, etc. New York in 1731 passed an Act preventing levying on specialties more than the principal, interest and costs of suit, &c., &c. Dickerson "American Colonial Government, p. 253.

(11) Examples given by Dr. Dickerson are a Virginia Act of 1732 which allowed a married woman to dispose of her land by deed or will during her husband's lifetime, p. 260; A similar Act of Massachusetts in 1762, ditto p. 261. An Act of Pennsylvania in 1755 exempting two persons named therein from prosecution for debt for a term of years ditto, p. 261; an Act of South Carolina, 1723 (of 1733), altering a will by taking the property from one son and giving it to another, ditto p. 261, &c., &c. These it may be remarked are also abnoxious to provision (*a*).

(11) Shortt and Doughty, p. 136.

(12) See Dickerson, p. 273.

(13) See Dickerson, p. 262. Examples given by Dr. Dickerson are Virginia Acts of 1705 for the better regulation of William and Mary College; the Acts of

Virginia (1705 and 1725) declaring Slaves to be real estate which were not allowed to be repealed so as to make Slaves personal estate—the Author adds "Scores of similar cases could be cited," p. 262.

The same provision appears in Carleton's Instructions (1768). Shortt and Doughty, p. 214.

(14) Shortt and Doughty, pp. 422, 475, 554, 555.

(15) Shortt and Doughty, p. 136. This is repealed in Carleton's Instructions (1768), p. 213.

(16) Shortt and Doughty, pp. 422, 475, 555.

(17) Shortt and Doughty, pp. 421, 475, 554.

(18) July 7, 1766, and Ordinance was passed by the Council that no one should "sell by retail Rum, Brandy, Wine, Syder or other spirituous and strong Liquors, mixt or unmixed . . . . or keep any common Tippling House or Victualling House without License": the license cost 36 shillings ($7.20)—2s (40 cents) to the Clerk of the Peace, 8s ($1.60) to the Deputy-Secretary, and the remaining 26s ($5.20) "to be appropriated to publick Uses as the Governor and Council shall think proper." "Ordinances Made and Passed, &c." pp. 82, 83.

(18) Shortt and Doughty, p. 422. This is repeated in the subsequent Instructions, Shortt and Doughty, pp. 475, 554.

(19) Shortt and Doughty, p. 423.

(20) 24 Geo. III C. C, "Ordinances, &c.," pp. 139 sqq. Perhaps the Pierre Du Calvet case is the most celebrated of Haldimand's alleged misdeeds in that behalf. Du Calvet on being released brought an action in the English Court of King's Bench against Haldimand; it never came to trial as the unfortunate plaintiff was drowned on his return from this Continent to which he had come to collect evidence: Actio personalis moritur cum persona. I have examined the facts of the case in a paper read before the Royal Society of Canada (not printed).

(21) Shortt and Doughty, p. 555.

(22) There is no substantial difference between Laws and Ordinances, Rules and Regulations.

(23) Shortt and Doughty, p. 135.
(24) " " p. 136.
(25) " " pp. 210 sqq.
(26) " " p. 405.
(27) " " pp. 422, 475, 555.
(28) " " pp. 132.
(29) " " p. 219.
(30) " " p. 420.
(31 " " p. 475.
(32) " " p. 552.
(33) " " pp. 420, 475, 554.
(34) " " p. 554.

Old Church Silver in Canada.

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Presented by Duncan C. Scott, F.R.S.C.

(Read May Meeting, 1918)

Much space would be needed for a minute description of the old silver vessels preserved in Canadian churches and ecclesiastical institutions.

These vessels may be divided into three classes, namely:

(1) Vessels of European origin, imported into Canada or presented to churches by devoted members and other persons.

(2) Vessels of American manufacture.

(3) Vessels wrought in Canada.

To the first of these classes belong such historical Sacramental services as those in the two Nova Scotia churches of St. Paul's, Halifax, and Christ Church, Windsor; in Trinity Church, St. John, New Brunswick and in the Episcopal Cathedral in the City of Quebec.

The royal service in the historic church of St. Paul's, Halifax, consists of four vessels, which were made by Francis Garthorne of London, a well-known royal silversmith to the courts of William and Mary and Queen Anne. The chalice and one of the flagons are engraved with the royal arms of George III and are stamped with the maker's mark only. The other flagon and the alms dish have the royal arms of Queen Anne as borne from 1707 till 1714 and reveal the partially erased cipher of that sovereign superimposed by that of George III. These two vessels bear the London date-letter for the year 1711-12 as well as the maker's mark. This service is said to have been transferred from Annapolis Royal to St. Paul's.

The substitution of one sovereign's arms and cipher, as has been done on this service, for those of another was not unusual in the 17th and 18th centuries. Much of the plate at Windsor Castle was altered in this manner at the accession of successive sovereigns.[1]

Francis Garthorne, the above maker, made several services of Sacramental vessels for American Colonial Churches, which, happily, have escaped the vicissitudes of time, and are reverently preserved to this day. Passing mention may be made of the royal services presented to Trinity Church, New York, by William and Mary and

[1] *The Gold and Silver of Windsor Castle*, by E. Alfred Jones.

Queen Anne, and wrought by that silversmith,[1] who was also the maker of the historic service in St. Peter's Church, Albany, New York, the gift of Queen Anne to "Her Indian Chappel of the Onondawgus."[2]

An illustration of the silver of St. Paul's, Halifax, has appeared in the year book of that parish. A later silver chalice and two patens in this church were made in 1819-20 in London, while a silver spoon appears to have been made in New York early in the 19th century, though it is stamped with imitations of English marks.

An English pewter baptismal bowl, of late 18th or early 19th century date, in this Halifax church, is by the same maker as a pewter mug in the Hospital at Quebec.

The second Sacramental service in Nova Scotia has a pair of similar cylindrically-shaped flagons of large dimensions and of massive silver, which were made in the year 1729-30 by the London silversmiths, Joseph Allen & Co., the makers of the royal services in the three Episcopal churches of Christ Church, and Trinity Church, Boston, Massachusetts, and St. Philip's, Charleston, South Carolina, all of which were the gifts of George II.[3] The cipher and royal arms of George III are engraved upon these flagons, with this inscription:

CHRIST CHURCH
WINDSOR
NOVA SCOTIA

From a close examination of the surface of these vessels there are indications of the erasure of an earlier inscription, shield of arms or other device. Of the same date and by the same craftsmen is the silver alms dish, which also bears the same royal arms, the cipher of George III, and the same inscription. This dish, it may be observed, is identical with one in Trinity Church, St. John, New Brunswick. The plain bell-shaped chalice of Christ Church, Windsor, was wrought in 1763-64 by an unknown London maker and is engraved with the same royal cipher and arms, as well as the inscription, as the other vessels in this church. There are also two paten-covers of different sizes, one of which was made in 1729-30 by Joseph Allen & Co., while the other is undated, both being similarly engraved.

Although four of these vessels bear the London date-letter for 1729-30 and one for 1763-64, the service was not in possession of this Nova Scotia church until the year 1790, as is confirmed by the follow-

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[1] *The Old Silver of American Churches*, by E. Alfred Jones, 1913. Plates CII and CIII.

[2] *Ibid.* Plate III.

[3] *Ibid.* pp. 75, 85, 113.

ing extract from the Journal of Charles Inglis, first Bishop of Nova Scotia, under the date of April 16th, 1790;

"The Rashleigh, Captn. Wyatt, arrived
from London, and brought two Setts of
Church Plate from his Grace of
Canterbury—

One of those Sets was for Christ Church in Windsor, in
Nova Scotia, and consisted of—

2 Flaggons
1 Chalice
2 Patens
1 Large Dish or Paten."

Before passing from the Church silver of Nova Scotia to that of New Brunswick, a brief description may be included of the Sacramental vessels of the Parish Church (Christ Church), of the united parishes of St. George and St. Patrick at Shelburne, to which the legend lingers that a chalice and paten were the gift of Sir William Pepperell, the first American-born baronet and commander of the Massachusetts forces at the celebrated seige of Louisburg in 1745. But alas! faith in this time-honoured legend is banished by the inexorable decree of the infallible hall mark, which in this instance reveals the fact that these two vessels were wrought in London in the year 1820-21, sixty-one years after the death of the alleged donor.[1] The present writer has failed to trace the origin of this venerable tradition. It is not supported by the presence of an inscription, recording the name of the donor. It may be that the donor was the second Sir William Pepperell. Another suggestion which may be worthy of credence is that the chalice and paten may have been re-made in 1820-21 from the original gifts of the first baronet—a fate which has befallen countless ecclesiastical vessels in the precious metals in the history of Christianity in all countries from the earliest times until our own day. On the North American Continent, as well as in Europe, the transformation of historic silver sacramental vessels, the gifts of pious donors to their churches, has been of frequent occurrence.

The building of the present St. George's Church, Halifax, "the round church," was begun in 1800 from plans suggested, from remembrance perhaps of the Temple Church in London, by the Duke of Kent, Queen Victoria's father, who was then in command of the British forces stationed at Halifax and from designs by William Hughes. This church replaces the old German church, and the silver

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[1] Sir William Pepperell bequeathed money for the purchase of a piece of silver for the First Congregational church at Kittery, Maine, which still survives. *Ibid.* p. 236.

sacramental vessels were removed to St. George's and were doubtless used at the first service performed within its walls on July 19th, 1801, when a sermon was preached by the newly-appointed minister, Rev. George Wright, a loyalist refugee and former minister of St. Mark's Church, Brooklyn, New York. These vessels consist of a chalice with its paten-cover, a flagon of quasi-classical form and an alms basin, which are engraved with the sacred monogram in a glory, and the royal arms, and are inscribed:

SAINT GEORGE, HALIFAX, NOVA SCOTIA, A.D. 1779.

Stamped on each vessel is the London hall-mark for 1778-79 with the makers' mark of William Grundy and Edward Fernell.

The presence of the royal arms would seem to suggest that the vessels were a royal gift to the German church; but this suggestion is put out of favour by the discovery of an item in the old German manuscript book under date of 1st. January 1780, of the payment of £57-2-1 for their purchase. Richard Jacob, a member of the church, was deputed to make the purchase, and the authorisation for the payment was signed by an Elder, Otto Wilhelm Schwartz.

The writer of these notes was prevented by many circumstances from visiting the other old Anglican churches of Nova Scotia in his investigation of the history of old church silver. Subsequent enquiries by letter have failed to establish the presence of old vessels in some of these churches.

Before taking farewell of the historic city of Halifax, the privilege was granted of examining the Communion vessels of the old Presbyterian Church there, now known as St. Matthew's. These comprise both silver and pewter. In the more precious of these metals, the earliest vessel is a plain and massive Baptismal bowl, inscribed:

The Gift of FRANCIS WHITE Esqr. *to the first Protestant Dissenting Church in* HALIFAX Octo^r^. 25th, 1769.

The maker of this doubly interesting relic of the first Protestant Dissenting Church at Halifax was Benjamin Hurd of Boston or Roxbury, Massachusetts. (1739-1781).

The next vessel in point of date is a plain oval-shaped communion cup on a stem and base with beaded edges which is inscribed:

The Legacy of Mr. Joseph Pierpoint To the Protestant Desenting Congregation in Halifax Nova Scotia 1772.

A shield of arms, a lion rampant surrounded by ten rosettees, is engraved on the cup, which was bought with this legacy four years later. Stamped upon it is the London date-letter for 1776-1777 and the mark of the maker, William Grundy, who was the maker of a chalice and paten in St. John's Church, Richmond, Virginia. A similar cup in this church, dating from the last quarter of the 18th century, is inscribed:

Presbyterian Congregation Halifax Nova Scotia 1792.

The maker was Thomas Streetin of London.

The silver vessel in use for the Communion bread is in the form of a plain circular dish, which is inscribed:

THE PRESBYTERIAN CONGREGATION, HALIFAX, NOVA SCOTIA, 1817.

From the marks stamped upon this dish the place of manufacture is ascertained as Edinburgh in Scotland, the makers as W. & P. Cunningham and the exact date as 1790-91.

The inventory of the silver in this Presbyterian church concludes with a plain tea spoon of London origin of the year 1808-09 by the makers Richard Crossley & George Smith. It has been used for extracting sediment from the wine. Domestic spoons of different sizes, sometimes with their bowls pierced as strainers have often been presented to or bought by churches for this purpose. A perforated spoon, intended for the same use, of the same date and by the same makers is in the church of All Hallows, Bromley-by-Bow, England. Two old silver spoons in Fredericton Cathedral have had their bowls similarly pierced, as will be observed later.

A pair of large, circular pewter dishes, in use as alms dishes, bear the date 1788 on the backs and the stamp of the eighteenth century maker, one William Hunter, who was in all probability a Scotch pewterer.

The last of the relics of this Presbyterian church are two circular Communion tokens of pewter, inscribed:

P C
H
1784

The initials, it need scarcely be added, represent "Presbyterian Church, Halifax." Tokens such as these were in common use in Scottish churches in the eighteenth century.

An eighteenth-century pewter flagon of the Scotch laver shape has been transferred from St. Matthew's Presbyterian church to the Grove Presbyterian Church in Halifax, an offshoot of that church. This flagon was wrought by the same pewterers as the above pair of dishes and is inscribed:

PRESBYTERIAN CONGREGATION HALIFAX NOVA SCOTIA 1788

With these notes the writer ends his itinerary of the churches of Halifax.

Little opportunity was afforded for the examination of the silver of New Brunswick churches, except an exhaustive investigation of the vessels of Trinity Church, St. John, all of which bear the royal arms and cipher of George III and are inscribed:

Trinity Church, St. John's New Brunswick.

This service was brought there in 1790 by the good ship RASHLEIGH with the sacramental vessels for Christ Church, Windsor, Nova Scotia, and is mentioned at the same time in the journal of Bishop Inglis. Varying in date, the earliest are the plain paten and alms dish, both having been wrought in 1694-95 by the well-known royal silversmith, Francis Garthorne, previously mentioned. The writer throws out the suggestion that this silver was part of the Sacramental plate which Rev. Henry Caner, the resolute and distinguished loyalist minister of King's Chapel, Boston, carried away with him to England in the early days of the Revolutionary war. Next in date is a large plain chalice of the year 1729 or 1731 by the same makers Joseph Allen & Co. as several of the vessels at Christ Church, Windsor, previously described. A second English paten with a gadroned edge, and chased in the centre and on the border with a decoration of acanthus leaves, is unmarked, but was made at the end of the seventeenth century. The last vessels are a pair of plain flagons, of the same form as those at St. Paul's, Halifax, and Christ Church, Windsor, already described, and were made in London in 1763-64 by Thomas Heming, a prominent silversmith to the Court of George III.

In the most modern of churches old silver may occasionally be found. The writer in his quest neglected not the new Anglican Cathedral at Fredericton, the capital of New Brunswick. Here are to be seen two old English silver Apostle spoons of the sixteenth or seventeenth century, the gift in 1845 of Bishop Medley. One is inscribed: W.T. 1661 G.C. The unknown maker's mark on this spoon is that of a cinquefoil or rose, perhaps for Carlisle or Leicester, while the marks on the other were undecipherable in the dim light of the evening. Unfortunately, the bowls of both spoons were pierced as straining spoons for the sacramental wine at the time of their gift to the Cathedral.

Reference should have been made earlier to two pieces of old Scotch silver at King's College, Windsor, Nova Scotia. Both were made at Aberdeen, one in the seventeenth and the other in the eighteenth century. The first is a plain beaker such as are peculiar to Scotch churches from the late sixteenth century, when this type of domestic drinking cup was introduced from Holland by traders between that country and Scotland. In Holland it was in use both for sacred and secular purposes at that time.

The King's College beaker is inscribed:

FOR THE CHURCH OF KEARN 1663.

Inscribed on the dish:

Communion Plate 1776.

When and how these two church vessels crossed the Atlantic from Scotland is not recorded.

The writer's next visit was to the Anglican Cathedral in the City of Quebec, where several vessels the gift of George III are preserved. Among these is a pair of patens, wrought in London in 1803-04, which bear this inscription:

Hanc Pateram Nec non cœteram Supellectilem argenteam Divino cultu accomodatum In usum Ecclesiæ Consociatæ Angliæ & Hibernæ In Diocesi Quebencensi fundatæ Sacrari Voluit GEORGII TERTII *Britanniarum Regis Pia Munificentia Anno ab Incarnatione MDCCCIV.*

One of the most ornate credence patens extant is in this cathedral. Wrought by the same silversmiths and in the same year as the above patens, it is embellished in the centre with the sacred monogram in relief, supported by kneeling angels, and with the royal arms of George III and the episcopal arms of Quebec. The two massive altar candlesticks were made in the previous year and were likewise the gift of the same monarch. Equally ornate is the alms dish, which is enriched in its centre with a representation of the Last Supper, and on the rim with the symbols of the four Evangelists and the Holy Spirit, as well as being decorated with the arms of the same royal donor and with those of the see of Quebec. It stands on four feet in the form of cherubs. This dish was made in London in 1803-04 and is one of the most elaborate examples of ecclesiastical silver of this period. A pair of massive vase-shaped flagons and a pair of chalices of the year 1803-04 and from the same workshop as the candlesticks and patens complete the princely gift of George III to the Anglican Cathedral of Quebec. This gift, however, does not exhaust the list of silver sacramental vessels. There are three other vessels, beginning with a plain chalice of the same form and period (though not marked) as that of Christ Church, Windsor, Nova Scotia, and which bears the same royal arms and cipher of George III, while the second vessel is an alms dish, the counterpart of the dish in the same Windsor Church and wrought by the same royal silversmith, Thomas Heming. The chalice just mentioned was in use at celebrations of the Sacrament in the Recollet church, Quebec, when the British troops in the Garrison attended service there. A copy of this chalice was made by a Quebec silversmith about the year 1835 for this Cathedral.

A passing allusion has already been made to the danger of neglecting new churches in searching for old silver sacramental vessels. Trinity church in the City of Quebec is a case in point. In this church, built by Jonathan Sewell, whose career is familiar to all Canadians, as a chapel of ease to the Cathedral, are three old English silver vessels, namely: A large paten, 1710-11, by Matthew Lofthouse; a small paten, 1724-25, and a large plain chalice of the year 1785-86. These vessels are believed to have been the gift to this church by the heirs of its first rector, Rev. E. W. Sewell, who was the son of its founder and benefactor.

A set of silver vessels similar to that in St. Peter's Church, Albany, was presented by Queen Anne to "Her Indian Chappel of the Mohawks." This Indian tribe, as is well-known, was strongly loyalist in the American Revolutionary war, and when it emigrated to Canada, the above service was reverently carried away, and is religiously preserved to this day.

The writer will now endeavor to add a short account of the history of some of the sacred silver vessels in the Roman Catholic churches in the Province of Quebec,

Some seventeen years before the actual founding of Canada by the French, the Jesuits had sent missionaries among the Indians of Canada and no doubt brought vessels in the precious metals for the celebration of the Mass. With the founding of French Canada, churches were erected and all the necessary silver vessels and ornaments for the altar were brought from France. Frontenac, when he became Governor of Canada in 1672, is believed to have enriched churches with silver vessels and other ornaments of great value, as did the members of his staff and of his suite.

Champlain and other pioneers in the history of French Canada, Christian missionaries and others, were also benefactors of silver vessels.

In the early days of French Canada and on the establishment of missions, the princes and prelates of France, courtiers and merchants were generous in their gifts of money and of ornaments and silver vessels for the celebration of the Mass. These early vessels in the history of Roman Catholicism in Canada were wrought by French silversmiths not only in Paris but also in the Provincial Guilds of France, and have alas! perished in war and other destructive agencies, more particularly fire. For example in the great fire in Dec. 1650, which destroyed the Ursuline convent in Quebec (founded in 1639), several artistic and historical treasures in the precious metals perished, as well as vestments, embroideries, paintings and other objects, pious offerings from Old to New France.

At this early period, the custom of New Year's gifts had been inaugurated, and from one authority the fact is gleaned that on New Year's day in 1646, a crucifix, two enamelled images of St. Ignatius and St. Francis Xavier and other offerings were made to the Ursuline Convent.[1]

Francois de Montmorency Laval, first Bishop of Quebec, is believed to have brought many precious objects with him in 1659.

Relics enclosed in costly shrines, wrought by the skilled hands of the goldsmiths of France and other countries, have been bestowed upon some of the Canadian churches.

One of the most precious relics in the chapel of the Saints in the Ursuline Convent of Quebec City is a cross containing a fragment of the true Cross and of the Crown of Thorns, which was the gift of Dom Claude Martin in 1677.[2] For the centennial anniversary of the founding of this celebrated convent, a part of the silver plate belonging to the infirmary was sacrificed and melted, the metal being fashioned into a sanctuary lamp for the convent church.

The conquest of Canada by the British aroused at first much apprehension in the minds of the French ecclesiastics and superiors of religious houses, fearing as they did that the victory of the Protestant power would rob them of the right to worship in their own faith. This fear, natural as it was, was of short-lived duration, for in 1767 a letter from Mother Marchand of St. Etienne to the Ursulines, expresses anxiety, not as might be supposed, as to the condition of religion in Quebec, where they enjoyed tranquillity under the victors, but sorrow and grief at the persecution then being suffered by religious communities in Paris.[3]

Some losses of valuables are believed to have occurred by the invasion of Quebec by the Americans in 1775.

The most important collection of old silver examined by the writer in Quebec was that of the Archbishop, permission having been graciously granted and every facility accorded for its examination by the help and enthusiasm, combined with historical knowledge of the subject of Father Lionel St. G. Lindsay.

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[1] *Glimpses of the Monastery; Scenes from the History of the Ursulines of Quebec*, 2nd Ed., 1897, p. 203.

[2] *Ibid*, p. 236.

[3] *Ibid*. p. 296.

Beginning with the silver of French origin, there are two ewers of typical French style, both wrought in Paris by unidentified silversmiths of the 18th century. Earlier than these is a silver-gilt dish by a Paris silversmith of about the year 1700. The third 18th century piece is an ecuelle and cover, also of Paris workmanship, which is engraved with the initials of Joseph Signay, Archbishop of Quebec. Another charming French ecuelle bears the initials of Joseph Octave Plessis, Bishop of Quebec. The cover is of later date and was probably made in Quebec by a silversmith bearing the initials E.D. There are two other French ecuelles and one of the eighteenth-century French wine-tasters. A silver-gilt dish with beautiful ewers for wine and water, a navette, a censer and an important crosier, complete the list of French eighteenth century silver. One of the treasures examined was a beautiful Louis XIV gold snuff box of Bishop Jean Olivier Briand, Bishop of Quebec from 1766 to 1784.

The lack of a good book on French silversmiths' marks, renders impossible the identification of the makers' names and their exact dates.

Local silversmiths' handicraft is represented by two large oval dishes; a bowl for Holy Water; a pair of candlesticks; and a very large soup ladle, dated 1785, all by Francois Ranvoyzé of Quebec, of whom a brief biography is added later.

English silver of the 18th century is represented by a pair of square-shaped candlesticks in the "Adam" style of decoration, and by a small plain salver, made in London in 1761-62 and 1780-81, respectively, both of which belonged to Archbishop Signay. There is also a plain cream ewer.

A large oval tray, of late 18th or early 19th century date is puzzling from the conjunction of part of an English hall-mark, and the head of George III and the lion, with the maker's initials and name *S. Marion*. In the early nineteenth century contemporary English marks were reproduced by silversmiths of the City of New York and of Lisbon in Portugal. This tray may have been wrought in Quebec or Montreal by S. Marion, who wished to improve the occasion by adding two English marks. A long oval bread basket, which belonged to Archbishop Signay, appears to have similar marks.

Laurent Amyot, the second Quebec silversmith, is well represented, first by an important ewer, the most decorated example of his work observed by the writer; it belonged to Archbishop Signay. The second piece, a handsome ewer with fluted body, engraved on one side with a ship in a storm, is inscribed:

Tribut de respect et de reconnoissance offert par les propriétaires et assureurs du BRIG. ROSALIND DE LONDRES, *CAPT. BOYLE, au Revd. Messire Asselin Ptre. Curé de St. Louis DE L'ISLE AUX COUDRES* pour avoir *par son Exemple engagé ses paroissiens à aider à sauver le Vaisseau et sa Cargaison jetés par les glaces sur cette Isle le 27 Nov. 1832* et pour ses bontès envers les naufragés pendant LEUR SÉJOUR SUR L'ISLE.

A bishop's candlestick is his third production, having been made for Bishop Plessis.

The fourth and last Amyot piece is a little plain ewer, quasi-classical in form, with a beaded lip and a fluted border on the base.

When the Basilica of Quebec was re-built in the 18th century it was furnished with sacred silver vessels from the ateliers of Quebec goldsmiths. The objects of greatest interest to the writer were those by the local rivals, Ranvoyzé and Amyot. By the first are a large Holy Water bowl, fluted and chased with foliage; some censers of different decorations; an ostensorium converted into a reliquary; two acolyte candlesticks of different designs, one being dated 1799, and a pax. Amyot is represented by silver cruets on an oval dish.

The writer absolves himself from possible mistakes in ascribing dates to some of the French and other European silver, owing to the prohibition that certain sacred vessels of the church should not be handled by a layman, and therefore a careful examination was impossible.

In the General Hospital, founded in 1693, are several pieces of Ecclesiastical and domestic silver of much interest—French, English and Canadian.

The French silver begins with a pair of acolyte candlesticks, with their circular bases decorated with acanthus leaves, their baluster stems being similarly decorated; these date from the end of the 17th century. Of the same date is a pair of cruets for wine and water, embellished with symbols of the Passion. A late seventeenth-century French chalice is similar to one at Indian Lorette, and bears the same unknown maker's stamp, P.R., as a small bell-shaped beaker in the hospital. A somewhat undecorated ciborium is inscribed, *Ex voto* 1701.

The French silver of the eighteenth century includes a charming pair of domestic candlesticks, circular in plan, with baluster stems and fluted borders; and a small plain sanctuary bell. There are also four typically French beakers of this period.

A censer of late seventeenth century Spanish origin in the hospital was the gift of Bishop de Saint-Valier, its pious founder, who came from

Grenoble and who, as will be remembered, was a prisoner of war in the Tower of London from 1704 until set free by the Treaty of Utrecht in 1713.

Two bishop's candlesticks complete this inventory of purely ecclesiastical silver.

Included among the purely domestic objects are a number of silver spoons and forks of different patterns and dates, mostly of the eighteenth century, and of French and French-Canadian workmanship and a small spoon by the same unknown maker as the above Spanish censer.

The only piece of English silver observed by the writer was a small mug by a London silversmith of the year 1809-10.

In the history of silversmithing, none of the objects in this historic hospital surpass, or indeed equal in interest the examples of Canadian craftsmanship. Two were wrought in the city of Quebec by Laurent Amyot—a cocoanut cup mounted in plain silver and a plain beaker, while two other pieces were made at Montreal by a silversmith whose initials are R.C., whom it is hoped to identify in course of time. This Montreal silversmith's pieces are a charming little plain teapot, of sufficient holding capacity for a cup of tea, and a plain spoon, engraved with a crest, an arm holding a dagger.

Returning to an account of the treasures of the Ursuline Convent, they include three examples of French silver of the 18th century, namely, a spoon and fork which belonged to Louis D'Aillebout, the third French Governor of Quebec or his wife, Barbara, and which are engraved with a shield of arms; and an ecuelle and cover. To these may be added a piece of Canadian-wrought silver, namely, a chalice in the French style, by François Ranvoyzé.

The two pieces which aroused most interest were, however, the French spoon and fork which belonged to Esther Wheelwright, whose remarkable career, well-known as it is, is worthy of repetition here. At the age of seven she was borne away to the forest by one of the Abenakis tribe of Indians from her home at Wells in Maine, whither her father, John Wheelwright, had been banished for his religious opinions from Boston, Massachussetts. In the forest camp of these Indians, little Esther was discovered a year or two afterwards by Father Bigot, a Roman Catholic missionary, well-beloved by the tribe. After her release in 1708 by the efforts of the Marquis of Vaudreuil, who placed her with his daughter in this convent until an opportunity occurred to restore her to her parents at their home 700 miles distant. The familiar story of her final admission to the vows of religion and of her long life of sixty-six years in this religious community need not be repeated here.

The natural question arises, how came the silver spoon and fork into the possession of the Convent. The answer is that after nearly fifty years of separation from her family in New England, Mother Esther Wheelwright, as she then was, was visited at the convent by nephew, Major Wheelwright, who placed in her hands in the name of her family a gift of a silver fork, spoon and goblet.[1] The spoon and fork, engraved with the Wheelwright arms, have survived the storms and perils of time, but the goblet could not be traced.

The spoon and fork are of French workmanship—an ascription which is made on the authority of the marks stamped upon them. But a curious and interesting fact was revealed by the writer's examination of these interesting relics, namely, in the discovery of another maker's mark upon them—the mark of Jacob Hurd of Boston, Massachussetts (1702-58), a prolific silversmith and the maker of many vessels for churches in New England.[2]

A pair of silver candlesticks,[3] which was presented to the Church of the convent by Lady Carleton, wife of the Governor of Canada, have disappeared.

The Hôtel Dieu Convent and Hospital founded in 1639 by the Duchess of Aiguillon the friend of St. Vincent de Paul and niece of Richelieu, was once famous for its artistic and historic treasures; but many of these perished in the great fire of 1755. Subsequent losses have also been chronicled. A French 17th century clock made in Paris and fitted in a long wooden case by a Quebec carpenter in the 18th century, was exchanged by the authorities of the Hôtel Dieu some few years ago, and was bought by the present writer in Quebec. A silver bust, enshrining the skull of Jean de Brébeuf, the Jesuit missionary, and the bones of his fellow-martyr, escaped the observation of the writer in the chapel of the Hôtel Dieu.

The church of Indian Lorette is conspicuous for its possession of several important objects and beautiful vestments. These comprise a small 17th century reliquary, set with crystals, which is associated with Chartres; a pair of ewers with tray; four beautiful French vases in the style of Louis XV; a large French sanctuary lamp dating from the end of the 17th century; and two silver statuettes of St. Joseph and the Blessed Virgin. To this inventory may be added: six French tripod candlesticks and a crucifix of early 18th century; and a pair of French plain octagonal candlesticks of domestic rather than ecclesiastical character, which are marked with an unknown maker's mark,

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[1] *Glimpses of the Monastery; Scenes from the History of the Ursulines of Quebec*, 2nd Edition, 1897, p. 308.

[2] *The Old Silver of American Churches*, by E. Alfred Jones, 1913.

[3] *Glimpses of the Monastery*, etc., p. 312.

P.L., who wrought several objects here. The atelier of François Ranvoyzé is represented by domestic spoons and forks.

An object of interest in Lorette parish is a silver ostensorium by François Ranvoyzé whose son became a priest of this parish.

As the population and prosperity of Quebec grew in number and volume in the 17th and 18th centuries, the demand was created for silver plate and personal ornaments of gold and silver, as well as other luxuries of a modest character. The risk of loss of precious objects in the long sea passage from Old to New France and other circumstances combined to convince enterprising and prosperous parents of the desirability of sending their sons to Paris to be apprenticed to goldsmiths and jewellers. Before recording the history of one Quebec boy who was apprenticed to a Paris goldsmith, a brief account of French silversmiths, who had settled in Quebec, may not be inacceptable.

As early as the first decade of the 18th century one Michel Levasseur, practised the craft of the silversmith in Quebec, where he apparently enjoyed the privilege of being the only silversmith in 1708. According to a deed of 2nd May in that year he had made a declaration to teach his craft to his only apprentice, Pierre Gauvreau by name, and to no one else. But Michel Levasseur was relieved of this contract by the Intendant, Raudot, and was allowed to take another apprentice, one Jacques Pagé dit Carcy. This second apprectice was a clockmaker, meaning in this instance, nothing more than a repairer of clocks and watches, as well as a practical silversmith, and established an atelier on Mountain Hill in the City of Quebec.

A little later appear the names in the census for 1744 of the following silversmiths in the City of Quebec:

Jean Baptiste Deschevery dit Maisonbasse, described as a marchand-orfevre, in Sous-le-Fort Street.

Michel Cotton, whose workshop was in Buade Street.

The fifth silversmith, Paul Lambert, worked in Sault-au-Matelot Street in Lower Town, where also was another goldsmith, Joseph Mailloux.

The address of the seventh craftsman, Francois Landron, was Notre Dame Street, Lower Town, and that of the eighth silversmith, Francis Lefebvre, under the French regime in Quebec, was in De Meules Street.

There was another silversmith, one of the most conspicuous craftsmen in the history of that craft in Quebec, who worked there both under the French and the English. This was François Renvoizé, or Ranvoyzé, many of whose works have already been mentioned, who was born in that city on 26th December, 1739, the grandson of Pierre Ranvoyzé and his wife, Marie Goupel, emigrants from Caen, Normandy, and son of Etienne Ranvoyzé and his wife, Marie Jeanne Poitras. François Ranvoyzé, the silversmith, was married on 25th November, 1771, to Vénérande Pellerini. Whether he learned his craft from one of the above silversmiths in his native city, or was sent to Paris to serve an apprenticeship to one of the more experienced members of the goldsmiths' guild there, cannot at the present moment be precisely determined. That this French-Canadian silversmith enjoyed a considerable patronage from the ecclesiastics and churches of the province of Quebec is proved by the many examples of his skill which are preserved to this day, notwithstanding the losses sustained by various causes, such as fire and theft. The writer found evidence of his workmanship surviving in the Archbishop's palace in Quebec, in the Basilica; in the Ursuline Convent; and in Lorette, where, as has already been mentioned, his son became the parish priest. All the silversmiths above mentioned were born in Quebec or vicinity.

François Ranvoyzé was an envious man. A premium would not tempt him to accept as an apprentice the boy Laurent Amyot, soon to become Quebec's most talented silversmith, lest he should prove a formidable competitor. This boy was therefore sent by his father to Paris to learn his craft, and there he worked hard for two years, from 1784 to 1786, in the atelier of a goldsmith, whose name unfortunately has not been traced. The young Amyot returned to Quebec fully equipped for his craft, and during the remaining 33 years of Ranvoyzé's life was a steady and successful competitor, achieving as he did a large measure of success in supplying Quebec churches with sacred vessels and ornaments. Much of his success was due to the increased patronage which arose from the virtual severance of ecclesiastical connection between French-Canada and old France from the days of the Revolution and the consequent dissolution of the religious houses in France.

Laurent Amyot's workshop was on Mountain Hill in Quebec, where he died in 1838.

About the time of Amyot's death, Francois Sasseville began working as a silversmith at the corner of Palace Hill and Charlevoix Street, whether apprenticed to Ranvoyzé or Amyot, future researches into the history of the silversmith's craft in Quebec will, it is hoped, reveal.

The present writer during an enjoyable and instructive visit to Quebec in quest of knowledge for the history of this craft was privileged to converse with an old silversmith named Ambroise Lafrance, who was then in possession of the tools of Laurent Amyot, which had descended to him from the above François Sasseville, then to Pierre L'Esperance, who worked at the same address from 1863 to 1882, and finally to the said Ambroise Lafrance at the same location from 1882 to 1905, when he retired and removed to 26 rue St. Nicholas. The latter's youthful son, who has since been stricken down by tubercular disease, had also been intended for the craft, and before his early death had wrought a silver cup and a cross for the present writer.

A little school of silversmiths, if it may be so described, sprung up in the city of Montreal in the eighteenth century. One name only has, however, been so far recorded, namely that of Robert Cruickshank, who was a loyalist refugee from the American Colonies. The writer of these notes has two examples of old Montreal silver, a monstrance and sugar tongs, by unknown silversmiths of that city, as well as specimens of the work of François Ranvoyzé and Laurent Amyot.

Prehistoric Canadian Art as a Source of Distinctive Design.

By HARLAN I. SMITH, Archaeologist, Geological Survey, Canada.

Presented by L. J. BURPEE, F.R.S.C.

(Read May Meeting, 1918)

After the Franco-Prussian war, to the great chagrin of the Germans, the French paid the indemnity imposed upon them, in a surprisingly short time. This was largely due to their inimitable and distinctive French designs in laces, dresses and similar products which enabled them to gain and hold commercial supremacy in these artistic goods.

Owing to the present war and the great debt that all the nations have been obliged to assume, the competition in manufactured articles with which to pay these debts will be practically at its maximum. Canada, with its relatively small population and probable high cost of living, cannot enter into competition by duplicating European articles, but must offer for export products of purely Canadian design, somewhat after the French idea of distinctive styles. In order to guide the manufacturers towards the production of Canadian designs, it seems that the early Indian art might well serve as a suitable starting point.

The designs that have usually been used are practically all based upon Greek, Roman and other European art. Canada has imported from Austria and Germany many things that she could have designed herself. It has been the same in the United States. In the silk industry, for instance, the war practically cut off the sole supply of designs. The silk manufacturers have since employed museum specimens from various countries such as Peru, Mexico, and Siberia, as sources for ideas and motives for their designs, both woven and printed. The cotton manufacturers and the dress designers have also used such museum specimens. The results have been financially successful.

Canada can surpass this method in two ways: first, by using motives not merely for silk and cotton, but for all her products that require designs; and second, by using motives that are distinctive of Canada—not borrowed from foreign countries.

There are over one hundred and seventy-five different classes of Canadian manufactures dependent on good designs for success, and about a thousand Canadian firms manufacture them.

The prehistoric art of Canada, as distinct from historic Indian art, to-day includes no less than four hundred different specimens, which may be useful to designers in developing distinctively Canadian manufactures and trademarks. Besides these there are many duplicates, and when archaeological work has progressed further we may have many more.

A glance at a few of these earliest art works of Canada shows that each part of the country has an art all its own. The humid Pacific coast, with its great cedars and plentiful supply of sea food, where the modern Indians are noted for the sculpture of their great totem poles, has a remarkable prehistoric art in which animal forms predominate. Many prehistoric art specimens come from this area.

The interior plateau and Mackenzie basin form another art region where geometric figures are common.

The art of the buffalo plains, formerly inhabited chiefly by nomads is distinct from the other art areas of Canada, but as yet comparatively few archaeological specimens have been collected from this area.

Most of the specimens come from the eastern woodlands—the land of the birch canoe, maple sugar and wild rice. Both animal forms and geometric patterns are numerous. Some of this art is charactistically Algonkian, some is clearly Iroquoian. Many designs are on fragments of pottery or entire pots, although pottery is not found on the Pacific coast or in fact west of Blackfoot crossing. Entire pots are rare, having been broken by the frost or the plow.

An album of these motives for distinctively Canadian manufactures from prehistoric Canadian art has been prepared and may soon be published by the Geological Survey. Meanwhile the matter has been brought to the attention of over eight hundred firms in Canada by personal correspondence, and to still others through an exhibit, the public press, and lectures. Over fifty of the large firms have expressed a desire for the publication of the album, and some state that they have tried to secure distinctively Canadian designs, but have been unable to get them from the artists. A few state that they cannot get designs as usual because of the war. Six at once sent representatives to Ottawa to see the specimens. These representatives expressed surprise at both the quantity and quality of the motives. Several firms have volunteered to consider endowing scholarships, or otherwise aiding art schools that will devote attention to distinctively Canadian designs suitable for their business, so that they may have an opportunity to buy such designs.

The artists and designers of the country have also been informed that these firms are anxious for such designs, and have been urged to make them at once. After the war they will once more have to compete with European designers.

These prehistoric Canadian objects have already been used experimentally in designing several kinds of products. Art pottery developed from typical Iroquoian pots have been made by Miss M. Young of the Mines Branch of the Department of Mines, Canada, from Canadian clay. Art pottery is not manufactured commercially in Canada, and for every piece we buy money leaves this country. Miss Young has also made tiles from our clays, some of them based on British Columbian motives. She has also made tobacco jars, electric lamp stands, tobacco pipes, book props and candle sticks. She has used a single specimen for no less than eleven totally different designs. Others have since taken up the use of both prehistoric Canadian motives and Canadian clay.

Some of the designs seem so simple that one who is not an artist would imagine that they could have been created without a supplied motive, but we are assured by both practical workers and psychologists that it is impossible to design anything except by developing something already seen. Designers state that the most difficult thing for them to get is the original idea or motive. Once they have it they can develop it in many ways into innumerable designs, many of which might not be easily recognized as based upon it.

An art teacher in Winnipeg has made wall paper designs from photographs of the manuscript of the album of prehistoric Canadian specimens to submit to a large Canadian wallpaper manufacturer. This manufacturer requires so many designs that he cannot depend on one designer but draws upon New York, Paris, and London, and he has offered to consider contributing to an art school that will train wallpaper designers in distinctive Canadian design.

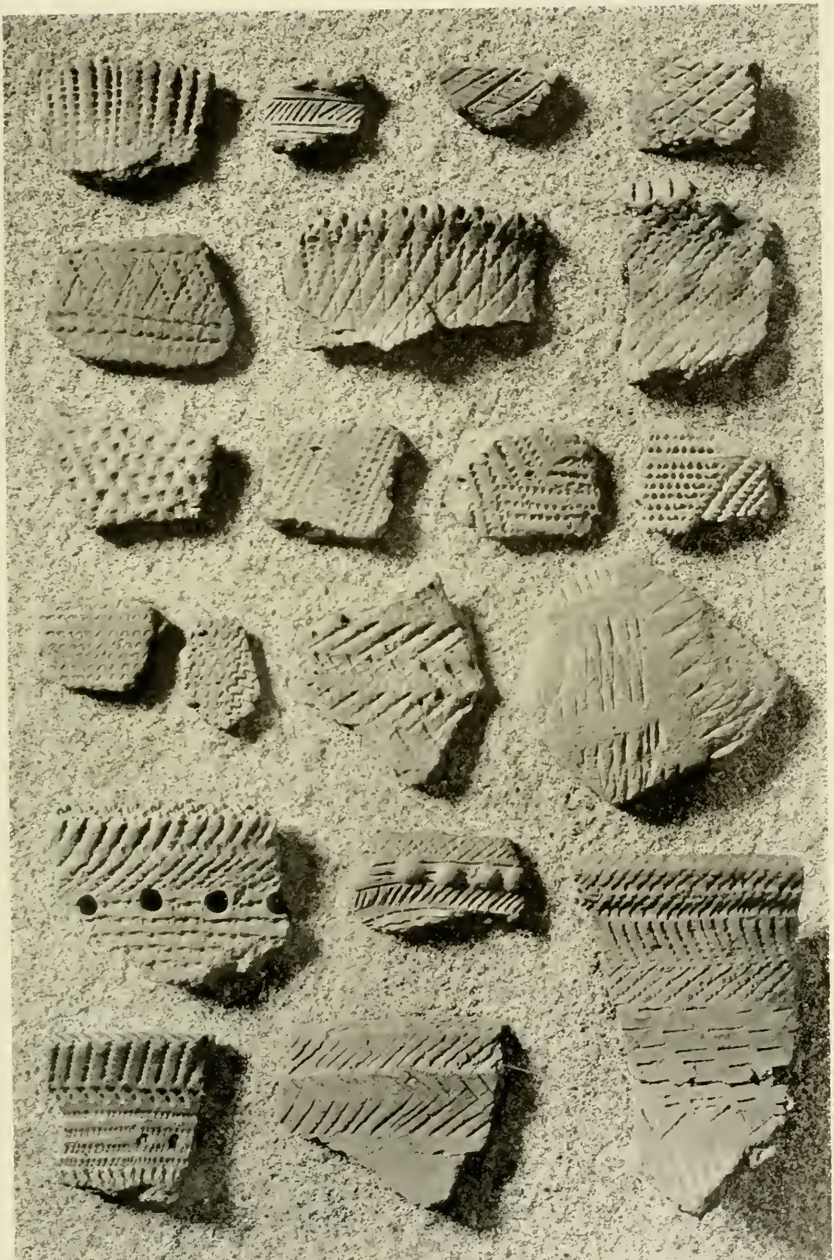
Some manufacturers in other countries have attempted products based upon primitive specimens, but have failed woefully because they have lost the spirit of the native art. This could be avoided by consultation with anthropologists familiar with the art. They would gladly point out any such departures.

Perhaps the most successful of these products of distinctively Canadian design is a book prop made by Miss Young after an engraved copper object from the Indians of British Columbia. This is far enough developed to prevent those who dislike anything Indian from recognizing its source, yet it is distinctively British Columbian. It is made of Canadian clay and is artistic.

May we not look forward to the time when, with the aid of schools of design and scholarships, this country can produce wares as well known and distinctive as Dutch tiles and oriental vases?

PLATE I.

Typical Iroquoian pot from near Eardley, Quebec (near Ottawa).



Designs on fragments of typical Algonkian pottery from Ontario.

Designs on fragments of typical Iroquoian pottery from near Roebuck, Ontario.

Plate IV.

Prehistoric pot from Ontario.

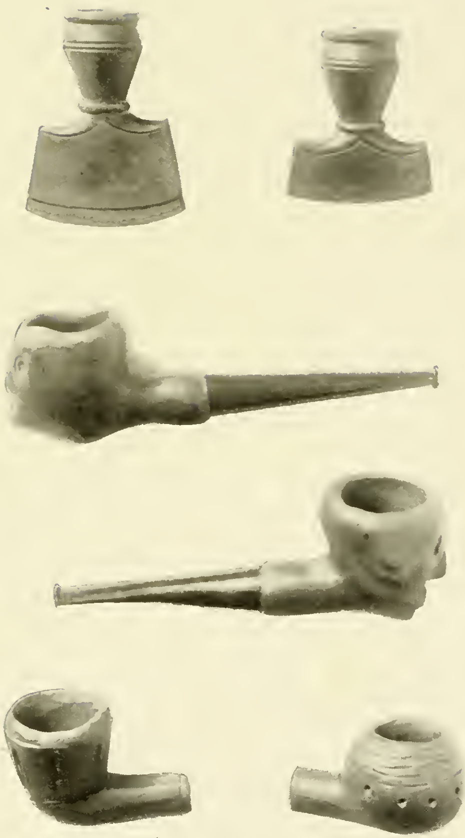
Book prop, made by Miss M. Young after an engraved copper object from the Indians of the coast of British Columbia.

Electric lamp stands, designs developed from typical Iroquoian pottery from Roebuck, Ontario.

PLATE VII.

Pottery designs developed from typical Iroquoian pottery found near Roebuck, Ontario.

Typical Iroquoian pot, from prehistoric village site near Roebuck, Ontario. A number of designs have been developed from this.



Pipes made of Canadian clay. Two reproduced by mechanical means from a Micmac Indian pipe. Four developed from prehistoric specimens from Ontario.

Pot, developed from a typical Iroquoian pot from near Roebuck, Ontario. Tile, developed from a design on a blanket from the Indians of the coast of British Columbia.

Dutch tile, oriental vase and English vases.

PLATE XII.

Urn and Tobacco jar, designs developed from typical Iroquoian pottery from Ontario and Quebec.

Tiles made by Miss M. Young; five after a woven design on bag from the Ojibwa Indians of the Eastern Woodlands; one after an engraved copper object from the Indians of the coast of British Columbia.

The Pre-Selkirk Settlers of Old Assiniboia

By REV. GEORGE BRYCE, D.D., LL.D., F.R.S.C.

(Read May Meeting, 1918)

The story of the Selkirk Settlers of Red River (1812-70) has been told by the writer and others, but it is important to notice that half a century before Lord Selkirk's colony took root, the Traders of the Hudson's Bay Company and the North West Company of Montreal had put their foot on the far interior of Rupert's Land. Founded in 1670, for a century the English company carried on their trade on the shore of Hudson Bay, but as the Montreal Company led by Joseph Frobisher penetrated the waters of the interior for trade in furs, and built the Fort of Sturgeon Lake, the Hudson's Bay Company men led by the distinguished Samuel Hearne, faced Sturgeon Lake Fort by a rival post—Fort Cumberland. These hostile establishments were at Poskoiac, or as we call it to-day "The Pas," on the great Saskatchewan River. Hearne's men were chiefly Orkneymen, engaged on the Orkney Islands, the last place of call made by the London ship as it came up the east coast of Scotland and crossed the North Sea to York Factory. The Nor'Wester voyageurs and workmen were chiefly French Canadians from Canada and their leaders of Scottish origin from Montreal. The employees of the two companies largely intermarried with the Indian women of the Cree nation. They rarely returned to their homes from the far West, and their children grew up a sturdy, agile, and daring race—the autochthons of the Interior, and like the Randolphs of Virginia, who claim descent from Pocahontas—the Indian Princess—boastful of the land of their birth. These children of the wilderness were in some cases sent for their education to Montreal or even at times to Edinburgh and Aberdeen. In most cases, however, whole families when their trading days were done, as Governor Archibald used to say, floated down the streams to the "Paradise of Red River" to make their homes alongside the Selkirk settlers—to enjoy schools and churches—the well known "Fiddler Library" and the society of the Selkirk colonists.

This paper will give an account by the writer of men and manners, as he saw them, on his making his abode under the shadow of Fort Garry in the year 1871.

The descendants of those of Orkney blood and those of French Canadian ancestry—while differing in temperament, speech, and often in religion—lived and worked harmoniously together, occupying strips of land running back from the Red or Assiniboine River—about two miles long. The junction of these two rivers, near which stood Fort Garry, was the centre of "Old Assiniboia." The groups of settlers usually of the same tongues were clustered into parishes. North from Fort Garry chiefly on both sides of the river were the English speaking parishes of St. Johns, Kildonan, St. Paul, St. Andrews and St. Clements. Southward from the centre of Assiniboia on Red River were the French parishes of St. Boniface, St. Vital, St. Norbert, Ste. Agathe and St. Jean Baptiste. On a small tributary of Red River was Pointe des Chênes. On the Assiniboine River were the English parishes of St. James, and Headingly, and further west the French parishes of St. Charles, St. Francois Xavier, Baie St. Paul, and still further west the English settlements of Poplar Point and Portage la Prairie, although the last two were not spoken of as being in Assiniboia. Near the junction of the two rivers stood Fort Garry, the nucleus of the city of Winnipeg. Fort Garry was the centre of life and business of the Colony. Here lived the Great Mogul of Assiniboia—The Resident Governor of the Hudson's Bay Company.

II.

The Bois-Brulés or Metis.

The Traders of the Great Montreal Company, to obtain a continued service of voyageurs and trappers, encouraged their men to marry the Cree women and continue on in the fur trade. Their children became an active, impulsive and powerful clan. The daring native youths grew up to use firearms as well as the paddle and canoe in the lakes and rivers. Living as they did invariably in cabins on the banks of the streams they also became mighty trappers and hunters. From the southern American prairies they bought "bronchos" —horses. The young Metis became most skilful riders, and were remarkable for success in following the buffalo herds on the western prairies. They became ardent supporters of the Montreal traders as the Selkirk settlers were of the Hudson's Bay Company.

On the banks of the Swan River, a tributary of Lake Manitoba, and near by Qu'Appelle, was a paradise of the traders. Here young Cuthbert Grant, the son of a sturdy Highlander of the same name, and of a Metis woman—thus having Scottish, French and Cree blood, —became the beau-ideal of the Swan River Parthian band. Around the Nor'Wester council-fire it was planned to attack and sweep out of existence the newly come Selkirk settlers—whom they called "jardiniers" or clod-hoppers. To make the plot more easy to be carried out, a part of the Selkirk settlers had been coaxed away by an adroit, dashing Highlander—Duncan Cameron—who sported a soldier's uniform—and used a plausible tongue as he promised to lead them to an El Dorado in Upper Canada. Following this departure Cuthbert Grant, the younger, with his band of cavaliers, on June 19th, 1815, swept down the northern bank of the Assiniboine River, turned northward to the plain near Kildonan—Lord Selkirk's Settlement—killed Governor Semple, and followers to the number of twenty-two men, at "The Seven Oaks." The wild intruders seized Fort Douglas, the colony fort, which stood on a site which is within the limits of the city of Winnipeg of to-day. To the whole "Bois-brulés" population it was a great triumph and they held Fort Douglas till the following spring of 1816, when Lord Selkirk and his DeMeuron mercenaries recovered the lost fort to be a nucleus to gather around him again his Scottish colonists.

The time-being conqueror, Cuthbert Grant, had his victory celebrated by the singer of the district of St. Francois Xavier on the banks of the Assiniboine, where Grant and the rhymer—Pierre Falcon—afterward took up their abode. The poet is singing of the victor Grant and satirizing the Governor his military opponent.

Extract:

(A military officer comes to parley with the Red River Metis).

"C'est à la Rivière Rouge,
Nouvelles sont arrivées,
Un général d'armée
Qui vient pour engager."

(He wishes to have the Metis who are great warriors serve him)

"Il dit qu'il veut emm'ner
Beaucoup de Bois-Brulés.
Ils sont en renommée
Pour de braves guerriers."

(He offers Cuthbert Grant, leader of the Bois-Brules, his silver epaulettes as a gift)

"Vous, Monsieur Cuthbert Grant,
Maître de régiment,
Mes épaulettes d'argent
Je vous en fais présent."

(The disappointed captain wishes much to flee off to the Far West)

"Bourgeois de compagnie,
Je dois remercier
De me faire ramener
Au fort de Mackenzie."

(The poet Falcon calls upon all to drink! drink! at the defeat of Governor Semple and victory of Grant).

"Amis, buvons, trinquons,
Saluons la chanson
De Pierriche Falcon,
Ce faiseur de chansons."

III.

A Champion of Native Rights.

As the natives born on the soil became more numerous and more educated by the School and Church they sought to enjoy greater freedom and the possession of natural rights. When communities were formed the Company saw a spirit of independence growing up. The Hudson's Bay Company had for more than a century and a half enjoyed a monopoly. Instead of meeting popular demand half way they introduced Judge Thom, a Scottish lawyer from Montreal, and constituted with a monopolist spirit an appointed Council of Assiniboia. The agent to guard their monopoly was made Recorder or Judge with almost absolute power. Twenty leading natives of fair means ap-approached the Governor to gain information as to whether they with a trace of Indian blood could "hunt, buy, sell or traffic in furs, etc." The Governor was pacific but the Recorder was inexorable. James Sinclair of the same stock as the Earl of Orkney of the same name, who is well known by Scott's beautiful ballad of "Rosabelle," became leader. The whole native population of Orkney and French descent was aroused. The crisis came in the case of a native trader Sayer being thrown into prison for selling furs. At his trial being held on Ascension Day, French and English comrades seized him and liberated him from the court room—the Metis shouting, "Vive la liberté! Le Commerce est libre! Le Commerce est libre!" The Recorder never sat as judge again, and the writer knew him in London some forty years afterward—a retired beneficiary of the Hudson's Bay Company.

IV.

Isbister—A Brilliant Son of Red River.

One of the most distinguished sons of old Red River Settlement was Alexander Kennedy Isbister who was born in 1822, son of an Orkney father in Fort Cumberland and at The Pas on the Saskatchewan River. He was educated at the McCallum School, now absorbed into St. John's College, Winnipeg. Having served as a clerk with the Hudson's Bay Company, Isbister went to England. He became a lawyer, took part in the passing of "The Reform Bill" and devoted himself as representative and adviser of his countrymen who were struggling as we have seen for liberty in Red River Settlement. Isbister's advice to his friends and relatives in the struggle of Sinclair and Sayer against "The Company" was invaluable. Having a bent to serve as an educationalist he retired from the Law Courts, and became Head of the College of Preceptors in London. It was in this capacity that the writer knew him. Having accumulated a considerable fortune, Isbister left all, with an obligation to support his mother and sister, to Manitoba University. By successful management the bequest has reached in value to $100,000 of invested capital of which all the revenue now goes in scholarships to Manitoba University. Dr. Isbister was a warm friend of liberty. He was devoted to his native land and will always be kept in memory on account of his magnificent bequests.

V.

Captain William Kennedy.

Forty years ago on the banks of Red River at the Rapids lived a cousin of Alexander Kennedy Isbister of whom we have just spoken. Of good Orkney descent he also was born on the Saskatchewan River and after various adventures became one of Lady Franklin's captains to go in search of Sir John Franklin who was lost in the Arctic Sea. While in command of his vessel he very nearly reached the spot where traces of Sir John Franklin were afterwards found by Captain McClintock in 1859. Lady Franklin herself fitted out the Prince Albert schooner and placed Captain Kennedy in command. On their long journey Kennedy's second in command was Lieutenant Bellot of the French Navy. Bellot made a long sledge journey in the great search, and discovered the Strait which now bears his name between North Somerset and Boothia in the Arctics. After returning from his Arctic Expedition Captain Kennedy, having done benevolent work in Central Ontario, settled down at the Rapids of the Red River where the massive bridge now stands some eighteen miles below the City of Winnipeg. The writer knew him well and remembers a most interesting lecture before the Manitoba Historical Society in which he declared that the Magnetic Pole discovered by Captain John Ross in 1831, where the magnetic needle stands vertical, as being at the centre of terrestial magnetism for the Northern Hemisphere of the earth, lying directly north of Winnipeg might be tapped to Winnipeg to supply the whole continent of North America with electricity. It was a matter of interest to the writer, to take part in the obsequies of the old Captain at the burial place of St. Andrew's on the banks of the Red River.

VI.

Louis Riel—The Elder.

Perhaps no name connected with "The Selkirk Settlement" is better known than that of Louis Riel. The name, however, applies to two men—father and son—senior and junior. They were both men of distinct mark. Louis Riel senior figured largely in the strike for freedom led by Sinclair, Isbister and others. Riel the Elder was proverbially known as "The Miller of the Seine." The Seine is a small tributary of Red River that flows in opposite to what is known as Point Douglas—(Douglas so called from Lord Selkirk's family name). The Seine empties within the limits of St. Boniface—the eastern suburb of the City of Winnipeg. Riel the Elder was always said to have been of Sioux, Irish and French descent. He was noted for his fiery temper, his dashing bravery, and his fearless opposition to "The Company." His water-mill ran during the spring and early summer, when the water was at high mark. His triangular descent left no doubt as to his fierceness of temper or manner. In the great Sayer affair which disturbed all Assiniboia to the very heart, it was the senior Riel who gathered his French compatriots in St. Boniface Cathedral on Ascension Day, 1847, made a fiery oration at the doors of the Church, dashed across the river at Point Douglas, and took five hundred men across on Sinclair's ferry boats who fired volleys from their guns, rushed to the Court House, and liberated Sayer—shouting "Le Commerce est libre! Vive la liberté!" Violent although the eruption was, it settled for all time the fact that to the Autochthons of Red River Settlement, there was freedom of trade as far as hunting and using and exporting natural products of the soil and river, both as regarding use or trade.

VII.

Louis Riel—The Younger.

The fiery leader of the Metis revolt in 1869-70 was Louis Riel, Junior, who though sprung on the mother's side from a respectable Metis family, carried a more violent disposition even than his father, and having a good education—a part in St. Boniface College and a further training in Montreal—added to his inherited disposition a megalomania unknown to the "miller of the Seine." It is not the purpose of the writer to discuss the rights and wrongs, the blunders and mistakes, the rashness and the stupidity, the cruelty and the cowardice on the part of both parties, who opposed each other in the Red River Rebellion of 1869-70. It was a melange of grossly despicable greed and unreasonable alarm on the part of the Metis; of confused uncertainty upon the part of the English-speaking descendants of the Selkirk settlers, and of the natives of the English parishes, with a third element of the imbecility and helplessness of the Hudson's Bay Company officials. As to the leader of the revolt, Louis Riel, junior, he gave in his youth as a student promise of quickness and intelligence, but by his self-conceit, importance, and his assumption of a Kaiserlike air and attitude as he dwelt in Fort Garry, in whose cells he kept in misery a band of prominent and innocent Canadians charged with no crime. It is far from being just to say that Louis Riel had no good parts. He had some prominent features of leadership in speech and in demeanour he was impressive; his courage and executive ability were undeniable. His authorization of some acts of cruelty and injustice probably arose from fear. An exile for fifteen years, his inspiration of the natives and Indians to rebellion in Saskatchewan in 1885, led to an ignoble end, and his attempt to introduce a new religious faith seems to have indicated a disordered mind. The attempt to make Louis Riel a martyr has failed to impress itself on any class of Canadian people.

VIII.

Hon. James McKay.

The prevailing distinction among the native people of Rupert's Land was to be able to run a foot race, chase a wolf, ride a restless broncho horse, or pursue the dangerous rush of a herd of buffalo. As in the old Biblical day a man was famous when he could with rapidity and skill cut down the mighty oak trees, so here men of great nerve and muscle gained a general reputation for deeds of skill or unwearied bravery. Such a man was Honourable James McKay having a trace of threefold blood in his veins. Broad and heavy set, he was nevertheless a champion runner or sprinter as the local usage would speak of him. His two brothers were respectively a Government official and a missionary to the Indians. When Assiniboia became absorbed in the new Province of Manitoba, after the transfer of 1870 it was thought necessary to have an Upper House or Legislative Council. McKay became a member of it and on account of the French blood in his veins he became a representative of the Metis section of the people. He was a man of means, of high reputation, as well as an example of political skill. When the Legislative Council was abolished in Manitoba in 1876 James McKay became a member of the Provincial Cabinet, while a majority of his colleagues were given other positions. His residence of "Deer Lodge" west of the young city of Winnipeg was a place of resort and James McKay was always looked upon as a peacemaker among the many disturbing elements of Old Assiniboia.

IX.

HON. JOHN NORQUAY.

Among the men of note of the native people of Old Assiniboia was Honourable John Norquay, a man of greatest ability in affairs, of skill as a speaker and a successful leader of men. He was an honour to Manitoba. Of Orkney and native descent he was a nephew of the Arctic explorer, Captain Kennedy. Born at Cumberland House on the Saskatchewan River, he was educated at St. John's College, Winnipeg. Early in 1870 he became a representative in the first local Parliament of the Province, and became premier of Manitoba in 1878. He was an excellent speaker, a patient and cautious leader and being of mixed blood was a most successful peacemaker among the Manitoba gathering of people of polyglot tongues. His efforts led on to the strong community feeling in his province, which has grown markedly from year to year since his day. The Orkneys of Scotland may well be proud of their eloquent son who died at forty-eight years of age in 1889.

X.

SHERIFF COLIN INKSTER.

While almost all of these notables described have passed away, there still remains the popular Sheriff of Manitoba, of Orkney and native blood, who is still actively performing the duties of his office. Born in Kildonan of The Old Red River Settlement he was on the formation of the province in 1870 appointed a member of the Legislative Council. On the Upper House of Manitoba being abolished by the Mackenzie Government at Ottawa the Hon. Colin Inkster was appointed High Sheriff and for forty-four years he has done his duty without shortcomings or criticism.

XI.

REVIEW.

It has been the good fortune of the writer to be a contemporary and to have acquaintance with almost all of the personalities that have been described since 1871. The scattered elements of early Manitoba have wonderfully coalesced. The heads of almost all of these native families who saw the transfer of their prairie homes to Canada have gone, but their descendants are to-day true and loyal Canadians.

For the fathers have grown up the children, and it is but just to take notice of others not so noted but yet worthy of honourable mention as having been nation builders in establishing a consolidated Manitoba. It is right to give their names "Lest we Forget," noble deeds quietly done by unostentatious "nation builders." Among the French are the worthy family names: Marion, Dauphinais, Delorme, Hamelin, Lepine.

Among the English-speaking people notable as industrious and sturdy children of the land are Vincent, Murray, Logan, McBeath, Gunn, Bannatyne, Pruden, McDermott, Bird, Flett, Hardisty, McFarlane, Cunningham, Lillie, Burke, Ross, Heron, Cooper, Harper, Garrioch, Tait, Spence, Truthwaite, Pruden and McKay families.

Mémoires de la Société Royale du Canada
SECTION I

SÉRIE III DÉCEMBRE, 1918, ET MARS, 1919 VOL. XII

L'engagement des Sept Chênes.

PAR M. L.-A. PRUD'HOMME.

(Lu à la séance de mai, 1918)

Il y a dans l'histoire des points d'arrêt, autour desquels convergent une foule de circonstances et se groupent des drames divers.

Il semble qu'à un moment donné, les éléments nombreux qui sont en ébullition dans un pays montent et déferlent comme les vagues de la mer.

Ils brisent le moule trop étroit qui les contient et déterminent une orientation nouvelle.

Ces tournants de l'histoire, préparés longtemps d'avance, s'imposent tout à coup comme la solution à un malaise longtemps contenu et un soulagement à une époque tourmentée.

C'est ce qui eut lieu en 1816.

La bataille de la Grenouillière, comme on est convenu de l'appeler, ne fut qu'une rencontre fortuite autour d'un marais. Malgré la mort du gouverneur de la colonie, elle n'aurait pas eu le retentissement qu'on lui a donné, si elle n'eut été la résultante de plusieurs années d'assauts et de luttes sanglantes entre les deux compagnies de traite qui se disputaient les fourrures de l'ouest.

Elle ne fut que l'acte final d'un long drame.

Effrayés de part et d'autres des ruines que ces hostilités avaient produites, les chefs de ces deux puissantes associations cherchèrent les moyens de terminer le conflit. Après avoir voulu s'égorger pendant nombre d'années, les deux compagnies s'éprirent tout à coup d'un beau zèle pour s'unir indissolublement. Seulement même dans cette fusion, elles cherchèrent encore à s'étouffer. Ce fut la compagnie de la Baie d'Hudson qui, comme on le sait, célébra ces épousailles de nécessité et de contrainte. La compagnie du Nord-Ouest, absorbée par sa rivale, disparut pour toujours de la scène.

L'engagement des Sept Chênes constitue donc un événement grave, puisqu'il détermina toute une évolution au Nord-Ouest. De ce chef, il mérite qu'on lui assigne la place qui lui convient dans l'histoire, afin de le mieux signaler à l'attention du public.

II.

Quelle fut la cause de ces luttes qui secouèrent l'Ouest et y semèrent le désordre et la ruine ? C'est à cette question que je m'efforcerai de répondre en quelques mots, dans un examen rapide des faits au point de vue historique et des réclamations juridiques des deux compagnies de traite.

La compagnie de la Baie d'Hudson obtint sa charte Royale le 2 mai 1670, ayant pour objectif le rêve poursuivi alors par les grands navigateurs de cette époque, la découverte d'un passage de l'Atlantique au Pacifique, au nord de notre continent.

Ses efforts dans cette direction furent à peu près nuls et on ne saurait l'en blâmer. Elle se contenta d'ériger des forts et de fonder des postes à l'embouchure des rivières qui déversent leurs eaux dans la baie d'Hudson.

Elle attendit sur ces rivages inhospitaliers la flotte des canots sauvages qui y apportaient à tous les étés les pelleteries soyeuses de l'intérieur. A de rares intervalles, elle fit bien quelques efforts pour pénétrer dans l'intérieur du continent mais ces tentatives n'eurent rien de permanent et n'aboutirent qu'à des expéditions passagères, sans occupation réelle du pays. D'ailleurs à quoi bon se lancer dans de telles aventures quand les Sauvages venaient la trouver dans la baie, sans qu'elle eut à se déplacer.

Lorsque les Français se répandirent dans l'Ouest, elle éprouva bien quelque velléïté de pousser un peu vers le Sud, mais lorsqu'en 1755 les traiteurs français abandonnèrent l'Ouest, elle retourna à ses habitudes sédentaires.

Toutefois, en 1772, elle eut un triste réveil. Joseph Frobisher débouchant tout à coup sur la rivière Churchill intercepta les fourrures destinées à la baie et lui coupa les vivres. De ce jour, elle comprit que son inaction pourrait à l'avenir causer sa ruine et elle se mit résolument à l'œuvre. En 1773 Samuel Hearne alla fonder un poste au lac Cumberland, à côté de celui de la compagnie du Nord-Ouest, pour signifier à cette dernière qu'elle n'entendait pas se laisser dépouiller, sans mot dire. Après ce premier effort, la compagnie de la Baie d'Hudson demeura seize ans stationnaire, pendant que sa rivale atteignait le lac Athabasca, d'où elle commandait la traite sur tout le parcours de la rivière McKenzie. Enfin, la compagnie de la Baie d'Hudson, secouant sa torpeur, se jeta cette fois sérieusement dans la mêlée. En 1790, elle fonda un poste au lac du Cygne; l'année suivante un autre à l'Ile à la Crosse, et, en 1794, elle établit un comptoir à dix-sept milles à l'est de Brandon, sur la rive sud de l'Assiniboine. De là, elle se porta à Edmonton, et à l'embouchure de la rivière Winnipeg. En 1796, elle érigea un fort au Portage la Prairie et à Carlton et enfin, en 1799, elle prit possession de la Rivière Rouge tout près de la frontière internationale.

La compagnie du Nord-Ouest était alors à l'apogée de sa puissance et entendait bien conserver les avantages de sa position.

En 1811 se passait en Angleterre un événement qui devait avoir une portée décisive sur l'avenir du Nord-Ouest et assurer finalement le triomphe de la compagnie de la Baie d'Hudson.

Lord Selkirk, ému de l'état de gêne des montagnards écossais, entreprit un mouvement d'émigration en Amérique. Il commença par s'assurer des deux cinquièmes des actions de la compagnie de la Baie d'Hudson, formant une somme de $200,000. Malgré une forte opposition de la part d'actionnaires qui faisaient également partie de la compagnie du Nord-Ouest, il se fit céder 116,000 acres carrés de terrain à .la seule condition de les coloniser. Ce territoire, auquel il donna le nom d'Assiniboia, constituait un véritable royaume. Le premier contingent des émigrants, envoyés par les agents de Selkirk, arriva au pays en 1811 et le dernier en 1815. Le nombre total des colons s'élevait à deux cent quatre-vingt-trois.

Miles McDonnell, représentant de lord Selkirk, fut nommé le premier gouverneur de la colonie. Il était catholique et il amena avec lui à la Baie d'Hudson le P. Burke, qui hiverna à la baie et retourna en Angleterre l'année suivante. Les Métis accueillirent avec sympathie les colons écossais. Comme ces derniers manquaient de tout au début et étaient peu habitués à vivre au bout du fusil, les Métis les amenèrent avec eux dans leurs quartiers d'hiver à Pembina. Les troupeaux de bison trouvaient dans le voisinage des montagnes Pembina, Tortue et du Tigre, un abri pendant l'hiver et c'est pour cette raison que les chasseurs se transportaient dans cette contrée pendant la froide saison. Ils partagèrent volontiers la chair du buffle avec les colons et depuis il se forma entre les Métis et ces derniers des liens d'amitié que le temps n'a pu détruire.

Évidemment la compagnie du Nord-Ouest voyait, d'un œil de défiance l'établissement de Selkirk. Elle sentait bien que ces nouveaux venus feraient cause commune avec la compagnie rivale. Elle y vit une menace pour le développement de la traite, dans laquelle jusqu'alors elle avait eu la haute main. Tel était l'état des esprits, lorsque, le 8 janvier 1814, le gouverneur McDonnell lança une proclamation qui attisa le feu qui couvait déjà sous la cendre.

McDonnell déclarait publiquement que lord Selkirk était le maître absolu du territoire d'Assiniboia et que lui seul avait le droit d'y faire la chasse et la pêche et même d'y couper du bois. Bref, il réclamait tous les droits que comporte le titre de propriétaire. *Alea jacta erat.* Le sort en était jeté. La compagnie du Nord-Ouest releva le gant et les actes les plus regrettables s'en suivirent.

Avant d'aller plus loin dans le tableau synthétique des événements qui se produisirent, je crois qu'il convient de préciser ici les raisons apportées dans le débat.

Tout le fond du litige, au sujet des titres à la propriété absolue des terres de la Rivière Rouge, repose sur le texte de la charte de la compagnie de la Baie d'Hudson.

Ce fut le 2 mai 1670 que le roi Charles II octroya cette célèbre charte à son aventureux cousin le prince de Rupert et à ses dix-sept compagnons. Le souverain concède à la compagnie le privilège exclusif de commercer "dans les mers, détroits, baies, rivières, lacs, anses, dans quelque latitude qu'ils se trouvent situés en dedans de l'entrée du détroit de la baie d'Hudson, ainsi que sur toutes les terres et territoires se trouvant dans les pays ou sur les côtes et confins des mers, baies, lacs, rivières et anses *susdits*."

Les adversaires de la charte interprêtent le dernier mot *susdits* comme limitant les droits de la compagnie aux terres qui se trouvent à l'entrée de la baie d'Hudson. Nous touchons là à une objection formidable. Si le sens, quoique général tout d'abord, est qualifié en le restreignant pour toute la concession à l'intérieur de la baie d'Hudson, la charte est évidemment sans effet quant aux territoires situés au sud de la baie, qui échappent ainsi à sa juridiction.

De plus, la charte se hâte d'ajouter cette exception formelle, "pourvu que ces pays, baies, lacs, rivières et anses ne soient pas occupés ou n'aient pas été concédés à aucun sujet d'un prince chrétien."

La charte, qui est d'une prodigalité sans égale, accorde le droit exclusif de pêcher, l'exploitation des mines, le titre de seigneur suzerain des terres d'après la tenure du manoir de Greenwich est, dans le comté de Kent, en franche tenure. La compagnie s'oblige de son côté de donner deux élans et deux castors noirs, au roi, chaque fois qu'il visitera ces domaines. Cette obligation, la seule qui lui était imposée, n'était pas onéreuse, comme on le conçoit bien. Pour gouverner les territoires que la couronne lui concède, la compagnie est investie du droit de faire des lois et règlements, imposer des pénalités, organiser des cours de justice, avec défense à tout autre sujet britannique de parcourrir ces territoires, sans la permission des officiers de la compagnie, de saisir tout délinquant et de le renvoyer en Angleterre. Le gouverneur assisté de son conseil est constitué juge de tout litige, tant au criminel qu'au civil, dans l'étendue de ses domaines. Bref, cette charte indique presqu'une abdication des prérogatives du souverain, en faveur des directeurs de la compagnie.

Aussi bien, nombre de légistes distingués firent une étude sérieuse de ce document extraordinaire.

C'est bien le cas de répéter ici l'adage "*Scinduntur doctores.*"

Des avocats éminents tels, que Romilly, Holroyd, Cruise, Scarlett et Bell, n'hésitent pas à déclarer la charte constitutionnelle et à proclamer que les titres de propriétaires des terres situées sur le parcours des lacs et rivières qui se jettent dans la baie d'Hudson, étaient garantis par la charte.

Sir Arthur Pigott, Spankie et Brougham, qui étaient également des lumières du barreau anglais, soutinrent au contraire que la concession territoriale était limitée à la baie et aux confins qui se trouvent à proximité de la baie. Il leur paraissait absurde de vouloir atteindre des pays situés à des centaines de mille au sud et de les inclure dans la charte.

D'ailleurs, pendant près de cent cinquante ans, la compagnie avait elle même déterminé la signification qu'elle prêtait à la charte, en se cantonnant dans la baie où les Sauvages venaient apporter leurs fourrures.

Ils prétendaient de plus:

1. Que la couronne n'avait pas le droit, sans l'assentiment du parlement impérial, d'aliéner un territoire plus vaste que celui de la Grande Bretagne et que le souverain ne pouvait céder une colonie, attendu qu'elle appartenait à la nation.

2. Que la charte contient une clause spéciale excluant de l'octroi toute contrée déjà cédée à un souverain chrétien. Or, le 29 avril 1627, c'est à dire, 43 ans avant l'existence de cette charte, Louis XIII avait donné ces mêmes territoires à la compagnie de la Nouvelle France.

3. Que par le traité de Ryswick, conclu en 1696, toute la baie d'Hudson fut cédée à la France et aucune réserve ne fut stipulée en faveur de la compagnie.

4. Que d'après le droit international, une simple formalité de prise de possession ne suffit pas pour acquérir un domaine à la couronne. Il faut qu'elle soit suivie d'actes d'occupation réelle, pourqu'elle puisse être opposée à un possesseur subséquent qui s'est établi dans la pays. Or, la compagnie laissa les Français découvrir et occuper l'intérieur de l'Ouest Canadien et permit ensuite aux traiteurs d'y

ériger des forts. Ses droits, si jamais elle put en réclamer, se trouvent ainsi périmés. Les droits acquis avec l'assentiment tacite des prétendus propriétaires doivent être respectés. De plus les lois françaises devinrent en force au Nord-Ouest par la découverte et l'occupation des Français. (Clement on the Constitution 2nd vol. p. 54 note 4 cité par le juge Anglin dans les rapports des décisions de la Cour Suprême, vol. 54, p. 125.)

5. Que le pays appartenait à la France, qui par le traité de Paris le retrocéda à l'Angleterre.

6. Que la compagnie admit elle-même que sa charte était invalide ou du moins que ses droits étaient douteux, puis, qu'en 1690, elle la fit confirmer pour sept ans par le parlement impérial.

Il serait oiseux de poursuivre la série des arguments apportés au débat. Ce qu'il importe de retenir surtout, c'est qu'il ne s'agissait pas d'une simple querelle de mots ou de subtilités abstraites. Les arguments touchaient à la substance même des droits réclamés de part et d'autre. C'est assez dire que les deux contestants pouvaient prétendre de bonne foi que leur cause était la meilleure.

La seule manière d'amener les deux compagnies à une solution de ce grave problème, eut été le recours aux tribunaux ou à une législation spéciale du parlement impérial. Le premier remède, pour être suivi de quelqu'effet pratique, impliquait la suspension de toute hostilité et le *statu quo* pendant que le procès s'instruisait. Or, une cause de cette nature, par suite de l'éloignement des témoins, aurait entraîné une enquête longue et volumineuse. Il en eut été de même du parlement. Comment espérer que pendant ces années d'attente, les deux compagnies se seraient enlisées dans leur position respective et auraient attendu les bras croisés la décision d'outre-mer. Elles étaient trop pressées d'agir et de se rendre maîtresse *de facto*, de la position pour demeurer dans une béate quiétude, en attendant la décision, alors que le fait accompli eut rendu peut-être toute sanction légale, d'une application douteuse, illusoire ou impossible. *Silent leges inter arma*. Dans des conditions aussi extraordinaires au sein des prairies qui commençaient à peine à émerger de la barbarie, les lois, si respectables qu'elles fussent, devaient se mouler sur les traits des nations qui les habitaient pour avoir quelque prise dans le sol et être en harmonie avec la situation particulière du pays.

D'ailleurs, dès l'arrivée des premiers colons de Selkirk la compagnie du Nord-Ouest se crut menacée dans son commerce. L'arrivée du gouverneur McDonnell à la Rivière Rouge fut loin de dissiper ses craintes. Le 4 septembre 1811, le gouverneur fit lire la concession faite à son maître. On se demanda avec surprise si le gouverneur prétendait expulser de la colonie tous ceux qui n'auraient pas reçu leur titre de lord Selkirk.

Toutefois, la première année qui suivit l'arrivée des colons ne fut pas orageuse. La compagnie du Nord-Ouest avait pour bourgeois à la Rivière Rouge Alexander McDonnell, cousin et beau-frère du gouverneur. Ces liens de famille exercèrent un tempérament sur les rapports entre les deux compagnies et Alexander McDonnell fournit même des provisions aux colons. Cette trève fut de courte durée.

Simon McGillivray, l'âme dirigeante de la compagnie du Nord-Ouest, ne tarda pas à laisser échapper le cri du cœur et à laisser percer la pensée intime qui l'obsédait. Le 9 avril 1812, parlant du projet de colonisation de Selkirk, il écrivait ces paroles significatives: "Il faut le forcer à abandonner cette idée là." De son côté, Selkirk entendait bien faire respecter ses droits de propriétaire, avec toutes les conséquences qu'ils comportaient pour la compagnie rivale. C'est ainsi que le 18 juin 1812, il écrivait à Wm. Hillier, agent de la compagnie de la baie d'Hudson, d'avertir les chefs de la compagnie du Nord-Ouest que les terres lui appartiennent, qu'ils doivent les abandonner, qu'ils n'ont aucun droit de couper du bois de chauffage ou de construction, que le bois déjà coupé doit être saisi et les bâtisses détruites, qu'il leur est également défendu de pêcher et que leurs rêts doivent être saisis. Il terminait cette lettre par les paroles suivantes qui se passent de commentaires: "Faites respecter nos droits de propriétaire sans scrupule partout où vous avez la force physique suffisante pour atteindre cette fin." Bref, lord Selkirk réclamait le sol avec tout ce qu'il produit ou contient, comme les seigneurs du moyen âge, arbre, plante, gibier, pierre qui roule et onde qui coule. Cette provocation en détermina une autre dans le camp opposé. John Pritchard, qui était en charge du fort Gibraltar, aux fourches de la Rivière Rouge, se mit à acheter toutes les provisions qu'il put trouver, pendant l'hiver de 1813-1814. Le poste de Pembina, qui avait été abandonné, fut rétabli dans le but également de mettre la main sur les provisions. Pritchard couvrit sa démarche du prétexte que cette mesure de précaution s'imposait à cause de la guerre avec les États-Unis. A ses intimes, il dévoilait sa pensée et leur confessait que le but visé était la ruine de la colonie par la famine. Le 8 janvier 1814, le gouverneur lança une proclamation défendant d'emporter des provisions en dehors de la colonie, pendant un an, sous peine de faire arrêter tout délinquent et de confisquer ses effets. Cette mesure peut paraître arbitraire à première vue, mais si l'on considère que la guerre avec les États-Unis avait rendu l'approvisionnement de la colonie, difficile et incertain et que les colons étaient déjà dans le besoin, on devra admettre qu'elle était justifiable et même nécessaire. Le gouverneur ne s'en tint pas là.

Au mois de mars suivant, il fit armer un parti de quinze personnes par le shérif John Spencer et plaça à sa tête John Warren. Cette bande se rendit à la montagne Tortue où elle saisit les provisions entre les mains de J. Bte. Desmarais, qui y tenait un poste de la compagnie du Nord-Ouest. Au mois de juin, Poitras et Soucisse étaient arrêtés sur la Rivière Souris par Spencer, qui leur enlevait 200 sacs de pemmican. C'était une déclaration de guerre et elle allait se poursuivre désormais jusqu'à l'escarmouche des Sept Chênes. Les employés des deux compagnies s'entraînèrent aux exercises militaires, pour mieux assurer la victoire. La défaite de la flotte anglaise sur le lac Érié, rendait précaires les communications entre Montréal et les postes de la compagnie du Nord-Ouest, en sorte que cette dernière prétendait que ses réserves en provision étaient une mesure de sage prévoyance.

Le gouverneur ne rencontra pas grand enthousiasme chez ses partisans pour soutenir sa cause. Pour réchauffer leur zèle, il promit une pension aux blessés. Peter Fidler, bourgeois de la compagnie de la Baie d'Hudson, menaça de se servir du fouet contre les récalcitrants et de confisquer les gages de ceux qui refuseraient de prendre les armes.

Selkirk écrivit au gouverneur d'agir avec prudence et modération, lui défendant toute provocation inutile mais lui ordonnant de protéger les colons.

Au mois de juillet, le gouverneur adopta un règlement qui lui aliéna l'esprit des Métis et des chasseurs libres. Il défendit de chasser à cheval les buffles de la prairie, parce qu'il craignait que les troupeaux, dans leur fuite, se dirigent vers le pays des Sioux où il était très dangereux de s'aventurer. Il défendit également d'enlever l'écorce des arbres pour en couvrir les bâtisses. A cette époque, en effet, le bardeau était inconnu. On couvrait les habitations de chaume ou d'écorce.

Un jour Miles McDonnell fit arpenter le terrain à la Fourche Winnipeg) et tira une ligne au milieu du jardin du fort Gibraltar. La mesure était comble et allait déborder. Dans les débuts du conflit les Canadiens-Français ainsi que les Métis, qui servaient presque tous dans la compagnie du Nord-Ouest, furent surpris des prétentions des officiers de la compagnie rivale à la propriété absolue du sol. A ces esprits frustres, les questions complexes que soulevait le texte de la charte à l'encontre de leur occupation paisible et incontestée de certaines parties du pays depuis quarante ans au moins, paraissaient étranges, vexatoires et irritantes. Les termes méprisants et les qualificatifs injurieux que les chefs s'adressaient réciproquement n'étaient pas de nature à les rassurer. Bref, ils en conclurent facilement qu'on voulait les chasser du pays. Il n'est pas étonnant que dans ces circonstances la majorité d'entr'eux demeura fidèle à la compagnie du Nord-Ouest. Ce qui porta l'indignation au comble furent les restrictions imposées à la chasse du bison.

Malgré ces mécontentements, ces braves gens n'avaient pas l'humeur guerrière. Ils étaient lents à se décider, mais une fois la résolution prise, l'action suivait de près. Les anciens du pays ne s'emballaient pas facilement. Il fallait une forte poussée pour remuer leur nature plutôt indolente, mais du jour qu'ils étaient lancés, ce n'était pas commode de les retenir et encore moins de leur résister. La compagnie du Nord-Ouest qui avait leur sympathie ne réussit guère non plus à les enrégimenter. Ce ne fut qu'au mois de février 1815 qu'ils se décidèrent à prendre une part active à la lutte, lors que McLeod voulut les empêcher de chasser à cheval. Le 5 août 1814 la compagnie du Nord-Ouest se décida à agir. Alexander McDonnell écrivit à John McDonald (Bras Croche) beau-frère de Wm. McGillivray: "Nous allons faire tout ce que nous pouvons pour défendre nos droits. Plusieurs de nos gens ne seront satisfaits que lorsque la colonie sera complètement ruinée par tous les moyens possibles. Pour atteindre cette fin, allons y de tout cœur et avec toutes nos énergies." Ce fut le mot d'ordre qui fut adopté par les chefs à l'assemblée des facteurs au fort William. *Delenda est Carthago.* Quelques écrivains ont porté une grave accusation contre la compagnie du Nord-Ouest. Ils ont prétendu que cette compagnie avait voulu soulever les Sauvages et les armer contre la colonie. Il n'y a aucun doute que certains officiers de la compagnie du Nord-Ouest exprimèrent des intentions dans ce sens et échangèrent en passant quelques paroles imprudentes mais sans suite avec les Sauvages. Cependant, je crois que ces quelques velléïtés particulières, sans plan préconçu ne sauraient constituer des motifs suffisants pour accuser tout un corps.

Nous avons à ce sujet l'autorité de W.-B. Coltman, commissaire spécial, qui fit une enquête sur les lieux en 1817. Or Coltman dans son rapport n'hésite pas à dire qu'il ne considère pas que la preuve ait établi une conspiration ou un plan pour inciter les Sauvages à prendre les armes.

Mais ce qui ne souffre pas de doute c'est le dessein bien arrêté et poursuivi avec constance de déraciner les colons et de les chasser du pays. La preuve à ce sujet est débordante. Pour parvenir plus facilement à leur but, les officiers de la compagnie du Nord-Ouest offraient aux colons de les transporter en Haut Canada, aux frais de la compagnie.

A cette époque cette compagnie pouvait faire de telles largesses sans s'obérer. Ses dividendes annuels s'élevaient à $2,000 par part. Les employés épousaient naturellement la cause de leurs bourgeois, dans l'espoir d'une promotion.

De là, l'esprit de corps qui décuplait leur force. Il faut bien l'avouer à cette époque on n'était pas toujours scrupuleux sur les moyens, sous le prétexte que dans l'Ouest, chacun n'avait d'autre alternative que de se rendre justice à lui-même. Tant pis pour les lois de la morale si elles cadraient mal avec l'intérêt personnel. La raison du plus fort était souvent considérée comme la meilleure. Aux époques troublées on est souvent porté à jeter la bride sur le cou des mauvaises passions et à étouffer la voix de la conscience. Malheureusement, il en fut quelquefois ainsi dans l'Ouest, durant ces luttes fièvreuses où les mauvais instincts surchauffés par la haine et l'intérêt prenaient vite le dessus sur le sentiment de la justice.

Et puis comment régler les difficultés qui surgissaient à chaque pas? Les juges de Paix étaient presque tous inféodés à un camp ou à l'autre et bien entendu, n'offraient aucune garantie d'impartialité. De part et d'autres on s'adressa aux magistrats de sa compagnie et on se battit à coups de mandats d'arrestation.

La compagnie du Nord-Ouest déclara en toute franchise par la bouche d'un de ses officiers, le bourgeois James Hughes, qu'elle ne chercherait pas le redressement de ses griefs devant les tribunaux, mais qu'elle allait elle-même se faire justice; c'est à dire quelle était bien déterminée à suivre sa rivale dans la lutte à main armée. Pour mettre ce programme à exécution, elle plaça à la tête du département de la Rivière Rouge, O. Cameron, officier d'expérience très énergique et agressif.

Il fit arrêter John Spencer. En même temps il voulut gagner le concours des Métis, en leur répétant que les colons voulaient les chasser et s'emparer de leurs terres. Malgré ces appels, les Métis continuèrent à demeurer paisibles en dépit des avanies que leur suscitait leur neutralité.

Un jour, un nommé Plante qui avait rendu quelques services au gouverneur fut vivement réprimandé et le bourgeois de la compagnie du Nord-Ouest lui ordonna de faire le voyage entre Montréal et la Rivière Rouge. A cette époque, cette corvée pleine de périls et de fatigue était considérée comme une punition.

Le 21 octobre 1814, McDonnell donna avis à Cameron et à ses associés d'abandonner le fort Gibraltar ainsi que tous les autres occupés par cette compagnie, dans un délai de six mois. Cameron se moqua de ces menaces et se prépara à lui résister, prétendant que sa compagnie avait succédé aux droits des premiers découvreurs du pays, LaVerendrye, LeGardeur de Saint-Pierre et La Corne de Saint-Luc et que comme sujet britannique, il ne pouvait être dépossédé sans une décision des tribunaux ou un ordre du gouvernement impérial.

Au mois de février 1815 le gouverneur envoya John McLeod à la Rivière Tortue pour faire exécuter la défense de chasser à cheval. Les Métis poussés à bout et craignant que McLeod ne s'emparât de leurs chevaux et de leurs provisions, s'insurgèrent et arrêtèrent McLeod. Des mandats d'arrestation furent émanés contre quelques Métis. Dès lors, ces derniers exaspérés firent cause commune avec la compagnie du Nord-Ouest.

Il y avait à cette époque environ 70 Métis en état de porter les armes et 20 à 30 hommes libres, c'est à dire qui chassaient ou traitaient à leur propre compte, tous d'origine française. Ces gens vendaient des fourrures ou des provisions aux deux compagnies. Coltman prétend qu'un quart de la population métisse était au service de la compagnie du Nord-Ouest et que le reste faisait la chasse.

Il convient de dire ici un mot des droits des Aborigènes et des Métis à la propriété du sol qu'ils occupaient.

De tout temps, le droit d'occupation des sauvages a été reconnu par les races civilisées. De temps immémorial ces races primitives erraient en liberté, dans ces immenses solitudes, où chaque tribu s'était assignée, en propre, un territoire de chasse. Sans doute les frontières étaient mal définies et souvent des conflits sanglants avaient lieu au sujet de prétendus empiètements sur le territoire du voisin.

Le territoire d'Assiniboia fut occupé tout d'abord par les Cris et les Assiniboines. Ces derniers s'étaient détachés vers 1795 de leurs frères les Sioux pour s'unir aux Cris. Les Sauteux n'arrivèrent à la Rivière Rouge que vers 1790 et ne pénétrèrent dans le pays qu'avec l'assentiment des Cris et des Assiniboines qui les avaient dévancés.

Les Métis comme descendants du côté maternel de ces tribus pouvaient donc eux aussi réclamer le titre de propriétaires du sol.

Après le départ des Français de l'ouest en 1755, il n'y a aucun doute qu'il resta au pays quelques rares individus qui s'attachèrent pour toujours à la vie des prairies et des bois et se firent chasseurs comme les sauvages avec lesquels ils s'allièrent.

Lorsque les traiteurs, après le traité de Paris, visitèrent de nouveau notre pays, ils trouvèrent à la Rivière Rouge des Métis français, chefs de tribu qui exigèrent une contribution comme reconnaissance de leur droit de suzeraineté dans le pays. Tels furent les premiers traités avec les propriétaires primitifs du sol. Ce fut avec le consentement tacite ou exprès des sauvages que les officiers de la compagnie du Nord-Ouest s'établirent dans le pays. Dans une brochure publiée par la compagnie du Nord-Ouest en 1817 intitulée "Récit des évènements qui ont eu lieu sur le territoire des sauvages depuis les liaisons du Très Hon. Comte de Selkirk avec la cie. de la Baie d'Hudson" on trouve à la page 133, la note suivante: "Lorsque les négotiants pénétrèrent pour la première fois dans ce pays, après la conquête du Canada, ils le trouvèrent tout couvert de Métis ou Brulés. Quelques uns d'entr'eux étaient alors les principaux chefs de différentes tribus de sauvages dans les plaines et portaient les noms de leurs péres." Cette expression "toute couverte de Métis" est une hyperbole, mais doit s'entendre d'un certain nombre.

A une réunion des Sauvages, tenue à la Fourche (Winnipeg) le 19 juin 1814, les Grandes Oreilles, premier chef des Sauteux, portant la parole au nom des siens disait: "Quels sont donc ces jardiniers (les colons) ? Quel motif les a fait venir ici ? Qui leur a donné nos terres ?" (Idem, p. 39 de l'appendice). Métis et Sauvages se considéraient donc propriétaires du sol. C'était cet ordre de choses que la compagnie de la Baie d'Hudson venait troubler, sinon renverser à sa base.

Sans doute, en 1817, lord Selkirk prit soin de régulariser ses titres, par un traité avec les Cris et les Sauteux mais en 1815 rien de tel n'avait été fait.

Les Métis s'adressèrent au mois de juin 1815 au gouverneur général du Canada à ce sujet. Ils demandaient la reconnaissance de propriétaires pour eux et leurs descendants sinon, ils annonçaient qu'ils avaient l'intention de se réfugier sur le Missouri pour traiter avec les Américains.

Une fois les Métis ralliés à la compagnie du Nord-Ouest, les évènements ne tardèrent pas à se précipiter.

Au mois de juin 1815 Laughlin McLean se rendit dans la colonie avec un groupe de Métis et forma un camp à la Grenouillère. Ils s'emparèrent des colons et de leurs biens et les amenèrent au camp. Les colons abattus et découragés se décidèrent à quitter le pays. Ce parti pour prévenir leur retour mit le feu au moulin à farine et détruisit 18 maisons qui constituaient ce qu'on appelait le fort.

C'était la ruine de la colonie. Le 21 juin, le gouverneur était fait prisonnier et envoyé avec les 130 ou 140 personnes qui constituaient la colonie, à la Rivière Nelson, pour de là, se rendre à la Baie d'Hudson et retourner en Angleterre.

Pendant que se déroulaient ces événements, Colin Robertson, ancien officier de la compagnie du Nord-Ouest, qui avait changé d'állégéance, partait de Montréal au printemps de 1815 avec vingt commis. Il devait se rendre d'abord à la Rivière Rouge et retourner en Angleterre par la Baie d'Hudson.

En route, il apprit la dispersion des colons et l'arrestation du gouverneur. Il atteignit bientôt la Rivière Rouge et se hâta de se rendre à la Rivière aux Brochets (Norway House) pour y laisser les commis que devait utiliser le gouverneur Thomas, en charge du département du Nord. Il ramena avec lui une partie des colons et retourna à la Rivière Rouge. En arrivant, il s'empara de quelques canons, fit Cameron prisonnier mais le laissa libre sur parole. Il s'efforça également de relever le prestige de la compagnie de la Baie de Hudson et de rallier à sa cause les Métis et les hommes libres.

Le 19 mai 1815, cette dernière compagnie avait nommé comme successeur à Miles McDonnell, un homme d'une grande distinction dans la personne de Robert Semple. Il arriva dans la colonie le 3 novembre de la même année, accompagné d'Alexander McDonnell comme shérif d'Assiniboia et de James Sutherland comme proposé à la garde des entrepôts de la compagnie. Il était suivi également de 160 colons, presque tous recrutés en Écosse. Semple était un esprit cultivé et un homme de talent mais qui ne soupçonnait même pas que les droits de lord Selkirk fussent au moins discutables. Il approuva la conduite de Robertson, mais crut qu'il aurait dû garder Cameron sous arrêt. Il avait peu de confiance dans ses promesses de respecter à l'avenir les colons et de garder la paix. Au mois de décembre suivant, Semple partit pour un voyage d'inspection, afin de se rendre compte par lui-même de la situation et de l'état des différents postes de la compagnie.

Il demeura absent trois mois. Durant cet interrègne Robertson le remplaça. Robertson apprit par divers courriers, que les Cris et les Assiniboines du fort des Prairies, allaient s'assembler au printemps pour fondre sur la colonie. Il s'en ouvrit à Cameron qui leur dit n'en rien connaître. Ce dernier suggéra d'aller lui-même à Qu'Appelle pour voir Alexander McDonnell, lui faire partager ses intentions pacifiques et détourner l'orage qui se préparait. Robertson y consentit.

Cameron partit donc pour ce poste.

Pendant son absence, Robertson put se rendre compte des dispositions des Métis. Pour prévenir l'attaque qu'il prévoyait au printemps, il s'empara du fort Gibraltar dans une attaque de nuit le 17 mars 1816. Il se prépara à attendre la flotte de la compagnie rivale qui devait descendre la rivière Assiniboine à l'été, et la couler à fond.

Il fit main basse également sur le courrier de la compagnie du Nord-Ouest et put ainsi se rendre compte de ses plans. Cameron fut bientôt de retour, revêtu de l'uniforme de capitaine pour les pays

Indiens. Robertson le fit prisonnier et le 19 mars, il se rendit maître du poste de Pembina. Le 30 mars 1816, lord Selkirk écrivait à Robertson "qu'il fallait expulser la compagnie rivale de ses domaines. Il faudra sans doute, ajoutait-il, avoir recours à la force pour y parvenir mais n'oubliez pas de n'adopter que des moyens légaux. Que le gouverneur émane les mandats voulus, afin qu'on ne puisse nous reprocher d'agir illégalement."

Afin de se débarasser du chef, Cameron fut envoyé le 18 mai à la factorerie de York avec les paquets de fourrure saisis au fort Gibraltar.

Semple envoya P. C. Pambrun à Qu'Appelle avec 22 hommes pour s'emparer du poste de la compagnie du Nord-Ouest. Cette dernière l'attendait de pied ferme et le fit prisonnier. Elle alla ensuite piller le poste de Brandon. Enfin le 10 juin, le fort Gilbraltar était démoli et une partie de la charpente mise en radeau, était descendue au fort Douglas. Ce qui restait fut incendié.

De part et d'autre on se portait à des mesures de violence et les colons qui voyaient venir l'orage, mettaient en cache les objets de valeur.

Semple, plus modéré que Robertson, ne s'entendait pas toujours avec lui. Tout en approuvant publiquement ce qu'il avait fait pendant son absence, il se plaignait privément de sa trop grande rigueur.

Robertson aurait préféré rester dans la colonie et offrit ses services à Semple, qui lui conseilla de suivre les instructions qu'il avait reçues à son départ et de retourner en Angleterre. Robertson prit donc la route de la Baie d'Hudson. C'est ici que commencent à se dérouler les évènements qui dans quelques jours, vont se terminer par la sanglante tragédie des Sept Chênes.

Le 17 juin, Semple fut averti de se tenir sur ses gardes. Un Métis, du nom de Moustouche Boutino, vint lui dire qu'Alexander McDonnell, avec un parti de Métis, venaient d'atteindre Portage la Prairie et se présenteraient devant le fort Douglas dans deux jours pour l'attaquer. Il ajouta que le capitaine Bourassa avait donné instruction à ses hommes de tirer sur les colons, au cas où ces derniers commenceraient les hostilités. Louis Nolin, interprête, informa le gouverneur que d'après les renseignements qu'il avait reçus, les Métis se proposaient de s'emparer de son fort. Le même jour, deux chefs Sauteux accompagnés de dix guerriers offrirent leurs services au gouverneur au cas où il serait attaqué. Semple les remercia mais répondit qu'il ne croyait pas que la compagnie du Nord-Ouest eut formé un tel dessein.

Il leur enjoignit de ne pas s'immiscer dans les démélés entre les deux compagnies, mais de rester en paix. Le lendemain, les Sauvages le pressèrent de nouveau, mais en vain, de leur permettre de combattre à ses côtés.

Toutefois le 18 juin, il fit avertir les colons de se réfugier au fort, tous les soirs, pour éviter une surprise. Alexander McDonnell se trouvait en effet au Portage la Prairie à la tête d'un parti d'environ 120 hommes dont les trois quarts étaient Métis. De cet endroit, il expédia un détachement de 60 à 70 hommes pour escorter deux charettes contenant 20 sacs de pemmican. Il plaça à leur tête Cuthbert Grant et les capitaines Michel Bourassa et Antoine Houle. Ce parti comprenait quatre sauvages et six Canadiens-Français; le reste se composait de Métis. Alex. McDonnell leur donna instruction de passer à travers la prairie, avant d'atteindre le fort Douglas, de manière à éviter le fort, de ne pas provoquer d'attaque et de ne pas alarmer les colons. Après avoir ainsi contourné le fort, ils devaient se diriger vers la Rivière Rouge et y attendre les canots, qui devaient arriver vers cette date de Montréal. Les charges de pemmican étaient destinées aux canotiers de la brigade de Montréal. En cas d'attaque, toutefois, ce parti avait l'ordre de se défendre. Il n'y a aucun doute que la bande de Grant ne désirait nullement faire le coup de feu. Leur intérêt leur commandait de ne pas brusquer un engagement qui aurait pu entraîner leur ruine.

La brigade de Montréal ignorait la prise du fort Gibraltar et la lutte à mort déjà engagée entre les deux compagnies. Or, à moins d'être avertie, en passant en face du fort Douglas, elle aurait été arrêtée et toutes les marchandises destinées à la traite, contenues dans ces canots, auraient été confisquées. Il importait donc d'éviter une telle catastrophe qui eut paralysé la traite pendant une année. Il eut été absurde alors de la part de Grant de risquer dans une rencontre de compromettre l'avenir de sa compagnie.

Mais après la jonction avec les canots, Grant avait-il l'intention de prendre le fort Douglas ? C'est bien possible. Pambrun prétend que pendant qu'il était prisonnier à Qu'Appelle, Alex. McDonnell aurait déclaré qu'il voulait affamer la colonie et qu'il aurait même suggéré à un chef sauvage de l'aider à chasser les colons. Je crois qu'il convient de citer ici le rapport présenté par la compagnie du Nord-Ouest, dans l'ouvrage déjà cité, à la page 42. Naturellement cette version a besoin d'être contrôlée par d'autres témoignagess et constitue le plaidoyer *pro domo* de cette compagnie.

"Pendant ce temps là, le gouverneur Semple et son coadjuteur (Robertson) se brouillèrent, on ne sait trop pourquoi. Le premier, mortifié du contre-temps qu'il avait éprouvé dans sa tentative sur le poste d'Alexander Macdonnell, jugea convenable de couper la communication entre ce poste et le lac Winnipeg, à travers lequel passent les canots venant d'Athabasca et d'autres parties éloignées qui s'approvisionnent aux dépôts de la Rivière Rouge. Les postes plus bas étaient déjà détruits et si ces canots ne pouvaient pas tirer de provisions au fort Qu'Appelle, environ 500 hommes se trouveraient exposés à la merci de M. Semple. Une chaloupe cannonière, commandée par un lieutenant Holt, fut stationnée sur le lac et des batteries furent élevées sur les bords de la rivière, afin d'obtenir ce brillant résultat. Les Canadiens prirent, de leur côté, tous les moyens propres à déjouer le projet de rapine et de famine ourdi contr'eux. Ils dépêchèrent des exprès audevant des canots qui allaient descendre, afin de les prémunir contre le danger; et désirant néanmoins empêcher toute contestation actuelle entre leurs canotiers et les gens du gouverneur Semple, ils essayèrent à l'époque où l'on attendait les canots d'ouvrir par terre une communication entre Qu'Appelle et le lac Ouinipic. On expédia à cet effet environ 50 Sauvages ou Brulés, avec un convoi de vivres. Ils reçurent l'ordre formel et il leur fut strictement enjoint de passer à une grande distance, derrière le fort Douglas (station de Semple) et la colonie, de ne molester personne et s'il était possible de passer sans être aperçus. Conformément à ces instructions, l'escorte s'avança, en longeant un marais qui ne lui permit pas de faire un plus long circuit, jusqu'à environ quatre milles du fort Douglas, dans l'intention de tourner et de se rapprocher ensuite, de la rivière, par le sentier ordinaire, à peu près à une même distance plus bas. Tandis que ces gens s'avançaient paisiblement, ils rencontrèrent un ou deux colons qu'ils retinrent, de peur qu'ils n'allassent donner l'éveil dans le fort; et avant d'arriver à la place choisie pour leur campement, un certain nombre de leur parti, qui les avait précédés, s'était également assuré des personnes de quelques pêcheurs, auxquels ils ne firent d'autre violence que celle de les empêcher d'aller éventer leur arrivée. Mr. Semple apercevant de l'endroit le plus élevé du fort, à l'aide d'un télescope, le circuit que venaient de faire les sauvages et jugeant vraisemblablement que si la communication était établie, ses projets allaient être déjoués, résolut, malheureusement pour lui, de se mettre à la poursuite du détachement, et sortit du fort à la tête de 28 hommes et de ses officiers avec tout l'appareil militaire. Les sauvages et les Brulés croyant n'être point aperçus et n'appréhendant par conséquent nul danger, étaient fort éparpillés. Vingt-quatre d'entre eux avaient, comme on l'a déjà dit, dévancé les autres. Les vingt-six restés en arrière, se voyant poursuivis par une forte armée, songèrent à rejoindre leurs camarades. Cependant ils envoyèrent au devant de cette troupe, un Canadien nommé Boucher, qui se trouvait parmi eux et parlait l'Anglais, afin de demander pour quelle raison, Mr. Semple était à leur poursuite. Après quelques pourparlers, Mr. Semple saisit brusquement la bride du cheval de Boucher, le désarma et ordonna qu'on le retint prisonnier. Celui-ci cherchant à s'évader, le gouverneur donna l'ordre de tirer sur lui et ses gens sentant le danger qu'ils courraient dans un pareil conflit témoignèrent de l'irrésolution; alors il les traita de lâches. Enfin quelques coups de fusil furent tirés; une balle effleura l'oreille de Boucher, une autre perça la couverte d'un sauvage qui s'avançait vers le gouverneur dans une attitude amicale et proférant des paroles de paix. Se voyant acceuilli aussi traitreusement le Sauvage ajusta son fusil et le déchargea. Ce fut pour son parti le signal du combat. M. Semple et vingt de ses gens y perdirent la vie et il y eut de l'autre côté deux individus de tués, savoir un Sauvage et un Brulé. Il est naturel que Lord Selkirk impute au parti opposé l'initiative dans ce déplorable évènement. Mais il va encore plus loin. Il lui plaît d'accuser la compagnie du Nord-Ouest d'avoir détaché cette force, non pour escorter les approvisionnements qui lui étaient confiés, mais bien pour attaquer le fort Douglas. Les faits parlent d'eux-mêmes et repoussent suffisamment l'assertion odieuse de sa seigneurie. Les sauvages avaient dépassé l'établissement; une partie était campée à environ dix milles plus bas que le fort. Elle se composait de 24 individus, qui ne vinrent point prendre part à l'action. L'engagement a eu lieu à une distance de quatre milles audessous du poste. Ajoutons les précautions prises pour éviter toute rencontre, le grand détour pratiqué à cet effet, et surtout cette circonstance non contestée par la partie adverse, que les gens du gouverneur sortirent du fort, se mirent à la poursuite des sauvages et firent feu sur eux, les premiers. Les sauvages et les Brulés étaient tous à cheval. Mettant pied à terre, au premier feu, ils s'abritèrent derrière leurs chevaux et ils mirèrent leurs antagonistes pardessus le dos de leurs animaux; ce qui leur donna sur ceux-ci un immense avantage et explique en même temps l'extrême disproportion du nombre de tués dans l'un et l'autre parti. Joignons y l'habitude où sont les sauvages, lorsque la fortune se décide pour eux de se précipiter et de s'acharner sur leurs adversaires; excès auxquels ils se livrèrent alors d'autant plus volontiers qu'ils avaient été injustement provoqués. C'est par suite de cet abus de la victoire que fut sacrifié le gouverneur Semple. Cependant un Brulé, nommé Grant qui paraît avoir agi comme chef du parti, fit tout ce qu'il put pour le sauver. Il l'avait relevé blessé de dessus le champ de bataille et il le tenait entre ses bras, conjurant ses camarades de s'en tenir là, lorsqu'un sauvage Sauteux lui brûla la cervelle, en s'écriant: 'C'est toi, chien que tu es, qui a été la cause de tout cela et tu ne vivras plus.' "

Consultons maintenant des témoins de l'autre camp ou neutres. Pierre Soucisse atteste que Cuthbert Grant, Michel Bourassa et Antoine Houle, en partant de Qu'Appelle, annoncèrent qu'ils se proposaient de reprendre leur fort (Gibraltar) à la Fourche, mais qu'ayant appris subséquemment sa destruction, ils résolurent de s'emparer du fort Douglas; puis qu'ils voulaient tout d'abord mettre leurs provisions en sûreté et ensuite affamer le fort en lui coupant toute communication et le forçant ainsi de se rendre par la famine. Ce témoignage est d'une grande valeur car Soucisse était un homme très honorable.

Alexandre Sutherland leur prête un autre dessein. Ils devaient, dit-il, placer une batterie sur la rive est de la Rivière Rouge, vis à vis le fort Douglas, tirer sur ceux qui sortiraient du fort et lancer des matières enflammables sur le toit des maisons.

Quoiqu'il en soit de ces conjectures, le 19 juin à 5 heures de l'après-midi Grant et son détachement apparaissaient dans la prairie à l'ouest du fort Douglas. La sentinelle les signala. Ils étaient alors vis à vis le fort mais au nord-ouest du chemin. Du fort on ne pouvait les apercevoir que lorsqu'ils traversaient une hauteur. Quelqu'un monta sur le toit de l'écurie du fort avec une longue vue pour mieux les observer. Il reconnut qu'ils étaient à cheval et qu'ils se dirigeaient vers le bas de la Rivière Rouge. Semple mis au courant de la situation dit aussitôt: "Il faut aller les rencontrer, que vingt hommes me suivent." Plusieurs insistèrent pour l'accompagner. Il refusa disant qu'il ne voulait que s'assurer de leur intention et protéger les colons qui travaillaient sur leur ferme.

Alexandre McBeath, un vieux soldat du 73e régiment, se trouvait en ce moment dans le voisinage du fort. Il rencontra trois colons, James Sutherland, Wm. Sutherland et McBeath, qui se rendaient au fort pour y chercher protection. Il dit que trois cavaliers de la bande de Grant lui demandèrent quelques renseignements sur le chemin à suivre. Bientôt il aperçut Semple avec 20 ou 30 hommes. Il lui dit que les gens de la compagnie du Nord-Ouest étaient fort nombreux et qu'il ferait bien de prendre avec lui deux canons et de se tenir adossé à la rivière pour éviter d'être cerné. Il lui offrit d'aller chercher les canons mais Semple répliqua que la chose n'était pas nécessaire, qu'il ne voulait que leur parler. McBeath continua sa route vers le fort, lorsque Bourke le rejoignit, lui criant en passant que le gouverneur lui avait ordonné d'aller chercher un des gros canons, en cas de besoin.

John Pritchard qui était avec Semple atteste qu'ils attendirent quelque temps après le canon, mais que Semple décida ensuite d'avancer quand même en suivant le chemin. Ils ne tardèrent pas à se trouver en face des Métis dont la figure était tatouée à la manière des sauvages. Ils portaient également des plumes sur la tête. Semple ordonna aussitôt de retraiter en étendant sa ligne. Les Métis avancèrent au petit trot et les enveloppèrent en forme de demi-lune. Aussitôt un Canadien du nom de Boucher s'avança vers eux à cheval en agitant une main et leur criant: "Que voulez-vous? Semple lui répondit par les mêmes paroles: "Que voulez-vous? Boucher répondit: "Nous voulons notre fort." Semple lui répliqua: "Allez à votre fort." Pritchard dit qu'il n'entendit pas le reste de la conversation, mais qu'il vit Semple saisir le fusil de Boucher et qu'aussitot il entendit des détonations de fusil des deux côtés. Il ne saurait dire de quel côté commença la fusillade. En quelques instants Semple et ses suivants tombaient tués ou blessés. Le capitaine Rodgers, qui était tombé, se leva. Pritchard lui conseilla de se rendre. Il s'avança vers l'ennemi, levant les mains en l'air et criant en anglais et en français "Mercy-Quartier." Un nommé Thomas McKay lui tira une balle dans la tête, tandis qu'un autre l'éventra avec un couteau. Quant à lui, Pritchard, un Canadien du nom de Lavigne réussit à lui sauver la vie. Morin dit Perreault et Mageau l'amenèrent prisonnier au camp de Grant. Ce dernier lui dit qu'il avait lui-même blessé Semple et qu'il était tombé avec l'os de la cuisse brisé, que Semple lui avait demandé s'il était Grant et que, sur sa réponse affirmative, Semple lui dit: "Je ne suis pas mortellement blessé, si vous pouviez me faire transporter au fort, je crois que je pourrais vivre," qu'il lui promit de le faire et le confia aux soins d'un Canadien, mais qu'un sauvage s'approcha de lui et lui déchargea son fusil en pleine poitrine et le tua sur le champ. Grant dans son témoignage confirme ces derniers faits et ajoute que ce sauvage se nommait Machicabaou.

Michel Haydon ajoute quelques détails au récit qui précède. Lorsque Semple dit à Boucher "allez à votre fort," Boucher lui aurait répondu: "Pourquoi avez vous détruit notre fort, s . . . canaille." Là-dessus Semple saisit la bride de son cheval et lui dit: "Misérable que tu es de me parler ainsi" et ordonna à ses hommes de le faire prisonnier, mais que Boucher s'échappa aussitôt en fouettant son cheval. Il prétend qu'un coup de feu partit des rangs de la compagnie du Nord-Ouest et tua Holt. Sur ce point, il est contredit par tous les témoins. Haydon dit également que Semple fut blessé à la deuxième décharge et dit à son entourage: "Faites ce que vous pouvez pour vous sauver," mais que ses suivants, au lieu de se sauver, l'entourèrent pour connaître la gravité de sa blessure et qu'à ce moment, une autre décharge les tua presque tous, que les survivants agitèrent leurs chapeaux et demandèrent quartier, mais qu'ils furent presque tous tués à coups de fusil ou de couteau, qu'il réussit à atteindre le fort, mais que le Dr. White, poursuivi par six Métis, fut tué à ses côtés, qu'enfin les seuls qui échappèrent au massacre furent Michael Kilkenny, George Sutherland, Donald McKay, John Pritchard, Anthony McDonnell et lui-même.

John Bourke qui avait reçu l'ordre d'aller chercher un des canons (3 pound field piece) partit du fort avec Hugh McLean. Ils avaient à peine parcouru un demi-mille, qu'ils entendirent le bruit de la fusillade et virent que Semple était cerné. Ils rebroussèrent chemin afin d'empêcher le canon de tomber entre les mains des ennemis, puis ils se rendirent au lieu du combat.

L'un des Métis lui cria "Avance! Avance! ton gouverneur est ici, viens le voir et prendre ses ordres." Il s'avança mais aussitôt il lui cria de rendre ses armes. Il s'enfuit avec John McNaughton qui fut tué, tandis que lui même était blessé.

Arrivé près du fort, il aperçut McLean et Farquarhson qui, pour la seconde fois, amenaient le canon pour secourir Semple. Bourke leur fit rebrousser chemin, leur annonça que tout était fini et qu'il ne leur restait plus qu'à se sauver au fort.

D'après Louis Nolin, lorsque les Métis arrivèrent à la Grenouillière, ils firent prisonniers trois colons: Wm. Bannerman, Alexandre Murray et Alexandre Sutherland et leur dirent qu'ils ne voulaient pas molester les colons mais s'emparer des officiers et qu'ils étaient surtout irrités contre Colin Robertson. Deux autres témoignages non moins importants sont ceux de Joseph Pelletier dit Assiniboine et J. Bte. Marsellais qui étaient présents à l'engagement et qui depuis avaient pris du service dans la compagnie de la Baie d'Hudson. Tous deux affirment que le premier coup de feu partit du camp de Semple, que la balle effleura la joue de Boucher, qu'un deuxième coup fut tiré également par les suivants de Semple sur un Sauvage qui reçut la balle dans sa couverte, que ce fut alors que le combat devint général. Pelletier prétend avoir entendu Grant dire à Boucher, en l'envoyant comme parlementaire, de sommer Semple et les siens de se rendre sinon qu'ils allaient tirer sur eux et que telles étaient leurs instructions s'ils opposaient aucune résistance.

Antoine Houle parle dans le même sens et ajoute que Grant lui dit qu'il leur donnerait le signal quand il faudrait ouvrir le feu. Il y a ici confusion de la part de ces deux témoins. Boucher ne songea nullement à demander à Semple de se rendre. Grant crut que Semple venait pour l'attaquer et c'est pourquoi il se prépara à lui résister. Les instructions de Boucher étaient de s'assurer des intentions de Semple simplement. Aussi bien les premières paroles de Boucher précisent bien l'objet de son message: "Que voulez-vous." Rien d'étonnant que pendant que Boucher s'avançait, Grant ait harangué ses hommes et les ait invités à ne pas fléchir s'ils étaient attaqués.

Ce qui se passa d'ailleurs ne laisse pas de marges aux commentaires. *Res ipsa loquitur.* Grant donne une autre version au sujet du premier coup de feu. Il prétend qu'un Sauvage s'était avancé en toute confiance vers le parti de Semple, mais que John Moor lui fit signe de s'arrêter, que le Sauvage ne comprit pas la signification de ce signe ou ne le remarqua pas et continua à s'avancer et que John Moor tira dessus. Il n'y a aucun doute que le premier coup de feu partit du côté de Semple, par accident ou par erreur, probablement. Ce fait est incontestable et le rapport de Coltman ne laisse pas le moindre doute sur ce point. A cet engagement, il n'y avait que trois Sauvages de présents. Le premier se sauva dès la première décharge. Le second Machicabaou se cacha dans un trou en entendant la première détonation et il n'en sortit qu'après le combat. Le troisième est celui qui reçut la première balle dans sa couverte.

Écoutons maintenant Charles Bellegarde qui va nous donner d'autres détails. Il fut l'un des derniers à avertir le gouverneur d'être sur ses gardes, puisqu'il le vit moins d'une heure avant le signalement du parti de Grant. "Gouverneur," lui dit-il, "n'avez-vous pas peur? On dit que les Métis viennent pour nous faire prisonniers." Le gouverneur répondit qu'il ne craignait rien, qu'il avait un document à leur lire et qu'après cela, ils pourraient le tuer, s'ils le voulaient. Bellegarde dit que la rumeur s'était accréditée, que les Métis voulaient cerner le fort pour le forcer à se rendre et ensuite chasser les colons du pays. Il vit une quinzaine de Métis descendre de cheval et arrêter quelques colons pour les forcer à retourner au fort, afin d'épuiser plutôt les provisions de bouche, mais qu'aussitôt trente Métis arrivèrent en toute hâte, criant: "Voyez les Anglais qui nous poursuivent." Les Métis dirent à Bellegarde qu'ils avaient instruction de ne pas attaquer. Bellegarde rencontra Grant et lui fit part du dessein de Semple de lui lire un document et de faire une entente avec eux. A ce moment, le groupe qui avait arrêté les trois colons fit mander à Grant ce qu'ils devaient en faire. Dans le même temps, quelques Métis à cheval vinrent avertir Grant que les charrettes chargées de provisions, qui se trouvaient en arrière, étaient poursuivies par les Anglais. Grant se dirigea aussitôt vers cet endroit, entraînant avec lui une partie de ses hommes, afin de protéger les provisions. D'après Boucher lorsque les premiers coups de feu furent échangés, il n'y avait pas plus de 30 personnes présentes, mais qu'à la fin de l'engagement, ce chiffre s'était grossi d'une vingtaine de Métis, accourus au secours de leurs camarades. D'après ces témoignages, on doit en conclure que ni les uns ni les autres n'avaient prémédité cet engagement. Semple ne se proposait que de parler à cette troupe, s'entendre avec leurs chefs et de ne pas les molester, s'ils n'attaquaient pas les colons. Il en était de même des Métis qui évitèrent soigneusement toute provocation et ne firent que se défendre une fois attaqués. Le premier coup de feu fut tiré par Moor ou Holt. Il importe peu par lequel des deux, vu qu'ils faisaient partie de la troupe de Semple.

Pour tout résumer en quelques mots, cet engagement fortuit fut occasionné par le fait que les Métis crurent que les Anglais voulaient s'emparer des charettes de provisions, et qu'un coup de fusil tiré accidentellement par l'un des hommes de Semple, au moment où leur parlementaire était au milieu d'eux, fut considéré comme une déclaration de guerre. de leur part. Quelques témoins ont déclaré que Semple donna l'ordre de tirer. Ce fait est contredit. D'après la preuve, cette accusation n'est nullement fondée.

Il est hors de doute que la compagnie de la Baie d'Hudson voulait garder le fort Gibraltar, parce qu'elle prétendait être propriétaire du pays. La compagnie du Nord-Ouest n'entendait pas se laisser dépouiller de la sorte et se proposait probablement, soit dans cette circonstance ou une autre, de s'emparer du fort Douglas et chasser les colons inféodés à sa rivale. Les esprits étaient échauffés.

On prétendait que si Robertson tombait entre les mains de ses ennemis il serait scalpé. Dans le camp de la compagnie de la baie d'Hudson, on entendait répéter qu'il fallait tenir la chaudière prête pour faire bouillir le sang des Métis. Évidemment ces exagérations de langage, échappées à la colère du moment, n'exprimaient pas les sentiments véritables ni des uns ni des autres mais nous donnent une idée des frictions profondes qui s'étaient produites entre les deux compagnies.

Semple était un brave homme, mais sans connaissance de l'art militaire. Il crut qu'il était de son devoir de se porter au secours des colons. Irrité par les paroles cavalières de Boucher, il saisit la bride de son cheval, en même temps qu'un coup de feu partait de son camp. Cet incident fut la mèche qui détermina l'explosion. C'est l'opinion de Coltman et les témoignages justifient cette conclusion.

Les Métis ne perdirent qu'un homme du nom de Batoche et un blessé du nom de Trottier. Ce dernier eut la jambe brisée. Leurs adversaires eurent 20 tués et un blessé. Quelques auteurs comptent 21 tués. Je crois que cette erreur provient du fait qu'ils incluent dans ce chiffre un colon qui se noya accidentellement la veille.

Un Sauvage du nom de Fils Kenis, qui le lendemain se trouvait sur le théatre de ce combat, dit qu'il y vit 20 cadavres. Alexander McBeath, qui aida à leur donner la sépulture, mentionne le même chiffre. Si on se demande pourquoi cette disproportion si extraordinaire entre les morts dans les deux camps, la réponse est toute trouvée. Les

Métis étaient des chasseurs habiles qui ne manquaient presque jamais de toucher juste.

Les soldats de Semple étaient bien loin de posséder la même adresse et commirent la faute de se tenir en peloton. De plus les Métis abrités derrière leurs chevaux n'étaient pas exposés comme leurs adversaires. Aussi bien l'engagement ne dura qu'un quart d'heure; après trois ou quatre décharges Semple et les siens avaient mordu la poussière.

On a prétendu que dans quelques cas des blessés furent achevés par des Sauvages. La preuve sur ce point est assez faible. Mais en admettant que quelques actes de cruauté, à part le cas de Semple, aient été commis par des Sauvages, avant que la fumée du combat ait été dissipée, alors que pendant l'enivrement de la victoire et la vue du sang répandu, les passions aveuglaient les combattants et leur faisaient perdre le contrôle de la raison, il ne faudrait pas oublier, comme explication (je ne dis pas comme excuse et encore moins justification) que ces représailles étaient malheureusement passées dans les habitudes des Sauvages.

Dans leurs guerres, les Sauvages ne donnaient pas de quartiers. Le seul moyen de se protéger contre les ennemis était de les affoler par la terreur et par le sort réservé aux blessés et aux prisonniers. Tel était le code moral de la guerre chez les aborigènes avant l'arrivée des missionnaires au milieu d'eux. On sait que ces derniers ne réussirent à adoucir ces caractères farouches et à déraciner ces instincts de cruauté, que par un travail patient et un dévouement inlassable.

On a accusé les Métis d'avoir abandonné les cadavres dans la prairie, sans leur donner une sépulture convenable. C'est une calomnie. Grant demanda aux colons de venir enterrer leurs morts. Le shérif Alexander McDonnell s'occupa de ce soin. Malheureusement quelques-uns des cadavres ne furent recouverts qu'imparfaitement. Des loups réussirent à déterrer quelques ossements et à les ronger. A la fin de juin, Séraphin Lamarre, informé de ce fait, envoya Antoine Pelletier et Marion Ducharme réparer ces omissions et faire cesser de si navrants spectacles.

Le lendemain de cet engagement, le fort Douglas se rendit sans coup férir et pour le moment la compagnie du Nord-Ouest demeura maîtresse de la Rivière Rouge.

Le 3 mai 1817 sir John C. Sherbrooke, gouverneur en chef de l'Amérique Britannique du Nord, lança une proclamation nommant W. B. Coltman et John Fletcher commissaires spéciaux pour s'enquérir des offenses commises dans les territoires des Sauvages avec pouvoir, comme magistrats, de faire exécuter les ordres du prince régent, de faire cesser toute hostilité et de traduire les coupables.

devant les tribunaux. Coltman se rendit à la Rivière Rouge durant l'été de 1817, mais son collègue n'alla pas plus loin que le fort William. Coltman était membre du conseil exécutif du Bas-Canada. Il fit restituer à chaque compagnie les forts et les biens qui leur appartenaient avant ces actes de violence, conformément à la proclamation royale déjà citée. Dans son rapport Coltman suggère que la colonie de la Rivière Rouge soit gouvernée directement par le gouvernement impérial et propose l'union des deux compagnies. Ce rapport très documenté fut consigné dans le journal de la Chambre des Communes en Angleterre, en 1819. C'est surtout grâce aux renseignements contenus dans ce long mémoire que j'ai pu reproduire, à traits rapides, l'engagement des Sept Chênes, ainsi que les événements antérieurs qui le préparèrent.

La Maréchaussée de Québec sous le Régime Français

Par M. PIERRE-GEORGES ROY, M.S.R.C.

(Lu à la séance de mai 1918)

Par son édit signé à Condé, en Hainaut, le 9 mai 1677, Louis XIV établissait un office de prévôt de la Maréchaussée en la Nouvelle-France.

L'édit de création nous dit quelles étaient les attributions de la Maréchaussée:

"Les soins que nous avons pris de créer des offices de judicature et de les remplir de personnes d'une probité reconnue, pour juger et terminer les différends de nos sujets du pays de la Nouvelle-France, et pour punir les crimes suivant les lois de notre royaume, ont produit un très grand avantage à nos dits sujets, et il ne reste plus, pour la perfection de cet ouvrage, que d'établir une jurisdiction pour la recherche et punition des crimes qui pourront être commis par des gens sans aveu et vagabonds, demandant une justice plus prompte, ce qui étant premièrement de la fonction des prévôts de nos cousins les maréchaux de France, nous avons estimé nécessaire d'en créer un à l'instar d'iceux établis en notre royaume, et de remplir cette charge d'une personne dont la capacité, l'expérience et la vigilance nous sont entièrement connues.

"A ces causes et autres à ce nous mouvant, de l'avis de notre conseil et de notre certaine science, pleine puissance et autorité royale, nous avons par le présent édit perpétuel et irrévocable, créé, érigé et institué, créons, érigeons et instituons un office de prévôt de nos cousins les maréchaux de France en notre pays de la Nouvelle-France. *Pour informer contre tous prévenus de crimes, décreter et iceux juger en dernier ressort. Assisté de nos officiers Royaux ou de personnes graduées en nombre porté par nos ordonnances, particulièrement connaître de tous vols, assassinats, de guets-à-pens, meurtres commis par personnes non domiciliées, et généralement de tous les crimes dont connaissent les dits prévôts, suivant et conformément à nos édits et ordonnances*, auquel office nous avons attribué cinq cents livres de gages par chacun an, dont le fonds sera fait dans l'état des charges de notre Domaine d'Occident, ensemble le pouvoir de pourvoir aux six offices d'archers que nous avons pareillement crées pour exécuter ses ordonnances et decrets, et lui prêter main forte quand besoin sera, et auxquels nous avons pareillement attribué à chacun soixante livres de gage, dont le fonds sera fait dans le dit état........"[1]

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[1] *Edits et Ordonnances*, vol. 1, p. 97.

PRÉVÔTS DE LA MARÉCHAUSSÉE DE QUÉBEC

Philippe Gaultier de comporté

Le premier prévôt de la Maréchaussée, Philippe Gaultier de Comporté, fut nommé le 9 mai 1677 par l'édit qui créait son office.[1] Il décéda à Québec le 21 novembre 1682. Sur Philippe Gaultier de Comporté on peut consulter le *Bulletin des Recherches Historiques*, vol. VII, p. 368, et Laure Conan, *Silhouettes Canadiennes*, p. 161.[2]

Paul Denis de Saint-Simon

Nommé par le Roi le 24 mai 1689.[3]

En 1714, Paul Denis de Saint-Simon donnait la démission de sa charge en faveur de son fils, Charles-Paul Denis de Saint-Simon. Pour une raison ou pour une autre, il voulut un peu plus tard retirer sa démission et reprendre son office, mais le Roi refusa de se prêter à ce marchandage.

En 1710, le 20 janvier, Paul Denis de Saint-Simon avait été nommé temporairement au Conseil Souverain, pour remplacer un conseiller absent. Le 12 mai 1714, le Roi retenait la première place vacante au Conseil pour M. de Saint-Simon et, en attendant, lui donnait séance au Conseil. Nommé le 1er avril 1717, pour remplacer Nicolas Dupont, il fut installé le 6 décembre 1717.

Paul Denis de Saint-Simon décéda à Québec le 14 octobre 1731.

Charles-Paul Denis de Saint-Simon

Nommé par le Roi le 12 mai 1714.[4]

Le 2 novembre 1740, le gouverneur de Beauharnois proposait au ministre de nommer M. de Saint-Simon au Conseil Supérieur pour remplacer M. Guillimin, décédé depuis deux ans. L'intendant Hocquart, qui avait son candidat, s'opposa au choix de M. de Saint-Simon et gagna son point.

M. de Saint-Simon décéda à Québec le 7 septembre 1748.

Charles-Denis Regnard Duplessis de Morampont

Nommé par le Roi le 1er mai 1749.[5]

Il fut le dernier prévôt de la Maréchaussée.

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[1] *Edits et Ordonnances*, vol. 1, p. 97.

[2] Nous possédons sur M. Gaultier de Compoi té de nombreux renseignements inédits que nous espérons publier avant longtemps.

[3] Insinuations du Conseil Supérieur, cahier 2.

[4] *Edits et Ordonnances*, vol. III., p. 92.

[5] *Edits et Ordonnances*, vol. III., p. 372.

M. Duplessis de Morampont passa en France sur la fin du régime français et ne revint pas au pays.

On peut consulter sur M. Duplessis de Morampont l'ouvrage de M. J.-Edmond Roy, *Lettres du Père Duplessis, de la Compagnie de Jésus*, p. VI (appendice).

GREFFIERS DE LA MARÉCHAUSSÉE DE QUÉBEC

René Hubert

Le premier greffier de la Maréchaussée de Québec fut René Hubert. Il fut nommé par commission de l'intendant Duchesneau le 22 septembre 1681. Le 20 avril 1700, le Roi donnait des lettres de provisions à Hubert.[1] En 1714, Hubert fut nommé greffier de la Prévôté de Québec. Il exerça les deux charges de greffier de la Prévôté et de la Maréchaussée jusqu'à sa mort arrivée à Québec le 31 août 1725.

Pierre Frontigny

Le 31 août 1725, l'intendant Bégon donnait une commission à Pierre Frontigny pour exercer la charge de greffier de la Maréchaussée en attendant le bon plaisir du Roi.[2] Le 23 avril 1726, le Roi lui donnait les provisions de cette charge.[3]

M. Frontigny décéda à Québec le 17 avril 1728.

Nicolas-Gabriel Aubin de L'Isle

Le 18 avril 1728, l'intendant Dupuy donnait une commission de greffier de la Maréchaussée à M. Aubin de l'Isle pour exercer en attendant le bon plaisir du Roi.[4] Ce ne fut que cinq ans plus tard, le 1er avril 1733, que le roi lui accorda des lettres de nomination.[5]

M. Aubin de l'Isle décéda à Québec le 8 février 1747.

Jean-Andre La Maletie

Nommé par le roi le 1er janvier 1748.[6]

En 1758, M. La Maletie, désireux de retourner en France, résignait sa charge de greffier.

Sur M. La Maletie, consulter notre *Famille Foucault*, p. 10.

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[1] Insinuations du Conseil Supérieur, cahier 2.

[2] Insinuations du Conseil Supérieur, cahier 6. Information de vie et mœurs aux Archives Judiciaires de Québec, pièce no 2056.

[3] Insinuations du Conseil Supérieur, cahier 6.

[4] Ordonnances des Intendants, cahier 12B. Information de vie et mœurs conservée aux Archives Judiciaires de Québec, pièce no 2061.

[5] Insinuations du Conseil Supérieur, cahier 7.

[6] Insinuations du Conseil Supérieur, cahier 9. Information de vie et mœurs, conservée aux Archives Judiciaires de Québec, pièce no 2119.

Jacques Perrault

Nommé par le roi le 1er mars 1758.[1] Il fut le dernier greffier de la Maréchaussée.

M. Perrault décéda à Québec le 18 mars 1775.

On trouvera des renseignements biographiques sur M. Perrault dans *La vie de Joseph-François Perrault* de M. P.-B. Casgrain, p.16.

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[1] Insinuations du Conseil Supérieur, cahier II. Publiée dans *Edits et Ordonnances*, vol. III., p. 117. Information de vie et mœurs conservée aux Archives Judiciaires de Québec, pièce no 2151.

Le Siège de l'Amirauté de Québec sous le Régime Français

Par M. PIERRE-GEORGES ROY, M.S.R.C.

(Lu à la séance de mai 1918)

L'Amiral de France, sous l'ancien régime, avait des pouvoirs très étendus. C'est lui qui était chargé de la police des ports et de la surveillance des sièges d'Amirauté.

L'Amiral de France percevait: 1° des droits pour la délivrance des congés aux capitaines de navires; 2° un droit de feux, tonnes et balises, établi dans douze ports seulement; 3° la moitié du produit des objets provenant des bris et naufrages; 4° le tiers des successions maritimes non réclamées; 5° le produit des amendes et des confiscations prononcées dans les sièges d'Amirauté. Le droit de feux, tonnes et balises suffisait à peu près à payer les dépenses faites par l'Amiral dans l'intérêt de la navigation. Dans bien des cas, les droits prélevés sur les naufrages et les successions maritimes étaient abandonnés aux intéressés. Les amendes, souvent, étaient aussi remises. Quant au droit de congé, il était fort modique.

Dans les sièges d'Amirauté, la justice civile et criminelle était rendue au nom de l'Amiral de France.

Quelles étaient les attributions des officiers des sièges d'Amirauté?

Elles étaient de deux sortes: les unes judiciaires, les autres administratives.

Comme officiers de justice, ils connaissaient de toutes les causes relatives aux contrats maritimes tels que les contrats d'association, les chartes parties, les affrétements, connaissements, polices d'assurances, obligations à la grosse aventure et autres semblables, passés, soit entre des négociants régnicoles, soit entre ceux-ci et des négociants étrangers. Ils connaissaient aussi des dissensions entre les armateurs, les capitaines de navires et les gens des équipages; des saisies de navires; des difficultés sur les réclamations des effets naufragés; en un mot, de toutes les questions qui naissent du commerce maritime. En temps de guerre, ils étaient de plus chargés de constater la validité des prises faites sur les ennemis, et c'est sur leurs procédures que le Conseil des prises rendait ses jugements.

Au point de vue administratif, les officiers d'Amirauté avaient la police des ports, quais et havres et celle de la pêche; ils surveillaient les maîtres des quais, lesteurs et délesteurs, interprètes, courtiers, jaugeurs et autres officiers qui leur étaient subordonnés. Ils s'employaient au sauvetage des navires et effets naufragés, à la conservation des épaves de mer, à celles des prises maritimes; veillaient à l'exécution des traités de commerce et de navigation, à l'observation des lois sur le fait de la contrebande par mer.[1]

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Dans la Nouvelle-France, les attributions des Sièges d'amirauté furent d'abord données à l'intendant. Plus tard, l'intendant, à cause de la multiplicité des affaires de sa charge, se déchargea sur la prévôté de Québec de la plupart des affaires qui avaient un caractère maritime.

En 1698, l'intendant Bochart Champigny obtenait du roi de France et du grand-amiral la nomination d'un juge d'amirauté à Québec.

Le 27 octobre 1698, l'intendant Bochart Champigny écrivait au ministre:

"Monseigneur l'amiral m'a fait envoyer cette année des commissions de juges pour les causes maritimes, mais elles n'étaient point accompagnées de provisions de Sa Majesté qui sont nécessaires suivant l'Ordonnance de 1681. Et je n'ai point reçu de vous aucun ordre sur ce sujet; si vous avez agréable, Monseigneur, d'en faire expédier, cet établissement se fera l'année prochaine; il a été fait choix pour juge du sieur Dupuy, dont la probité et la bonne conduite vous sont connues par les assurances que je vous en ay données, étant effectivement un des plus judicieux et des plus désintéressez officiers que nous ayons. La commission de procureur du Roi m'a été envoyée en blanc, celle de greffier a été remplie de Le Pailleur, homme sage et intelligent, et celle de receveur du sieur Duplessis, commis en ce pays de M. de Lubert. Il me paraît, Monseigneur, que ce sera un bien que cet établissement se fasse séparément de la prévôté, où il y a beaucoup d'affaires."[2]

Le 30 mai 1699, Louis XIV signait les lettres de provisions de M. Paul Dupuy de Lislois, comme juge de l'amirauté en la Nouvelle-France.[3]

Le même jour, 30 mai 1699, Michel Lepailleur était nommé par le Roi greffier de la nouvelle juridiction.[4]

Les lettres de provisions signées par le roi en faveur de MM. Dupuy et Lepailleur donnaient en mandement au Conseil Souverain de

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[1] J.-Edmond Roy, *Rapport sur les Archives de France relatives à l'histoire du Canada*, p. 238.

[2] Archives du Canada, Correspondance générale, vol. F., p. 141.

[3] Archives du Canada, Collection Moreau Saint-Méry, tome VI, 1er vol., folio 193.

[4] Archives du Canada, Collection Moreau Saint-Méry, tome VI, 1er vol., folio 193.

les mettre et instituer en possession et jouissance de leur office respectif. Ni M. Dupuy ni M. Lepailleur ne présentèrent leurs lettres de nomination au Conseil Souverain. Paul Dupuy de Lislois avait été nommé, le 1er juin 1695, lieutenant particulier de la prévôté de Québec. Il exerça cet office jusqu'en 1710. Nous sommes donc en droit de conclure qu'il n'accepta pas la charge de juge de l'amirauté créée pour lui le 30 mai 1699.

Le lieutenant-général de la prévôté de Québec continua à exercer pendant plus de dix-sept ans les fonctions de juge de l'amirauté de Québec.

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Le 12 janvier 1717, par lettres patentes du roi de France, un siège d'amirauté était établi à Québec.

Le préambule du règlement édicté le même jour par Louis XV donne la raison de l'établissement de ce tribunal:"........attendu qu'il n'y a point encore d'amirautés établies dans les colonies d'Amérique, ni des Indes Occidentales, ce qui donne occasion à toutes sortes de juges et de praticiens de s'attribuer la connaissance des affaires maritimes, sans aucune capacité ni connaissance des ordonnances, ce qui cause un préjudice considérable au commerce et à la situation de la navigation, que les rois prédécesseurs de Sa Majesté ont toujours regardés comme affaires très importantes, et qui ne pouvaient être bien administrées que par des ordonnances particulières, et par des juridictions établies exprès pour les faire observer......"

Le Siège de l'amirauté de Québec devait être composé d'un lieutenant-général, d'un procureur du Roi, d'un greffier et de un ou deux huissiers.

La nomination de ces officiers appartenait à l'amiral de France mais ils devaient obtenir une commission de Sa Majesté.

Le lieutenant-général de l'amirauté pouvait être choisi parmi les juges des juridictions ordinaires, mais il devait rendre la justice au nom de l'amiral. Le lieutenant-général de l'amirauté ne pouvait être en même temps conseiller au Conseil Supérieur.

Le lieutenant-général de l'amirauté et le procureur du roi devaient être reçus au Conseil Supérieur, où se portaient les appels des sentences de leur tribunal, mais le greffier et les huissiers étaient reçus par le lieutenant-général même.

Pour être lieutenant-général ou procureur du roi de l'amirauté il fallait être âgé de 25 ans. Il n'était pas nécessaire d'être gradué pour exercer les charges de lieutenant-général ou de procureur du roi de l'amirauté, mais il fallait "avoir une connaissance suffisante des ordonnances et des affaires maritimes."[1]

Le siège de l'Amirauté de Québec, établi le 12 janvier 1717, ne commença à fonctionner qu'à l'été de 1719. La première audience fut tenue le 19 août 1719. Ce tribunal exista jusqu'à la chute de Québec le 13 septembre 1759. Il avait donc vécu juste quarante ans.

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Que sont devenues les archives du siège de l'Amirauté de Québec ?

L'article 45 de la capitulation de Montréal disait:

"Les registres et autres papiers du Conseil Supérieur, de la prévôté et *Amirauté* de la même ville, ceux des juridictions royales des Trois-Rivières et de la ville de Montréal, ceux des juridictions seigneuriales de la colonie, les minutes des Actes des notaires des villes et des campagnes, et généralement les actes et autres papiers qui peuvent servir à justifier l'état et la fortune des citoyens, resteront dans la colonie, dans les greffes dont ces papiers dépendent."

Malgré cette clause pourtant très claire, les archives des amirautés de Québec et de Louisbourg furent transportées en France.

Le 8 mai 1761, le ministre écrivait à M. Poncet de la Grave que les registres et minutes des amirautés de Louisbourg et de Québec avaient été déposés aux archives de La Rochelle, pour être retournés dans les colonies, si l'occasion s'en présentait, quand la paix serait rétablie. On espérait encore que le Canada retournerait à la France!

Les anciennes archives de l'Amirauté de Québec sont aujourd'hui conservées aux Archives de la Marine, à Paris. Dans les voûtes du Secrétariat Provincial, à Québec, on conserve deux registres des causes de l'Amirauté de Québec, l'un pour l'année 1741, et l'autre pour les années 1749-1756.

Les Archives Judiciaires de Québec possèdent également quelques dossiers et pièces détachées des procès qui furent soumis à l'ancien Siège de l'Amirauté de Québec.

Dans le rapport du comité nommé par lord Dorchester en 1789, pour examiner les anciennes archives françaises, nous lisons, à la date du 4 août 1789:

"Le comité a ajourné au bureau de M. le secrétaire Pownall, pour examiner l'état et le contenu d'une grande caisse de documents endommagés, mentionnés dans l'inventaire de M. le secrétaire Pownall.

"Le comité constate que cette caisse contient des registres des causes dans la Cour d'Amirauté, avant la Conquête, ils sont tous si

[1] Le règlement du 12 janvier 1717 enregistré au greffe du Conseil Supérieur de Québec, le 22 novembre 1717, a été publié au volume premier (p. 358) des *Edits et Ordonnances*.

pourris que l'on ne peut les lever, excepté un registre pour 1759, qui a le titre suivant sur la seconde feuille:

"Le présent registre contenant cent quatre-vingt-dix-huit feuillets, celui-ci compris, a été paraphé par premier et dernier feuillet par nous Guillaume Guillimin, conseiller du roi, lieutenant particulier de la prévôté, et lieutenant-général civil et criminel de l'Amirauté de cette ville, pour servir à l'enregistrement des causes d'audience de l'Amirauté; fait à Québec le huit juin, mil sept cent cinquante-neuf;" il est signé Guillimin.

"Ce livre est aussi dans un très mauvais état; il contient sur 22 feuilles écrites, marquées 1 à 22, des jugements de la Cour d'Amirauté, authentiquées par la signature de M. Guillimin, juge de cette cour, excepté les deux dernières feuilles qui n'ont pas de signature.

"Dans la caisse il-y a un inventaire sur deux feuilles de papier, en bon état, avec le titre suivant:

"Récapitulation du greffe de l'Amirauté, le tout par lettres alphabétiques, et à leur rang d'années, comme il est spécifié ci-après."

"Cet inventaire paraît être une liste des registres et documents détachés concernant les causes d'Amirauté, commençant avec l'année 1731 et finissant par l'année 1759."[1]

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Nicolas-Gaspard Boucault qui, comme on le verra plus loin, fut procureur du roi de 1728 à 1736 puis lieutenant-général du siège de l'Amirauté de Québec, de 1736 à 1750, écrivait dans son *Etat Présent du Canada*:[2]

"Les juges de la Prévôté (de Québec) ont connu des causes maritimes jusqu'en l'année 1717, auquel temps M. le comte de Toulouse, amiral, ayant obtenu qu'il sera établi sur sa nomination des juges de l'Amirauté dans toutes les colonies, comme dans le royaume, il a été établi à Québec un lieutenant-général de l'Amirauté, un procureur du Roi et un greffier; le siège de cette jurisdiction est aussi dans le Palais (de l'intendant)."

LIEUTENANTS-GENERAUX DE L'AMIRAUTE DE QUEBEC

Jean-Baptiste Couillard de Lespinay

Nommé le 20 novembre 1717 par Louis-Alexandre de Bourbon, comte de Toulouse, amiral de France, il fut agréé par le roi Louis XV

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[1] *Rapport concernant les Archives Canadiennes pour l'année 1904*, p. 17.

[2] Etude manuscrite de 1754 et conservée à la Bibliothèque du Parlement à Ottawa.

le 18 janvier 1718. Sa commission fut enregistrée au greffe du Conseil Supérieur de Québec le 31 juillet 1719.[1] M. Couillard de Lespinay exerça cette charge jusqu'à sa mort arrivée à Québec le 8 mars 1735. On trouvera des détails biographiques sur lui dans notre *Famille de Chavigny de la Chevrotière*, p. 134.

Nicolas-Gaspard Boucault

Nommé le 27 mars 1736 par Louis-Alexandre de Bourbon, duc de Penthièvre, amiral de France, il fut agréé par le roi Louis XV le 1er avril 1736. Sa commission fut enregistrée au greffe du Conseil Supérieur de Québec le 20 août 1736.[2] M. Boucault retourna en France, à l'automne de 1747, mais il ne résigna sa charge de lieutenant-général de l'Amirauté que dans l'été de 1750. Pour renseignements biographiques sur M. Boucault, voir *Bulletin des Recherches Historiques*, vol. III, p. 25.

Guillaume Guillimin

Nommé le 8 juin 1750 par Louis-Jean-Marie de Bourbon, duc de Penthièvre, amiral de France, il fut agréé par le roi Louis XV le 11 juin 1750. Sa commission fut enregistrée au greffe du Conseil Supérieur de Québec, le . . . . . . [3]

M. Guillimin fut le dernier lieutenant-général de l'Amirauté de Québec. Pour détails biographiques sur M. Guillimin, on peut consulter notre *Famille Guillimin*, p. 22.

PROCUREURS DU ROI DE L'AMIRAUTÉ DE QUÉBEC

Jean-François Martin de Lino

Nommé le 20 novembre 1717 par Louis-Alexandre de Bourbon, comte de Toulouse, amiral de France, et agréé par le roi Louis XV le 18 janvier 1718. Sa commission fut enregistrée au greffe du Conseil Supérieur de Québec le 31 juillet 1719.[4] Décédé à Québec le 5 janvier 1721. Consulter sur lui le *Bulletin des Recherches Historiques*, vol. XXI, p. 156.

Jean-Baptiste-Julien Hamard de la Borde

Nommé le 20 février 1722 par Louis-Alexandre de Bourbon, comte de Toulouse, amiral de France, et agréé par le roi Louis XV

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[1] Insinuations du Conseil Supérieur, cahier 5, folio 4, Commission et agrément publiés dans *Edits et Ordonnances*, vol. III, p. 94.

[2] Insinuations du Conseil Supérieur, cahier 8, folio 6.

[3] Insinuations du Conseil Supérieur, cahier 9, folio 78. Commission et agrément publiés dans *Edits et Ordonnances*, vol. III., p. 110.

[4] Insinuations du Conseil Supérieur, cahier 5, folio 5.

le 12 mars 1722. Sa commission fut enregistrée au greffe du Conseil Supérieur de Québec le 12 octobre 1722.[1] M. Hamard de la Borde quitta la Nouvelle-France en octobre 1726.

Nicholas-Gaspard Boucault

Nommé le 4 mai 1728 par Louis-Alexandre de Bourbon, comte de Toulouse, amiral de France, et agréé par le roi Louis XV le 18 mai 1728; sa commission fut enregistrée au greffe du Conseil Supérieur de Québec le 4 octobre 1728.[2] Huit ans plus tard, le 27 mars 1736, M. Boucault était promu lieutenant-général de l'Amirauté de Québec.

Henry Hiché

Nommé le 1er avril 1736 par Louis-Alexandre de Bourbon, comte de Toulouse, amiral de France, et agréé par le roi Louis XV le 3 avril 1736. Sa commission fut enregistrée au greffe du Conseil Supérieur de Québec, le . . . . 1736.[3] Nommé conseiller au Conseil Supérieur de Québec le 15 mai 1754, M. Hiché abandonna sa charge de procureur du Roi de l'Amirauté en octobre de la même année. Sur Henry Hiché, consulter *l'Histoire du Notariat* de M. J.-Edmond Roy, vol. 1, p. 352.

Ignace Perthuis

Nommé le . . . avril 1754 par Louis-Jean-Marie de Bourbon, duc de Penthièvre, amiral de France, il fut agréé par le roi Louis XV le 18 avril 1754. Sa commission fut enregistrée au greffe du Conseil Supérieur de Québec le 14 octobre 1754.[4] M. Perthuis fut le dernier procureur du Roi de l'Amirauté de Québec. Il s'en alla en France après la conquête.

GREFFIERS DE L'AMIRAUTÉ DE QUÉBEC

Charles Guillimin

Le premier greffier du siège de l'Amirauté de Québec fut Charles Guillimin. Il dût être nommé en même temps que le premier lieutenant-général et le premier procureur du Roi, c'est-à-dire le 20 novembre

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[1] Insinuations du Conseil Supérieur, cahier 5, folio 134.

[2] Insinuations du Conseil Supérieur, cahier 6, folio 123.

[3] Insinuations du Conseil Supérieur, cahier 8, folio 9. M. Hiché avait déjà fait les fonctions de procureur de l'Amirauté de Québec, de septembre 1726 à octobre 1728, après le départ de M. Hamard de la Borde pour la France (Commission de l'intendant Dupuy, cahier 12 B, folio 1, des Ordonnances des Intendants).

[4] Insinuations du Conseil Supérieur, cahier 10, folio 4. Agrément du roi publié dans *Edits et Ordonnances*, vol. III, p. 112.

1717. Mais M. Guillimin, qui était négociant et s'occupait de la construction des vaisseaux, refusa d'accepter cette charge. Sur M. Guillimin, voir notre *Famille Guillimin*, p. 3.

Jean-Claude Louet

Le deuxième greffier du Siège de l'Amirauté de Québec fut le notaire Jean-Claude Louet. Sa commission n'a pas été conservée. Il entra en fonctions dans l'été de 1719. Renseignements biographiques sur Jean-Claude Louet dans l'*Histoire du Notariat* de M. J.-Edmond Roy, vol. 1, p. 351.

Jean-Claude Louet fils

Le troisième et dernier greffier du Siège de l'Amirauté de Québec fut Jean-Claude Louet fils. Nous n'avons pas, non plus, sa commission. Nous savons cependant qu'en 1737, Jean-Claude Louet père, frappé de paralysie, abandonna l'emploi d'écrivain de la marine qu'il remplissait concurremment avec ses charges de notaire et de greffier de l'Amirauté. Son fils dût lui succéder comme greffier de l'Amirauté en cette même année 1737, puisque nous le voyons agir comme tel en septembre 1737. Sur Jean-Claude Louet fils, on peut consulter une étude de R. G. P., *Les Sommations Respectueuses*, dans la *Presse* du 3 juin 1916.

Nos ancêtres étaient-ils ignorants?

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

(Lu à la séance de mai, 1918)

Les impressions qui me restent sur les beaux chanteurs et leurs couplets, sur les amateurs de musique et leurs instruments, sur les intellectuels de tous genres sont de 1850 dans un milieu de quatre mille âmes, ce qui n'est pas tout le pays tant s'en faut, et je compterais ces souvenirs pour rien si je n'avais pas vu le parti que la nouvelle école des chercheurs de légendes, de contes, de vieux airs, de refrains oubliés sait tirer de ce qui, en apparence, nous semble de nulle valeur. Ces étudiants m'ont fait comprendre la signification qui s'attache véritablement aux moindres indices d'un état de choses déjà perdu dans le lointain du temps, comme, par exemple, la chanson du duc de Guise, assassiné en 1563, et que ma mère, née en 1804, savait très bien, ainsi que *Passez votre chemin beau prince* que j'ai vu cité dans les histoires du XVIIe siècle. De suite une chaîne s'établit entre notre époque et le cours de deux ou trois cents ans en arrière. Une femme qui était allée à Montréal et avait admiré la banque nouvellement construite disait: "C'est beau comme un ouvre de reine," soit: comme le Louvre où est la reine, probablement Marie de Médicis vers 1615. N'ai-je pas entendu un vieillard, né autour de 1770, qui se piquait de beau langage, corriger en souriant monsieur le grand-vicaire Cooke qui venait de prononcer "joie" et "roi"? Lui, il disait "joué" et "roué," comme du temps de Louis XIV. De même "money" pour "monnaie." Et voyez donc ce que débite le personnage de Molière:

Quand un homme s'en vient m'embrasser avec joie,
Il faut bien le payer de la même monnaie.

La rime infaillible du grand comique n'a pas fait erreur: on disait "joué" et "money" ce qui rendait un son identique, car la rime est faite pour l'oreille, non pas pour les yeux. Et voilà comment les bagatelles d'autrefois nous ramènent à des us et coutumes qui remontent au temps de notre départ de France, dont personne n'a gardé la mémoire jusqu'à nos jours.

Mille et mille contes circulent dans les soirées de campagne qui prennent leurs sources plus loin encore. Certains couplets ont l'âge des pyramides d'Égypte; nous les connaissons en français parce que nos ancêtres les ont traduits.

Le Convoi de Malbrouk nous vient des Arabes d'il y a douze siècles, qui le tenaient des peuples de la haute antiquité. On en a fait l'application au duc de Marlborough en toute candeur et conscience. Quand Marlborough mourut dans son lit, il y a juste deux cents ans, sa femme ne monta point sur la tour "si haut qu'elle put monter" pour apercevoir un page qui apportait la nouvelle de ce trépas, mais le texte arabe le donne ainsi et on l'a fidèlement copié. Nous étions alors sous la domination française. Cette version en notre langue s'est-elle répandue parmi nous sans retard, ou bien avons-nous attendu l'année 1780 pour la connaître, comme ont fait les Parisiens, ou encore est-ce seulement par la suite que ces couplets se sont glissés en Canada ?

Il va de soi que, à partir de 1760 notre commerce avec la France cessa tout-à-fait, et qu'il ne vint plus aucun fonctionnaire des Bourbons séjourner sur les bords du Saint-Laurent, mais n'allons pas en conclure que nos rapports avec l'ancienne mère-patrie avaient cessé et j'insiste sur ce point: en ce qui concerne chanson, musique, littérature, les communications n'étaient que diminuées et pas du tout interrompues.

Nous étions restés avec un clergé insuffisant comme nombre parce que les prêtres originaires du royaume s'en étaient retournés chez eux. Les moyens de créer un clergé national nous manquaient et ce n'est que vers 1820 que nous avons commencé à nous fournir nous-mêmes à cet égard. La liste de l'abbé Tanguay montre que de 1760 à 1820 nous recrutions en France. Tous ces ecclésiastiques ont eu de l'influence intellectuelle sur nous. On ne mentionne ordinairement que ceux de 1793-1795 échappés à la révolution et qui se réfugièrent ici, mais il y en avait beaucoup d'autres, et je dis qu'il est venu aussi des laïques et non pas des moins instruits. Toute cette partie de notre histoire demande une étude spéciale.

La classe éclairée de notre peuple n'était pas tout-à-fait sans lien avec des Français. De plus, on voit par les ventes de bibliothèques du premier quart du XIX siècle la surprenante quantité de livres qui dataient de longtemps dans nos bonnes familles et les presbytères. Ainsi s'explique le langage toujours assez élevé, jamais vulgaire de nos meilleures classes, car il n'y a pas à contredir là-dessus, et je divise la situation en deux points: 1° le cultivateur avait conservé sa vieille langue parfaitement et 2° les "gens instruits" de la campagne et des villes parlaient un excellent français.

Mais il y a plus. Les fils de familles allaient faire des cours en France et revenaient mieux outillés. Ceci encore devrait faire l'objet d'une recherche spéciale. Ce que j'en ai vu me donne la conviction que l'on découvrirait bien des faits qui sont trop oubliés maintenant. Les autorités britanniques ne voyaient nullement d'un mauvais œil ces voyages en France. On agissait de la même façon en

Angleterre où il était de mode de parler français pour marquer que l'on apportenait aux couches supérieures de la société. De ce que, sous Robespierre (1793) on a empêché cinq ou six jeunes Canadiens de revenir de France, il ne faudrait pas conclure que notre gouvernement s'était toujours opposé à ce qu'on allât étudier à Paris. Les lettres écrites des bureaux de Québec disent en bon français qu'il y avait à craindre que ses jeunes gens ne revinsent avec des principes républicains, ce qui signifie révolutionnaires. Ces mesures ont duré trente mois et non pas trente années comme on le croit généralement.

Ainsi, le langage, l'instruction, les manières de vivre non seulement se conservaient parmi nous, mais se développaient en dépit de notre séparation de la France. En 1800 nous ne dépassions pas cent trente mille âmes, avec une classe instruite très élevée pour ce chiffre.

En ce qui concerne la littérature populaire, chansons, contes et proverbes, nous avons dû en importer de 1760 à 1800 moins que depuis les débuts de la colonie, mais il ne me paraît pas y avoir eu suspension.

Ceux qui revenaient de France en rapportaient des livres. Je vois par les arrivages des navires d'Angleterre, dans les vieilles gazettes, que les chargements comprenaient des caisses de livres français adressées à nos marchands et cela explique les éditions de 1770, 1775, 1780, 1790 trouvées dans maintes et maintes bibliothèques. Hier j'ai acheté Racine, Corneille, Boileau, Molière, dix volume despareillés de 1778, portant l'*ex-libris* de Blackstone avec sa signature de 1796. Ce Blackstone, fils du grand légiste, vivait aux Trois-Rivières. L'examen des dates des éditions comparées aux dates de possession en Canada suffirait pour prouver un commerce suivi de livres de toutes sortes et souvent de superbes collections.

Le clergé a toujours dit que, de 1760 à 1820, il avait passé par une pénurie d'instruction, c'est vrai. Cela s'entend des moyens requis pour former des prêtres, mais le clergé lui-même n'était pas ignorant (ma foi! il lisait Voltaire et les encyclopédistes) ni la classe supérieure de notre peuple. Nous avions des écoles élémentaires en nombre suffisant, et qu'est-il besoin de plus pour la masse? La France n'était sous ce rapport pas mieux que nous, cependant la plupart de ses grands hommes sont sortis des petites écoles. La révolution de 1789 a proclamé "instruction générale dirigée par l'État," ce qui était une nouveauté en Europe. Idée généreuse que de vouloir instruire tout le monde, mais impraticable car les sept-huitièmes des jeunes gens y répugnent. Nous n'étions pas pire qu'en France peut-être, si toutefois nous n'étions pas mieux. Et quand arriva notre première assemblée législative (1792) comment expliquer l'apparition de ces huit ou dix orateurs, écrivains, hommes de science politique dont l'histoire nous fait connaître les noms et les actes? Assurément ils venaient d'un milieu autre que le bas peuple, ils avaient respiré l'air des bibliothèques, c'étaient des intellectuels et ils portaient en eux la démonstration vivante que, depuis 1760, nous n'avions pas dégénéré. Ces fruits de toute beauté attestaient la vigueur de l'arbre qui les avait produits. Non! la séparation d'avec la France n'a pas affecté chez nous les choses de l'esprit, je dirai même que tout a marché à notre avantage puisque, au lieu d'un régime étouffant, nous avons vécu dans une atmosphère libre qui permettait à la pensée, au talent, à l'action, à l'énergie de se déployer et de prendre de l'essor. Intellectuellement nous étions en 1790 supérieurs à ce que nous avions été en 1760. Il y avait de l'acquis, du progrès, des ressources jadis inconnues de tous. Ces résultats font voir que l'instruction avait avancé, au lieu de reculer.

Du côté du peuple, dira-t-on, où en était les choses de l'esprit? Je vois d'abord vous faire convenir que tous les peuples de l'Europe étaient plongés dans l'ignorance. Ceci n'est pas contestable. Mais, laissons ceux-là. Aux colonies régnait plus de vigueur généralement parceque les hommes qui ont le courage de s'expatrier pour améliorer leur sort ne sont plus tout-à-fait le bas de l'échelle sociale. A cet égard j'ai comparé les éléments constitutifs de notre premier établissement avec ce que l'histoire des autres colonies nous a révélé et nous sommes dans la bonne note partout.

Nos fondateurs n'appartenaient qu'à une seule classe: l'homme des champs. Ils venaient tous de la même région de France, donc étaient d'un type unique et ils n'ont pas été à la peine de se fondre les uns dans les autres pour créer une nation nouvelle. La langue pareillement—elle était uniforme et elle est restée de même. Peu de colonies ont eu ces avantages et à tout cet ensemble il faut joindre la croyance religieuse qui ne différait dans aucun groupe canadien.

La part de l'instruction scolaire était plus large du côté des femmes, par tradition, par besoin, et la tradition s'était fondée sur le besoin. Voici comment:

Chaque cultivateur possédait un métier accessoire: menuisier, forgeron, fabricant de clous, cordonnier, faiseur de bardeaux, tisserand, boulanger, maçon, serrurier, fabricant d'outils, scieur de long, etc. Le principe était de n'acheter chez les marchands que le moins possible, comme les haches, vrilles, ciseaux, marmites, etc. L'habitant s'habillait de pied en cap. La femme aussi. L'échange des services se faisait par troc. Pas d'argent. On tenait des comptes. Ceci regardait la mère et les filles. Dès qu'il y eut à Québec quarante petites filles, on fit venir les Ursulines pour ouvrir une école (1639) et, par la suite, cette méthode se développa en proportion des familles qui augmentaient en nombre. Toute femme se trouvant à savoir lire et écrire, jugez de son influence sur la langue, et toute femme ayant passé par l'école jugez de ces manières.

A présent il faut noter que la colonie se formant d'elle-même était peu nombreuse. En 1660, nous ne dépassions guère deux mille âmes et il y avait au moins vingt-cinq prêtres dont une partie s'occupait des Sauvages mais était en contact avec les habitants. Les religieuses, institutrices ou hospitalières pouvaient être du même nombre. C'était beaucoup de gens éclairés pour une si petite population et cela durait depuis le commencement de la colonie. Il en fut de même par la suite. L'influence intellectuelle de cinquante personnes de cette classe sur deux mille âmes, hommes, femmes, enfants, devait être sensible puisque nous n'avions pas de coureurs d'aventure, ni de vagabonds mais seulement des gens de familles stables, établis sérieusement et depuis leur enfance habitués au même régime qui leur tenait au cœur.

En 1665 nous arrivions à près de trois mille âmes. C'est alors que fut organisé un bureau, à Québec et à Paris, pour faire venir des "filles du roi," la plupart orphelines de fonctionnaire que le roi faisait instruire dans les communautés religieuses. Jusqu'à 1672 il en arriva deux cents, peut-être un peu plus. En 1673 la dernière se mariait. Encore une influence intellectuelle qui n'est pas mince considérant le bas chiffre de la population.

Qu'on retourne l'histoire de n'importe quelle façon il reste partout cette vérité: le peuple canadien n'était pas commun, ignorant, dépourvu d'instincts élevés, pliant sous la misère, se tenant à raz du sol comme le paysan de France dont parlent les livres. La Hontan, à lui seul, en dit assez pour nous satisfaire, mais nous avons de plus vingt témoins qui le valent. La Hontan nous donne une comparaison parfaite de ce qu'il voit dans l'habitant et de ce qu'il ne trouve pas dans le paysan de France.

Arrêtons-nous à 1680. A cette date nous avions reçu à peu près trois mille (c'est au plus) personnes de France et le recensement donne 1568 ménages, soit 9,710 âmes. La période de fondation se ferme ici. L'empreinte est faite. Ce que nous étions alors nous le sommes aujourd'hui. Les guerres de 1684 à 1760 n'ont fait qu'empêcher l'immigration. De 1680 à 1760, il n'est venu que mille personnes qui ont été à mesure absorbées dans la masse devenue 20,000 en 1710, 40,000 en 1740, 65,000 en 1765.

C'est un grand point pour servir de base aux observations que de savoir au juste à quelle sorte de gens on a affaire, aussi ce petit chapitre d'histoire est-il indispensable à ceux qui étudient la littérature populaire et veulent se rendre comptes des mille particularités qu'ils rencontrent au cours de leurs recherches.

La langue étant celle de la Normandie, du Maine, de l'Anjou, de la Touraine, du Poitou, et de la Saintonge on sait tout d'abord à quoi s'en tenir. J'ajoute que nous n'avons pas de mots de patois et il est facile de comprendre cette épuration parce que j'ai expliqué ci-dessus. Ne poussons pas l'affirmation jusqu'à dire que tous les Canadiens parlent gramaticalement, pareille chose n'existe dans aucune nation, et soyons satisfaits de pouvoir constater qu'ils font usage d'un très bon français, tous, y compris les illettrés. Nous ne craignons sous ce rapport la comparaison avec aucun groupe français du monde entier. Les provinces d'où nous sommes sortis avaient été le berceau de la langue française et nous avons gardé celle-ci pure de tout alliage, soit d'accent, de patois ou de tournures barbares. Il en serait autrement si nous avions eu pour fondateurs des Provençaux, des Bretons, des Alsaciens ou des Basques. Les Français éclairés qui nous visitent et qui ne savent d'où nous venons disent en arrivant: "Vous êtes Normands ou Poitevins" et c'est la vérité. Je ne cite pas l'opinion des Français qui ne connaissent pas la France, mais j'en ai rencontré un bon nombre de ceux-là!

L'étude d'un peuple embrasse plus qu'on ne croit en passant. En 1865, parcourant la province du Haut-Canada (Ontario), j'ai été partout surpris de la pauvre cuisine que les cultivateurs à l'aise regardaient comme excellente par comparaison avec la table qu'ils avaient quittée dans les îles britanniques. Or, depuis deux siècles et demi au moins, les voyageurs, les hommes du commerce, les prêtres, les fonctionnaires font l'éloge de la cuisine canadienne. Il y a un fort degré de différence en civilisation et savoir-vivre entre un peuple qui se nourrit bien et celui qui se nourrit mal, toute chose étant d'ailleurs semblable en ce qui concerne les moyens de subsistance. Il faut être tant soit peu artiste et gens de goût, de raffinement, pour atteindre à l'art culinaire et bien des traits de tempérament ou de caractère se rattachent à cette culture. Avec la bonne table ou a l'esprit de conversation, la vie s'anime, un repas est une fête. Avec la pitance vulgaire, mal apprêtée on a un réfectoire de jour de funérailles.

Qui n'a pas célébré la politesse et la gaîté des Canadiens! Voilà encore un contraste avec l'ancien paysan de France et tant d'immigrants de diverses nations qui arrivent ici taciturnes, renfrognés, grossiers, mal élevés en un mot. Nos cultivateurs ont été toujours de véritable "gens de société" par les égards qu'ils se témoignent les uns aux autres et par leur urbanité en général. C'est tout le contraire d'une race restée au bas de la civilisation. Elle monte sans cesse. La recherche qu'elle met dans son comportement, sa maison, ses habits indique un niveau supérieur à celui des autres peuples de la même classe.

Dans ce milieu, la musique et le chant ont toujours été en honneur. Défiez-vous d'un homme qui n'aime pas la musique. Ceci ne s'adresse pas au Canadien. Un homme jovial n'est pas méchant. S'il est porté à rire et, s'il s'attendrit à l'audition d'une phrase mélodieuse, n'ayez crainte, c'est un bon cœur. La musique relève l'esprit et quand tout un peuple chante, ce qui est le cas chez nous, les brutalités sont rares.

Depuis onze quarts de siècle nos gens font du théatre. J'en ai écrit l'histoire, mais elle pourrait être complétée. C'est une autre marque intellectuelle qui n'est pas à laisser dans l'ombre.

L'école nouvelle se tient en quelque sorte derrière le rideau de l'histoire où elle découvre des indices de caractère, des éléments peu appréciés jusqu'ici, mais qui, une fois mis au jour, expliquent bien des choses. Ainsi, lorsque, il y a cent ans, a débuté notre littérature, pourquoi n'a-t-elle pas copié celle de France, j'entends non pas la langue mais les sujets traités? Vous voyez les Américains et les Anglais du Canada commencer par se repaître de ce qui se publiait en Angleterre et se faire l'écho de leur mère-patrie. Nos Canadiens sont allés droit au sol canadien et en ont tiré toute leur inspiration. Outre l'histoire qu'ils ont abordée dès la première heure, ils observaient les mœurs et coutume, en parlaient constamment, ne songeaient point à sortir du pays, y trouvaient abondance de matière et ils ont ont de suite créé un sentiment national qui est bien à nous. La cause de ceci est visible, ce n'étaient plus des colons débarqués de la veille; ils avaient eu le temps, à travers plusieurs générations, de se transformer et de prendre l'empreinte de la patrie nouvelle. Je doute fort que nous eussions eu le courage de parler de littérature canadienne en 1760 si le drapeau français eut continué de nous couvrir; non, vous auriez vu parmi nous une pâle copie, une redite des livres de France. La question n'est pas, je le répète, de savoir si nous écrivons aussi bien ou beaucoup plus mal que les Français, mais jamais vous ne me montrerez une page canadienne qui n'est pas de la plume d'un Canadien—donc notre littérature est à nous. Tenez, faites lire le présent article à n'importe quel étranger, il s'y perdra, s'il n'est pas dans le sens canadien, il ne comprendra que le gros du sujet et encore! Ce qui est de nous ne peut intéresser que nous. Les autres ont leur littérature, ils s'y tiennent. Faisons de même. Il y a cent ans, le fonds chez nous était préparé de longue main, nous nous sommes mis à l'exploiter et un pareil fait démontre de suite que nous n'étions pas un peuple ignorant. De vulgaires colons, d'après le sens que les

Européens attachent à ce terme, n'auraient pu en aucune manière élever si haut leur pensée.

Le genre d'étude qui se développe maintenant nous ménage des surprises agréables. Tout ce que je regrette c'est qu'on n'y ait pas songé il y a longtemps. La mine est riche.

Arrêts, Edits, Ordonnances, Mandements et Règlements Conservés dans les Archives du Palais de Justice de Montréal

Deuxième partie, 1701-1725

Par E.-Z. MASSICOTTE

Présenté par M. BENJAMIN SULTE, M.S.R.C.

(Lu à la séance de mai, 1918)

L'an dernier, dans ces Mémoires, a paru la première partie de la liste chronologique des arrêts, édits, etc., conservés dans les archives du palais de justice de Montréal; cette partie comprenait les documents datés de 1653 à 1700. Nous continuons, maintenant, la publication de notre travail en donnant la nomenclature des pièces datées depuis 1701 à 1725.

Les documents répertoriés dans cette deuxième partie proviennent de fonds divers et pour permettre de les retrouver facilement, nous avons mis au bas de chaque intitulé ou résumé, des indications abrégées dont voici l'explication: La mention, (Arch. générales) signifie que la pièce est placée à sa date dans la série des documents de toutes sortes classés par ordre chronologique; la mention, (Reg. des aud.) signifie que la pièce est transcrite dans le registre des audiences de la prévôté.

Deuxième partie—1701-1725

1701, 14 mars. Ordonnance du Conseil supérieur que son règlement du 18 janvier 1700 et son arrêt du 28 juin ensuivant seront exécutés en leur forme et teneur. Défense est faite d'avoir des marchandises "soit en allant à ou en étant audessus de Montréal, Chambly, Lachine," à peine de 500 livres d'amende et de confiscation des "canots, charettes, bœufs et chevaux qui les mèneront,"

(Reg. des aud. 1701.)

1701, 30 mars. Ordonnance du Conseil supérieur que le règlement du 22 novembre 1700 sera exécuté selon sa forme et teneur[1] et

[1] 1700, 22 novembre—Ord. du C. S. que le pain blanc de 6 lbs. vaudra 20 sous, le pain bis de 8 lbs. 20 sous, le pain bis de 10 lbs. 20 sous et le pain blanc de 6 onces, 1 sou 4 deniers, jusqu'à la récolte prochaine. Les boulangers seront tenus d'avoir du pain des 4 sortes, à peine de 50 livres d'amende et de marquer sur chaque pain le poids qu'il pèse. Défense à tous d'acheter plus de grains qu'il leur en faut etc., à peine de 500 livres d'amende etc.

pour ce enjoint aux habitants de vendre les blés, blé-d'Inde et pois qu'ils ont de trop au prix de six livres le minot d'ici le 1er mai; après cette date le prix sera de 5 livres le minot jusqu'à la récolte. Défense de vendre à plus haut prix ou de cacher des grains, à peine de 500 liv. d'amende. Visite sera faite des greniers.

(Reg. des aud. 1701.)

1701, 8 mai. Ordonnance de Philippe Rigaut de Vaudreuil, gouv. de Montréal enjoignant à tous les officiers, commandants & autres, depuis le fort Remy jusqu'au fort St. Paul au bout de l'Ile de Montréal et depuis le fort du Sault jusqu'à Chateauguay et autres lieux de laisser faire la visite des maisons et caves par le sieur Deschambault et de lui donner tout le secours qu'il demandera.

(Arch. générales.)

1701, 5 juin. Ordonnance du Roy nommant le sr Alexis Fleury Deschambault lieutenant général civil et criminel à Montréal, pour trois ans, en l'absence du sr Juchereau de Saint-Denis, nommant aussi Pierre Raimbault procureur du roi. Enregistrée à Montréal, le 2 juin 1702.

(Reg. des audiences, 1702.)

1701, 13 août. Ordonnance de M. Bochart Champigny intendant, permettant aux bouchers de vendre le bœuf à 5 sous la livre de Pâques à la Saint-Michel, puis le veau à 6 sous et le bœuf à 4 sous de la Saint-Michel au Carême à cause de la guerre. Dans les années à venir, cependant, on suivra les prix fixés dans le règlement du Conseil souverain du 2 avril 1674. Personne ne pourra tenir boucherie ou vendre des viandes sans autorisation à l'exception de l'Hôtel-Dieu; du Séminaire, des PP. Jésuites & de l'Hôpital Général des frères Charon. Fait à Villemarie. L. p. & a. le 21 août 1701, à la porte de l'église et sur la place publique par Hatanville.

(Arch. générales.)

1701, 22 août. Ordonnance de l'intendant Bochart, Sr. de Champigny annulant sur la plainte du séminaire de Montréal, toutes les permissions accordées aux cabaretiers; obligeant ceux-ci à obtenir de nouvelles permissions et à les faire renouveler tous les six mois. Fait à Montréal. L. p. & a. par Jean Petit, archer de la maréchaussée à Villemarie.

(Arch. générales.)

1702, 6 mai. Ordonnance royale, défendant aux habitants d'enivrer les Sauvages avec qui ils font commerce, à peine de confiscation des boissons et d'une amende, applicable moitié au dénonciateur, et de punition corporelle en cas de récidive.

(Reg. des aud. 1707.)

1702, 9 août. Ordonnance de l'intendant Jean Bochart déclarant exécutoire une ordonnance du sieur Juchereau, lieut. g.c. &c. rendue le 28 avril 1702 qui défendait aux habitants de laisser les cochons aller dans les rues à peine de 3 liv. d'amende.

(Registre des audiences, 1702.)

1703, 12 janvier. Ordonnance de M. Deschambault fixant le prix du pain comme suit: pain blanc, 2 sols la lb.; pain bis blanc, 15 deniers la lb., c'est-à-dire 16 lbs. pour 20 sols. Les boulangers devront toujours avoir du pain cuit, marqué à leur étampe. Défense aux boulangers de vendre du pain sans en avoir le permis. Défense aux cabaretiers de servir à leurs hôtes d'autre pain que celui des boulangers.

(Reg. des audiences, 1703.)

1703, 20 juin. Ordonnance de M. de Beauharnois, intendant, défendant, aux marchands de Montréal, d'équiper ou fournir des canots pour les envoyer en traite dans les profondeurs des bois. L. p. & a. le 15 juillet 1703 par J. Meschin.

(Arch. générales.)

1705, 17 septembre. Avis de Jacques Raudot, intendant, que passé le 10 octobre il ne sera plus reçu de castor gras. L. p. & a. le 27 septembre 1705 à la porte de l'église paroissiale et en la place royale, après un ban par un tambour de la garnison, par Le Pallieur.

(Arch. générales.)

1705, 26 octobre. Ordonnance de Jacques Raudot, intendant, validant les monnaies de cartes précédemment émises. L. p. & a. le 8 novembre 1705, après un ban par un tambour de la garnison, à la porte de l'église et sur la place d'armes par Le Pallieur.

(Arch. générales.)

1705, 9 novembre. Ordonnance de Jacques Raudot, intendant, défendant sous peine de 500 livres d'amende de vendre, donner ou troquer des boissons aux sauvages. L. p. & a. le 22 novembre 1705 à la porte de l'église et en la place d'armes par le Pallieur.

(Arch. générales.)

1705, 19 novembre. Ordonnance de Jacques Raudot, intendant, déclarant que les marchands qui auront fait venir directement des vins et eaux-de-vie de France auront seuls, conjointement avec les hôteliers et les cabaretiers, la liberté d'en vendre en détail à la charge néanmoins de mettre un bouchon à leurs portes, à peine de 10 livres d'amende. L. p. & a. le 2 décembre 1705 par Le Pallieur.

(Arch. générales et Reg. des aud. 1705, p. 689.)

1705, 20 novembre. Ordonnance de Jacques Raudot, intendant, disant que les pièces de 4 sols auront cours partout pour 4 sols et les sols de toute espèce pour 15 deniers. (On s'était plaint que les vieilles pièces de 4 sols n'étaient plus acceptées que pour 3 sols, 6 deniers.) L. p. & a. le 2 décembre 1705 par Le Pallieur.

(Arch. générales et Reg. des aud. 1705, p. 689.)

1706, 31 mai. Ordonnance de Jacques Raudot, intendant, obligeant les habitants de la Pointe-aux-Trembles de faire un fossé de 5 pieds de largeur par trois pieds de profondeur. Fait à Montréal.

(Arch. générales.)

1706, 22 juin. Ordonnance de l'intendant Raudot obligeant les habitants de donner une certaine pente aux rues; de raser les buttes et amoncellements de terre dans les rues; de fournir la sable, pierre ou cailloutage nécessaire et d'établir à chaque coin de rues des banquettes de 3 pieds de large et de 8 pouces de hauteur; défense aux charretiers de monter sur les banquettes à peine du 3 livres d'amende; défense de bâtir maison ou clôture sans permission du lieutenant général, nommé par les présentes grand voyer, à peine de 50 livres d'amende (La permission est taxée à 3 livres de France.); défense de jeter des immondices dans les rues à peine de 40 sols d'amende; défense de garder aucun cochon dans les maisons, à peine de 3 livres pour chaque cochon et de confiscation; défense de laisser vaquer des bêtes à cornes dans les rues à peine de 10 livres dont 3 pour l'huissier qui arrêtera les bêtes; défense de vendre des boissons sans permission à peine de 10 livres et de confiscation. Toutes les amendes seront remises au greffier pour servir aux améliorations urgentes de la ville. Enfin, un marché sera tenu les mardi et vendredi sur la place d'armes et défense est faite aux gens de la campagne de vendre par les maisons à peine de 3 livres; défense aussi aux hôteliers et cabaretiers d'acheter au marché avant huit heures du matin à peine de 3 livres. L. p. et a. le 27 juin par Lepallieur.

(Arch. générales.)

1706, 24 juin. Ordonnance de Jacques Raudot, intendant, obligeant tous les habitants de la Pointe-aux-Trembles à contribuer à faire le fossé ordonné le 31 mai précédent & ce sous peine de 10 livres d'amende. Fait à Montréal.

(Arch. générales.)

1706, 10 juillet. Ordonnance de Jacques Raudot, intendant, permettant que son ordonnance du 22 juin précédent ne soit pas exécutée dans toute sa rigueur, mais seulement comme suit: les habitants de la rue St.-François et de toutes les maisons de la basse-ville depuis le carrefour de l'Hôtel-Dieu jusqu'à la petite porte du bas de la rivière Saint-Pierre ne pourront plus élever des cochons. Les autres habitants pourront en nourrir deux au plus en les tenant enfermés jusqu'à Pâques. Quiconque en trouvera sur les rues pourra les tuer. Fait à Montréal.

(Arch. générales.)

1706, 7 décembre. Ordonnance de Jacques Raudot, intendant. Le Sieur Raudot a fait un règlement au mois de juin 1706 pour la ville de Montréal et en a confié l'exécution au juge Deschambault. D'autre part le sieur de Bécancourt, grand voyer du pays, a nommé le Sr Nolan, voyer à Montréal et pour éviter du trouble entre les deux fonctionnaires, M. Raudot fait défense au Sr Nolan de s'occuper de Montréal. Il pourra exercer ailleurs!

(Arch. générales.)

1706, 17 décembre. Ordonnance de M. Deschambault, lieutenant général, civil et criminel, défendant aux habitants de garder des cochons, à peine de 3 livres d'amende et de confiscation des cochons trouvés dans les rues. L. p. & a. le 19 décembre 1706 par J. Petit.

(Arch. générales.)

1707, 24 janvier. Arrêt du Conseil supérieur qui ordonne que l'ordonnance de 1667, au sujet de la saisie et vente des bestiaux, sera exécutée selon sa forme et teneur, mais qu'il sera laissé à celui sur qui on fera l'exécution, une vache, outre celle réservée par ledit article au lieu de trois brebis.

(Reg. des audiences, 1707.)

1707, 26 mai. Jacques Raudot intendant étant informé par le sieur Priat curé qu'il s'introduit en cette ville un libertinage entre les filles et les garçons lesquels sous prétexte de mariage retirent lesd. filles dans des maisons particulières & y paient leur pension et comme cela ne peut se faire sans un grand scandale, défense à tous, de retirer chez eux les dites filles, et ordre est donné de les renvoyer trois jours après la publication de la présente. . . Lesdites filles devront se mettre en service ou se retirer chez leurs parents. . . à peine de 50 livres d'amende.

(Arch. générales.)

1707, 6 juin. Ordonnance de Jacques Raudot, intendant, obligeant les habitants à fournir des "tomberéz de pierres, cailloux et déchets de chaux, suivant l'ordonnance du 22 juin 1706."

(Arch. générales et Reg. des aud. 1707, p. 88.)

1707, 4 août. Jacques Raudot, intendant, étant informé que les gens prétendent être en droit d'aller sur les terres non désertées pour y cueillir des noix, des raisins et même couper les arbres et les ceps, alors que les vrais propriétaires pourraient tirer profit de ces fruits pour faire des huiles et du vin, défense est faite de pénétrer sur le bien d'autrui à peine de 10 livres d'amende.

(Arch. générales.)

1708, 26 mai. Antoine-Denis Raudot, intendant, fait défense de commercer avec les sauvages au Bout de l'île ou à Lachine, à peine de confiscation des marchandises et de 300 livres d'amende. L. p. & a. le 27 mai 1708 par Lepallieur.

(Arch. générales.)

1708, 5 septembre. Ordonnance de l'intendant Raudot, que l'ordonnance de Sa Majesté du 6 mai 1702 et tous les règlements au sujet de l'eau-de-vie seront exécutés et en conséquence défense est faite à toute personne de vendre aucune boisson aux Sauvages à peine d'être condamnés à "être appliqués au carcan avec un écriteau où sera écrit: Vendeur d'eau-de-vie et autres boissons enivrantes aux Sauvages contre les défenses de Sa Majesté;" aussi a peine de confiscation des boissons et des marchandises et de 500 livres d'amende..

(Reg. des aud. 1708.)

1708, 18 octobre. Jacques Raudot, intendant. Etant nécessaire d'établir des arpenteurs et mesureurs de terre pour remplacer les anciens et étant informé par le sieur de Belmont, supérieur du séminaire de Montréal, que Mtre Anger, charpentier, est capable de remplir cette charge . . . commettons ledit Anger mesureur et arpenteur en ce pays.

(Arch. générales.)

1708, 14 décembre. Ordonnance de l'intendant Raudot faisant défense aux Frères Hospitaliers de Montréal, de faire des vœux et de porter le "capot noir, la ceinture de soye et le rabat."

(Reg. des aud. 1708.)

1708, 14 décembre. Ordonnance de l'intendant Raudot défendant aux Sœurs de la Congrégation de Notre-Dame de faire des vœux et déclarant nuls ceux qu'elles feront à l'avenir.

(Reg. des aud. 1708.)

1709, 10 janvier. Ordonnance du juge Fleury Deschambault obligeant les propriétaires et locataires de maisons à poser des échelles convenables sous quinze jours à peine de 10 livres d'amende. L. p. & a. le 13 janvier par LePallieur.

(Arch. générales.)

1709, 23 février. Ordonnance du lieutenant général, civil et criminel de Montréal. Vu que les habitants jettent immondices et neige devant leurs maisons ce qui fait que les chemins sont impraticables pour les traines, cariolles et gens de pied......chaque habitant devra enlever neige et immondices dans huit jours. L. p. & a. le 24 février 1709 par LePallieur.

(Arch. générales et Reg. des aud. 1709, p. 396.)

1709, 24 mai. "Règlement pour les viandes de boucheries" par le lieutenant gén. c. & c. de Montréal, "confirmé par l'ordonnance de Mgr. l'intendant en date du 16 juin ensuivant." Ces deux pièces, mentionnées dans un document judiciaire du 26 mars 1710, n'ont pas été retrouvées.

(Arch. générales.)

1709, 13 juin. Ordonnance de l'intendant Raudot. Etant informé que les habitants de ce gouvernement de Montréal nourrissent trop de chevaux qui ne leur rapportent rien et négligent l'élevage des bêtes à cornes et à laine qui leur rapporteraient profit; il est ordonné que chaque habitant de ce gouvernement n'aura pas plus de deux chevaux ou cavalles et un poulin à partir de la Ière semaine de 1710; ceux qui en ont plus devront les tuer à cette époque. Cette ordonnance ne s'applique pas à ceux qui font profession de charroyer pour le public.

(Reg. des aud. 1709.)

1709, 8 juillet. Règlement du Conseil supérieur, au sujet des honneurs décernés aux seigneurs dans les églises.
(Reg. des aud. 1717, p. 1272.)

1709, 11 novembre. Jacques Raudot, intendant, ordonne que les procédures dans les démêlés entre les familles Gaultier-Landreville et Brien-Durocher soient interrompues devant la justice royale et que les parties se présentent à lui, lors de son passage à Montréal.
(Arch. générales.)

1710, 5 mai. Arrêt du Conseil supérieur, rendu le 5 avril, établissant que le prix du bœuf, de Pâques à la Saint-Jean, sera de 4 sols, 6 deniers et de la Saint-Jean à Pâques, de 3 sols 6 deniers.
(Arch. générales.)

1710, 12 juin. Ordonnance du juge Fleury-Deschambault défendant à toute personne de vendre, "dans ou hors de la ville, aucune boisson, même de la bière," sans permission, à peine de 5 livres d'amende. L. p. & a. le 15 juin par J. Meschin.
(Arch. générales.)

1710, 22 juin. L'intendant Jacques Raudot fait défense à ceux qui vont à la chasse aux tourtres d'entrer sur les terres ensemencées, à peine de 10 livres d'amende. L. p. & a le 24 juin 1710 par J. Meschin.
(Arch. générales et Reg. des aud. 1710, p. 589.)

1710, 23 juin. Ordonnance de Antoine Denis Raudot défendant de vendre de la boisson en détail dans ou autour de la ville de Montréal, à peine de 50 livres d'amende et, en cas de récidive, à 100 livres et à être chassé de la ville; décrétant qu'il n'y aura que dix "cabarets aubergistes," que ceux-ci ne devront pas donner à boire aux Français, après 9h. du soir, à peine de 50 liv. d'amende et au double au cas de récidive, qu'ils ne devront pas donner à boire aux Sauvages en aucun temps sous peine des mêmes amendes et de la perte de leur privilège; défendant, également, aux personnes qui vendent par pot et pinte de vendre aux Sauvages à peine de 500 liv. et du double en cas de récidive; décrétant qu'il y aura, en outre, neuf cabaretiers qui débiteront de la bière aux Sauvages, desquels, il y en aura 3 pour le Sault St. Louis, 2 pour le Sault-au-Récollet, 2 pour les Nipissingues et 2 pour les "Abénakis, 8ta8ois et autres Sauvages qui viennent en traite en cette ville;" défense est faite à ces cabaretiers de donner à boire aux Sauvages "passé la retraite battue," ni de leur laisser emporter de la bière; mais ils seront obligés de laisser coucher les Sauvages chez eux, si ceux-ci veulent rester; permission aux 9 cabaretiers de vendre toutes sortes de boissons aux Français. Seront tenus les 10 "cabarets aubergistes" et les 9 cabaretiers d'obtenir un permis du juge Deschambault de Montréal avant de pouvoir débiter des boissons—Ordonnons enfin que le règlement de 1703 sera exécuté en sa forme et teneur. Fait à Montréal.

(Reg. des aud. 1710.)

1710, 23 juin. Ordonnance de l'intendant Raudot. Défense aux personnes du Bout de l'isle qui vendent de la bière aux Sauvages de leur en donner en quantité suffisante pour les enivrer, à peine de 50 livres. Défense de leur donner des boissons pour emporter. Fait à Montréal.

(Reg. des aud.)

1710, 26 juin. Les bouchers ayant déclaré qu'ils ne peuvent plus vendre la viande aux prix d'autrefois, à cause de la cherté des bestiaux, ordre est donné par Jacques Raudot, intendant, de convoquer les notables, marchands, bourgeois et artisans pour discuter les prétentions des bouchers. L. p. & a. à la porte de l'église de la Pointe aux Trembles, le 29 juin 1710 par Nicolas Senet.

(Arch. générales.)

1710, 2 juillet. Ordonnance de Antoine Raudot, intendant, permettant aux sieurs Joseph Guyon-Desprès, Paul Bouchard, Jean Brunet dit La Sablonnière et Nicolas Le Court de tenir boucherie pendant trois ans, mais avec obligation de vendre le bœuf, depuis Pâques jusqu'à la St. Jean, à 4 sous, et de la St. Jean à Pâques, à 3 sous la livre. Les bouchers sus-mentionnés devront déclarer sous huit jours s'ils acceptent. S'ils ne l'ont pas fait, le privilège sera vendu à d'autres. L. p. & a le 6 juillet 1710 par J. Meschin.

(Arch. générales et Reg. des aud. 1710, p. 593).

1710, 7 juillet. Ordonnance d'Antoine Denis Raudot défendant aux habitants de Montréal de "donner l'abandon à leurs bêtes et de laisser vaquer leurs chevaux l'hiver." Fait à Montréal.

(Arch. générales.)

1710, 31 octobre. Ordonnance de l'intendant Raudot. Vu le grand besoin de pain à cause des nombreux Sauvages à qui il faut en fournir, permission est accordée à Jean Roy, Estienne Forestier, Paul Bouchard et Jean Gervaise, anciens boulangers, d'exercer leur métier, en plus des cinq autres boulangers, nommés deux mois auparavant.

(Reg. des aud.)

1710, 28 novembre. Ordonnance du lieutenant général civil & criminel défendant aux marchands et autres qui ne sont pas cabaretiers de débiter des boissons "audessous du pot et de la pinte" à peine de 10 livres d'amende; défense aussi à ces personnes de donner à boire chez elles à peine de 50 livres d'amende.
(Arch. générales.)

1711, 30 janvier. Ordonnance de M. Fleury Deschambault défendant aux charretiers de faire courir leurs chevaux dans la ville sans tenir les "guides" en leurs mains, sous peine de saisie de leurs harnais et de leurs personnes. Ordre aux huissiers et aux archers de la maréchaussée de vaquer à l'exécution de la dite ordonnance.
(Arch. générales.)

1711, 6 juillet. Arrêt du roi qui ordonne que les terres concédées soient mises en culture et occupées.

Arrêt du roi qui déchoit les habitants de la propriété de leurs terres, s'ils ne les mettent en valeur. L. p. & a. le 29 janvier 1713, par LePallieur.
(Reg. des aud. 1713.)

1712, 25 avril. Arrêt du Conseil souverain. Vu la requête des cordonniers de Ville Marie demandant qu'il soit permis aux tanneurs de Montréal (isle) d'apporter en ville les jours de fêtes et dimanches les fournitures de "mollerie" nécessaires aux cordonniers, le conseil fait défense d'apporter, vendre, distribuer "aucuns cuirs ou mollerie" auxd. cordonniers les fêtes et dimanches, sous peine que de raison L. p. & a. le 8 mai 1712, LePallieur.
(Reg. des aud.)

1712, 18 juin. Ordonnance de M. Fleury Deschambault lieutenant général etc...... "tous ceux qui sont taxés de pierre, chaux et sable pour l'ouvrage du pont de Vinscene, devront y satisfaire dans trois jours,......à peyne d'y être contraints par les voyes de droit."
(Arch. générales.)

1712, 18 novembre. D'après son répertoire, le notaire N. Senet aurait mis, à cette date, dans son greffe, une ordonnance de l'Intendant, mais la pièce ne s'y trouve plus.
(Arch. générales.)

1713, juin. Arrêt royal, permettant à un certain nombre de sujets anglais de demeurer en la Nouvelle-France et d'y finir leurs jours.
(Reg. des aud. 1713, p. 1109.)

1714, 24 janvier. Ordonnance de M. Begon au sujet de l'achat et de la vente des blés "vu que la récolte de l'année 1713 n'a pas été abondante."

(Arch. gén. et reg. des aud., 1714, p. 977.)

1714, 23 juin. Ordonnance de M. Begon. Vu que le nombre des cabaretiers s'est multiplié, il est de nouveau réduit à 10 cabaretiers-aubergistes et à 9 cabaretiers pouvant vendre de la bière aux Sauvages, tel que réglé par l'ordonnance de M. Raudot du 23 juin 1710.

Fait à Montréal. L..p. & a. par LePallieur.

(Reg. des aud. 1714, p. 1019.)

1714, juillet. Lettres patentes concernant les justices de l'île de Montréal et de la côte Saint-Sulpice.

(Reg. des aud. 1718, p. 1324.)

1715, 22 mars. Ordonnance du juge Fleury Deschambault au sujet de l'entretien des banquettes (trottoirs.)

(Arch. générales.)

1715, 22 juillet. Ordonnance de Michel Bégon obligeant les habitants à faire transporter dans les endroits désignés, les terres, vidanges, etc., qui sont dans les rues vis-à-vis leurs bâtiments, afin de conserver le niveau des rues tel qu'établi par le Sieur de Catalogne.

(Arch. générales.)

1715, 5 août. Arrêt du Conseil supérieur obligeant les juges et procureurs à faire exécuter les articles 8, 9, 10, 11, 12, 13, 15, 16, 18 du titre 20 de l'ordonnance de 1667, concernant les actes de l'état civil.

(Reg. des aud. 1715, p. 1118.)

1715, 12 septembre. Arrêt et déclaration du roi concernant la régence du royaume.

En suite—1715, 22 septembre. Lettres patentes du roi sur l'arrêt précédent.

(Reg. des aud. 1716, p. 1244.)

1716, mars. Lettres patentes du roi portant amnistie pour les coureurs de bois.

(Reg. des aud. 1716, p. 1245.)

1716, 27 avril. Règlement "au sujet des honneurs dans les églises de la Nouvelle-France."

(Reg. des aud. 1717, p. 1247.)

1716, 28 avril. Déclarations du roi, concernant la distribution des congés pour aller en traite.

(Reg. des aud. 1717, p. 1259.)

1716, 28 avril. Arrêt du Conseil d'Etat touchant les réclamations de marchandises ou effets faites par les Sauvages du Canada.

(Reg. des aud. 1717, p. 1251.)

1716, 5 mai 1716. Arrêt du Conseil d'Etat pour la réunion des terres concédées par MM. du séminaire de Saint-Sulpice.

(Reg. des aud. 1717, p. 1252).

1716, 5 mai. Arrêt au sujet des fortifications de Montréal.

(Reg. des aud. 1717, p. 1251.)

1716, 19 mai. Ordonnance de Sa Majesté portant défense de vendre des marchandises fabriquées à l'étranger.

Ensuite, 1er décembre. Ordonnance du Conseil supérieur relative à l'enregistrement de la précédente ordonnance.

(Reg. des aud.)

1716, 5 juillet. Déclaration du roi au sujet de la monnaie de carte.

(Reg. des aud. 1717, p. 1273).

Dans les Edits et ord. roy. I, 370, cette pièce porte la date de

1717. Quelle est la vraie date ?

1716, 11 août. Règlement du Conseil supérieur concernant le bois de chauffage, les domestiques et les bouchers.

(Reg. des aud. p. 1271.)

1716, 15 septembre. Déclaration de Sa Majesté, au sujet de l'établissement d'un conseil pour la direction des affaires du royaume, outre le Conseil de régence.

(Reg. des aud. 1717, p. 1257.)

1716, 1er décembre. Ordonnance du Conseil supérieur, exigeant l'enregistrement des lettres patentes du roi qui révoquent toutes les concessions faites au Détroit, sur le lac Erié par le sieur de Lamothe Cadillac et qui accordent de nouveaux titres aux concessionnaires de bonne foi.

(Reg. des aud. 1716, p. 1247.)

1717, 22 février. Arrêt du Conseil supérieur de Québec qui déboute plusieurs seigneurs des fins d'une requête, tendant à faire reviser l'arrêt de 1709, au sujet des honneurs décernés aux seigneurs dans les églises.

(Reg. des aud. 1717, p. 1273.)

1717, 2 août. Déclaration du roi pour la conservation des minutes des notaires.

(Reg. des aud. 1720, p. 219.)

1717, 2 août. Déclaration du roi portant que les publications pour affaires temporelles ne se feront qu'à l'issue des messes de paroisses.

(Reg. des aud. 1720, p. 221.)

1718, 21 mars. Déclaration du roi qui réduit la monnaie de carte à la moitié de sa valeur.

(Reg. des aud. 1719, p. 1358.)

1720, 22 juillet. Le Conseil supérieur fait défense aux huissiers et sergents d'exiger de plus forts salaires que ceux qui leur sont alloués par l'édit du 12 mars 1678, à peine de 10 livres d'amende et de restitutions du quadruple.

(Reg. des aud. 1720, p. 222.)

1722, 17 mars. Ordre du juge d'enregistrer sans retard une ordonnance de M. l'intendant, en date du 6 février précédent, au sujet des "femmes enceintes par voyes illicites" ainsi que l'édit du roi Henri Second, du mois de février 1556.[1]

1722, 30 avril. Ordonnance de Michel Begon, intendant, autorisant les prêtres séculiers ou les religieux, faisant fonction curiale, à recevoir les testaments des habitants de leurs paroisses, à défaut de notaires. Trois témoins mâles et majeurs devront être présents et les témoins et le missionnaire ne pourront être légataires. L. p. & a. le 19 décembre 1723, par Dudevoir.

(Arch. générales Reg. des aud. 1723, p. 606.)

1723, août. Edit du roi concernant les monnaies.

(Reg. des aud. 1724, p. 742.)

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[1]L'ordonnance de 16 février 1722 n'a pas été retrouvée, nous avons donné l'intitulé d'une ordonnance à peu près semblable à la date du 9 août 1697.

1724, 4 janvier. Arrêt du roi concernant le dépôt des minutes des notaires.

(Reg. des aud. 1724, p. 751.)

1724, 4 février. Arrêt du Conseil du roi pour la diminution des espèces en matières d'or et d'argent.

(Reg. des aud. 1724, p. 743.)

1724, 27 mars. Arrêt du Conseil d'état du roi sur la dimunition "des espèces en matières d'or et d'argent et des espèces de cuivre et de billon."

(Reg. des aud. 1724, p. 744.)

1724, 22 mai. Ordonnance du roi confirmant les anciennes défenses et règlements au sujet de l'envoi des pelleteries dans la Nouvelle-Angleterre.

(Reg. des aud. 1724, p. 745.)

1724, 25 mai. Ordonnance de François-Marie Bouat, permettant, au fermier de la métairie des RR.PP. Jésuites, de faire vendre au premier jour du marché, un poulin et une pouliche qui errent dans les prairies du dit fermier et ne sont réclamés de personne.

L. p. & a le 25 mai 1724 par Antoine Perrin.

(Arch. générales.)

1724, 26 mai. "Lettres de terrier obtenues de Sa Majesté par MM. du séminaire de Saint-Sulpice aux fins de faire contraindre tous et chacun leurs vassaux, tenanciers et redevables des cens et rentes, redevances, quintes, reliefs, lots et ventes, indemnités et autres droits, d'apporter ou faire apporter par devant par devant Me Pierre Raimbault, notaire royal, les foi, hommage, aveu, et dénombrement," etc.

(Reg. des aud. 1724, p. 756.)

1724, 30 mai. Arrêt du Conseil d'état du roi, au sujet du "plan de la ville et enceinte de Montréal fait par le sieur Chaussegros, ingénieur."

(Reg. des aud., 1724, p. 752.)

1724, 10 juin. Ordonnance de Michel Begon, intendant, obligeant les propriétaires de terres labourables, prairies et pacages de la ville et gouvernement de Montréal, à partir du 10 juin 1725, à faire et entretenir leurs parts de clôtures mitoyennes, lorsque l'un d'eux voudra clore.

(Reg. des aud. 1724, p. 683.)

1725, 18 janvier. Ordonnance de l'intendant Begon de faire exécuter selon sa forme et teneur l'arrêt du conseil d'état du roi, défendant de tenir cabaret sans permission.

(Reg. des aud. 1725, p. 776.)

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SECTION II

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Henry James and his Method

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(Read May Meeting, 1918)

Foreign critics of the Latin race reconcile themselves with difficulty to the seeming lawlessness of our literature, and native critics like Matthew Arnold who are steeped in the Latin tradition concede us energy, enthusiasm, humour and imagination, but deny us the virtues that derive from organization and intellectual control. Our successes are prodigious, but they seem frequently to be attained in defiance of law and in despite of art. The pages of Voltaire and Coleridge familiarize us sufficiently with the argument and its rebuttal in so far as poetry and the drama are concerned, and we flatter ourselves that a very good case has been made out in defence of our alleged Gothic extravagance. But our very triumph is a concession, for we are not content until we have demonstrated that our irregularities are not wayward extravagance, but are subordinated in all strictness to the laws of the creative imagination.

What these laws of poetry and the drama may be I am not here concerned to state, and such as they are they exist not in any formal book of rules but in the mind and conscience of the artist. My present consideration is with prose fiction, that latest and lustiest birth of literature, which seems but yesterday to have outgrown the creeping stage of groping experimentation. I wish to consider some of the problems that the novel presents, and by an examination of the work of a few of the acknowledged masters of the craft I would if possible reach some conclusions as to the most effective methods whereby the novelist obtains from his material the maximum of result. I am well aware that many successful writers who might admit that they had an intention would deny that they had a method. We have the assurance of Scott and Dickens and George Sand that their novels planned themselves fortuitously, and that the development of the situations, sometimes even of the characters, was as great a surprise to them as to their readers. In a negative sense we may claim this as the method of happy improvisation, but a man must be extremely confident in his faculty to encounter the risks it involves. Spontaneity and design do not appear to rhyme together, yet I feel in the case of the writers whom I have named that the result would have been richer if the exuberance of invention had submitted itself to a more careful regulation. One may surely organize one's wealth of material with no necessary sacrifice of the appearance at least of spontaneity.

George Sand whom I have named among the writers relying for their charm upon the unpremeditated facility of their invention stands apart from the literary tradition of France, where carefulness of design and a studied calculation of effect prevail in the novel to a degree which few English readers recognize, and fewer still appreciate. In France the reading public is more discriminating and exacting than with us. We are satisfied certainly on easier terms, and a writer of fiction wins our approval if he can describe vigorously or poetically, write good dialogue, set a group of living characters in motion, and above all if he can persuade us to yield ourselves to his moral judgments and to concede the soundness of his social criticism. These are all essential things in fiction, and even the least didactic of novelists cannot write a great book which dispenses with any of them. But I fear that our ordinary successful writer aims at his effect from point to point, and taking advantage of the reader's habitual carelessness of mind neglects the fuller possibilities for beauty which the novel presents as a form of art. One novelist, however, we have had amongst us who set himself a severer standard of technical excellence than even the most exactingly conscientious of French writers, and it is for this reason that I have chosen Henry James to exemplify some of the more interesting aspects of composition.

Since Henry James's death two uncompleted novels have been published, "The Ivory Tower" and "The Sense of the Past," and both of them fortunately for our purpose are provided with a kind of "scenario" or rough colloquial sketch in which the author discussed with himself the various difficulties presented by his subject, and the manner in which he proposed to solve them. Such an opportunity of penetrating into the artist's workshop has never been offered to us by an author of the first rank, and we can almost afford to resign the finished materpiece for the privilege of participating in the act of its creation.

As originally planned "The Ivory Tower" would have been completed in ten books, but it breaks off abruptly at the opening of Book IV. The commentary permits us to measure our loss, for the subject as there presented fairly teems with Jamesian types and fairly bristles with Jamesian situations. Rosanna Gaw has been the means of having Graham Fielder recalled from Europe to America in order to be present at the death-bed of his uncle Betterman, who in a conciliatory mood has determined to nominate his nephew to the inheritance of his great wealth. Graham, or Gray as his friends prefer to call him, arrives in the full tide of the Newport season, and is speedily metamorphosed from an impecunious heir of the ages in Europe to an immensely propertied man in America. He is hopelessly incompetent in the matter of money, and places himself unreservedly in the hands of an old friend of his boyhood, Horton or Haughty Vint, who stealthily succeeds in transferring Gray's fortune to himself. The important women are three: Rosanna Gaw, wealthy but honest (the adversative word counts for much in the story), and sincerely Gray's friend with future transcendent possibilities implied; Cecilia (Cissy) Foy, beautiful and brilliantly unreliable, with tender inclinations for Haughty but mercenary designs on Gray; and Mrs. Bradham or "Gussy," who selfishly plays her own game while fanning Gray's attraction for Cissy her fascinating *protégée*. The story would have ended with the bankrupt Gray finding his happiness under conditions not the least mercenary with the steadfast Rosanna, and then presumably the pair would have settled down somewhere within sight or reach of the Pitti Palace. Such in baldest outline is the projected story with all its latent possibilities of crude and even melodramatic treatment. Its expansion by the hand of James would have been quite other, his votaries know.

What interests one in the notes is the writer's immense enthusiasm for his theme, and his sense of the finer values that are latent within it. As a precaution let me observe that his imagination does not kindle from the vulgar outlines of such a plot as I have with intentional crudity presented. He seems first to have adumbrated in his mind two or three central figures who are capable of taking defined shape and individual accent as they themselves project the situations that reveal them. Probably for the purposes of the present story James had chosen to represent a Europeanized American, in his original conception not markedly different from the multitude we encounter in the novels, but determined in a new direction by the special circumstance of late inherited wealth and consequent transplantation into a new environment. Thus definitely launched Graham Fielder creates by the logic of his character a new world, and it is a keen enjoyment for us to observe the intelligently exploring way in which this necessitated cosmos develops in the author's mind.

Having determined the general direction of his plot the author casts about for the names which shall be the supremely best in their representative value for the characters that group themselves about his central figure. In his quest we find him levying tribute upon the columns of "The Times," as Dickens might have explored the shop-signs of the slums. The names determined, the localities next concern him. Newport is chosen for the launching of his mimic world, and Newport in turn necessitates the late summer season. With an inveterate dislike, in spite of Balzac's and Turgénief's example, of solid blocks of retrospective explanation by the author James provides in his plan for an expositional scene between Rosanna Gaw and her friend Mr. Bradham. The main difficulty seems to be the precise determination of the ages of his characters. Rosanna is conceived as having been in Europe as a young girl of sixteen with her mother. This was sixteen years before the opening of the main action. They met the Fielders, mother and son, and their intimacy was fostered by the old business connection of Rosanna's father with Mrs. Fielder's half-brother Betterman. The latter had been estranged from Mrs. Fielder, chiefly one gathers because of her deficient Americanism, and now that she is contemplating a second marriage with an alien Englishman the brother delivers his ultimatum. Unless she consents to send her son to his care in America he will let her continue in her voluntary foolish poverty. The boy of fourteen is allowed by his mother to choose his own fate, and Rosanna describes to Mr. Bradham an interview among the Madonnas of a Dresden gallery—a scene that might conceivably have been more effective had the years of its actors been less tender—in which she confirms the youngster's intention to remain abroad.

As she had engineered Gray's fate in that earlier time, so now in her altered regard for his uncle Betterman, she has contrived, as has been stated, to have the young man recalled and a reconciliation effected. This compels James to a special consideration of the old man's case. He has lost his two children, and is represented as having reached in his old age a curious philosophical detachment from money. This was necessary in order to explain his bequest of unnamed millions to a man like Graham Fielder with a child's mind for matters monetary. This precipitates the further difficulty also of exhibiting Gray as far other than the fool he appears to be when placing himself so recklessly in Haughty's power. Then the misappropriation of the millions has to be organised, and this for James who is confessedly a sharer in Gray's practical incapacity is the most teasing problem that confronts him. Everything must occur for the sake of compactness within sixteen months, and the melodramatic pitfalls incident to Haughty's exposure must at all costs be avoided. The more attentively James confronts this particular problem the more "beauty" there seems to reside in it, and the relations between Gray and Haughty have a fascination for him proportional to their difficulty. "What glimmers upon me, as I said just now, is the conception of an entire frankness of understanding between the two young men on the question of Gray's inaptitudes...... Yes, there glimmers, there glimmers; something really more interesting, I think, than the mere nefarious act, something like a profoundly nefarious attitude, or even genius: I see, I really think I see, the real firm truth of the matter in *that.* With which I keep present to me the whole significance and high dramatic value of the part played in the action by Cissy Foy; have distinct to me her active function as a wheel in the machine...... But I must put her on her feet perfectly in order to see her as I should."

It is obvious that Henry James never committed himself to writing without the clearest articulation of his theme in his mind, although of course his composition is never slavishly tied down to the preconceived plan. "What I want is to get my right firm *joints,* each working on its own hinge, and forming together the play of my machine: they *are* the machine, and when each of them is settled and determined it will work as I want it." He has the right creative rapture as each new "joint" is discovered:—"a perfect joint," "a tremendous joint," "a joint of joints!"

Artful preparation, unity, economy, the careful co-ordination of parts so that no situation, no dialogue, no description is without its functional value—these, one gathers, are the essential things demanded by James in the novel that is engendered in the conscience of the artist, or at least they make possible the supremely essential thing which is to represent life in all its rich complexity and variety. "I cannot imagine composition existing in a series of blocks," he tells us in his essay on "The Art of Fiction," "nor conceive in any novel worth discussing at all, of a passage of description that is not in its intention narrative, a passage of dialogue that is not in its intention descriptive, a touch of truth of any sort that does not partake of the nature of incident, or an incident that derives its interest from any other source than the general and only source of the success of a work of art—that of being illustrative. A novel is a living thing, all one and continuous, like any other organism, and in proportion as it lives will it be found, I think, that in each of the parts there is something of each of the other parts."

The severe discipline to which James subjects his novels may be studied to the best advantage in "The Ambassadors," upon which excellent book he has brought to bear all the resources of his exacting art. His method is productive of undeniable and rare merits, but of disadvantages also that brook no denial. It gives us novels that are better *composed* than any our literature has known: in every detail of incident, in all the delicate variations of mood that reveal the characters we are conscious of the control of the artist over the crude stuff of life. Everything radiates from a centre, and everything is bounded by a circumference which encircles the theme as firmly as its containing wall encompasses a mediæval town. There is no escape, for guards are set about the gates—superfluous warders since the life within is very mellow and beautiful. Other novelists, Meredith might be named, are frequently poets in lyrical passages that detach themselves from the context. James conceived all his novels as harmonies; "a common grayness silvers everything;" and what Thackeray achieved once in the poetical atmosphere of "Henry Esmond," James achieved perpetually. But we are wilful enough to wish at times for some irruption of the incongruous, for some disconcerting thrust of humour which might strike an earthquake tremour through the gray walled town and rock its towers with laughter. We are impatient of so much perfection, and as readers we are not always sufficiently artists to enjoy reality so thrice strained and sifted, so winnowed and refined. In his earlier novels the compositional stress is not so importunate, and the diction is comparatively simple. In the later and as I think the finer books, while the structure is more wonderful the diction becomes increasingly involved. The story is clothed in tissue of cloth of gold, so that the muffled magnificence of the style impedes the movement, and compels us to ask whether the author would not more frequently have realised his vaunted economy of action had he been more studious of economy of utterance.

"The Ambassadors," published in 1903, is one of the late books which illustrates James's compositional methods in their highest rigour. The style by a singularly happy chance is rich yet not encumbered, and therefore both for method and expression this book has always seemed to me his greatest achievement in fiction.

The story is launched with Mr. Strether's arrival in England from Woollett, Massachusetts, on a vague mission which presently reveals itself. He is a hero of fifty-five, and thirty years before he had had a brief initiation into European civilization, but has passed the later spring and summer of his life in Woollett where the Puritan virtues flourish, and where the easy accessibility of Boston communicates the only intellectual glow. He has been conducting a review in the interests of its wealthy proprietor, a widow named Mrs. Newsome, who has evidently determined to reward his services with the gift of her fortune and her hand. Pending this event he is sent journeying abroad to Paris, in order to redeem young Chad Newsome from some feminine complication of which rumours have reached the startled Woollett ears. We encounter Strether first at Chester where Miss Gostrey, on scarcely sufficient provocation if the truth were told, takes the wanderer in hand, and gives him with the most winning and innocent grace his second initiation into the charms of the old world. With each stage of Strether's journey Woollett seems to recede more and more into the background. Accompanied by his friend Waymarsh, who strikes throughout a resonant nasal American note, Strether crosses to Paris to find the erring Chad and to lure him home to business and Woollett. When he presently encounters the young man he recognizes the extraordinary change that five years abroad have wrought in his appearance, his manner, and his point of view, and when later he makes the acquaintance of the fascinating Madame de Vionnet he realizes that she is in large measure responsible for the recreation of Chad. So deep have been the new influences operating upon Strether himself, and so fine a mesh has been woven about his Puritanic soul that he is not inordinately shocked at learning that Madame de Vionnet's husband is still alive. Indeed the process of Strether's saturation is so gradual, and his sensitiveness to impressions is so exquisite that the reader is compelled to sympathise with and share the salutary contagion. We are both fortified for the present with little Bilham's assurance that the relations between Chad and Madame de Vionnet are innocent.

Meanwhile Strether is in almost daily receipt of letters from Mrs. Newsome, and is under the compulsion of replying to them with equal frequency and length. The Woollett widow is punctually informed of all the Parisian happenings, but Strether not being a hypocrite she divines that her ambassador has become contaminated. The first result of this suspicion is the cold infrequency of her letters, the next result is the sudden arrival in Paris of the second ambassadorial group, Chad's sister, the incorruptible Sarah Pocock, her husband Jim with the emancipated Puritan's zest for the vulgar delights of Paris, and his pleasant little sister Mamie who is quick to take the impression of her new surroundings and who gives to Strether the only sympathy, ineffectual as it is, which he is destined to receive from the direction of America.

Sarah's mission we presently realise is less the saving of Chad, who is now looked upon as hopeless, than the rescue of Strether, who also proves intractable. The Pocock group and Waymarsh flit away, and Strether lingers on through the Parisian summer with Miss Gostrey, Chad and the Countess to cheer his solitude. A chance country outing reveals to him the far other than innocent relations of Chad and Madame de Vionnet. Yet even to this he reconciles himself for the strange beauty of the fact. But a species of disenchantment rests upon his soul. His friends profess their eagerness to retain him, but he is old and worn and resists their solicitation. He is serenely conscious of the loss of Mrs. Newsome's favour, and life in Woollett seems sufficiently meagre to him now. But thither the book at its close returns him, with few hopes but many gracious memories and a mind awakened.

From the outline I have given we can sufficiently divine the author's intention. His main concern evidently is not with the story of an infatuation represented in the relations of Chad and his Countess, for in the planning of his action James never yields to the romantic allurement of scenes in which this couple should be permitted to occupy the foreground alone. Everything that occurs in the book, every scene, every dialogue, every reflection is sifted through the mind of Strether, so that whatever else may be sacrificed the author has secured the advantage of a complete centralisation of the interest. Much obviously depended on the right choice of this central character. In an earlier and weaker book "The American," James presents us with Christopher Newman whose virtues are decidely not those of the imagination, and who is incapable therefore of assimilating or transmitting the finer values of the life with which he is in such imperfect contact. James never repeated this error. In all his subsequent books there will be found one or more persons characterised by an extreme sensitiveness to impressions, who serve therefore as subtle registers for recording all the finer implications of the most complex environment. Of these the ageing Strether is perhaps the most exquisite in organisation. Of imagination all compact, he is a man on whom nothing is lost, for whom the outer world emphatically exists, and in whose mind the most delicate processes of adjustment perpetually shape themselves to new perceptions of significance. Chad has but to make his late first appearance in a theatre-box for Strether to realise from the mere manner of his entrance that something momentous has occurred. His business now will be not with the unsophisticated youth that Woollett had known, but with a man whom the Woollett scales could not measure nor the Woollett judgment appraise. Reflection is stimulated by the realisation that his own life offers but a stunted growth. For its expansion it needed a mellower and a richer soil. Strether stands one day among the Odéon book-stalls, and his mind revives the first impressions that thirty years of absence have overworn. "He was there on some chance of feeling the brush of the wing of the stray spirit of youth. He felt it in fact, he had it beside him; the old arcade indeed, as his inner sense listened, gave out the faint sound, as from far off, of the wild waving of wings. They were folded now over the breasts of buried generations."

Strether's impressions have been accumulating for some weeks when we find him seated one day with Chad's friend Bilham on a bench in Gloriani's garden. He is pleasantly sustained by the mere fact of feeling that persons of high distinction are present,—authors, dramatists, artists, fashionable celebrities even—but he does not wish to talk with them, "having nothing at all to say and finding it would do beautifully as it was; do beautifully because what it was—well, was just simply too late. And when after this little Bilham, submissive and responsive, but with an eye to the consolation nearest, easily threw off some 'Better late than never!' all he got in return for it was a sharp 'Better early than late!' This note indeed the next thing overflowed for Strether into a quiet stream of demonstration that as soon as he had let himself go he felt as the real relief. It had occasionally gathered to a head, but the reservoir had filled sooner than he knew and his companion's touch was to make the waters spread. There were some things that had to come in time if they were to come at all. If they didn't come in time they were lost for ever. It was the general sense of them that had overwhelmed him with its long slow rush.

"'It's not too late for *you*, on anyside, and you don't strike me as in danger of missing the train; besides which people can be in general pretty well trusted, of course—with the clock of their freedom ticking as loud as it seems to do here—to keep an eye on the fleeting hour. All the same don't forget that you're young—blessedly young; be glad of it on the contrary and live up to it. Live all you can; it's a mistake not to. It doesn't so much matter what you do in particular, so long as you have your life. If you haven't had that what *have* you had? This place and these impressions—mild as you may find them to wind a man up so; all my impressions of Chad and of people I've seen at *his* place—well, have had their abundant message for me, have just dropped *that* into my mind. I see it now. I haven't done so enough before—and now I'm old; too old at any rate for what I see. Oh I *do* see, at least; and more than you'd believe or I can express. It's too late. And it's as if the train had fairly waited at the station for me without my having had the gumption to know it was there. Now I hear its faint receding whistle miles and miles down the line. What one loses one loses; make no mistake about that. The affair—I mean the affair of life—couldn't, no doubt, have been different for me; for it's at the best a tin mould, either fluted and embossed, with ornamental excrescences, or else smooth and dreadfully plain, into which, a helpless jelly, one's consciousness is poured—so that one 'takes' the form, as the great cook says, and is more or less compactly held by it: one lives in fine as one can, Still, one has the illusion of freedom; therefore don't be, like me, without the memory of that illusion. I was either, at the right time, too stupid or too intelligent to have it; I don't quite know which. Of course at present I'm a case of reaction against the mistake; and the voice of reaction should, no doubt, always be taken with an allowance. But that doesn't affect the point that the right time is now yours. The right time is *any* time that one is still so lucky as to have. You've plenty; that's the great thing; you're, as I say, damn you, so happily and hatefully young. Don't at any rate miss things out of stupidity. Of course I don't take you for a fool, or I shouldn't be addressing you thus awfully. Do what you like so long as you don't make my mistake. For it was a mistake. Live!' Slowly and socially with full pauses and straight dashes, Strether had so delivered himself; holding little Bilham from step to step deeply and gravely attentive. The end of all was that the young man had turned quite solemn, and that this was a contradiction of the innocent gaiety the speaker had wished to promote. He watched for a moment the consequence of his words, and then, laying a hand on his listener's knee and as if to end with the proper joke: 'And now for the eye I shall keep on you!'"

This unusually prolonged utterance is the focal point of the book. James has deliberately passed by the rich emotional possibilities of a first hand study of the relations of Chad and Madame de Vionnet, and has bent himself to catch the image of the European world as it fashions itself in Strether's sad reflecting eyes. Chad's affair is but one item in the glittering register. It is Strether's purgatorial penance to see, to know and to sympathise without the privilege of participation, and to feel his old prejudices wearing away with no power vouchsafed to supplant them by permanent contact with the renovating forces of which he is so yearningly aware. His enjoyments are vicarious and imaginative, and are always upon the high plane of feeling where sensation is instantly converted into thought. Such as he is, too little romantic or tragic for the purposes of the ordinary romance, Strether suits James's book exactly. The least querulous of heroes his stoic quality subdues his own particular problem to the proper pitch of subordination, while by his quick responsiveness to impressions he enables his creator to focus the whole bright picture in his reflecting mind.

Except in the autobiographical novel, which for our author does not exist, we are usually permitted access to the range of thought and feeling of several of the characters, and James himself is customarily more liberal in his concessions to our curiosity than in the book we have been discussing. "The Golden Bowl" is constructed with care, yet we have direct access to the mind of the Prince in the first volume, and in the second volume we are made free of the mind of Maggie Verver. We have generous contact too with Mrs. Assingham's range of impressions; and among the characters of the first order of importance it is only Charlotte who is revealed to us by indirection, from hints of dialogue that is to say or by the casual comments of her friends. The question naturally arises why James in "The Ambassadors" did not avail himself of the privilege of narration in the first person, but with the question comes the ready answer that his dearly earned compactness of treatment could never have been attained with the temptations to fluidity and divagation inherent in the first personal form. He evidently was willing to sacrifice much for this precious unity, and on the whole he has made the sacrifice I think with adequate compensation. In that scintillating book "The Awkward Age" it pleased him to experiment in a new direction. No single character usurps our attention, which is centered here on a chosen group whose individual members reveal themselves in dialogue of the most sparkling quality. Of reflective analysis there is not a trace, and the reader is blessedly left alone to make his own reflections and reach his own conclusions.

"The Ambassadors" is a remarkable *tour de force*, but it is a book in which James has imposed even upon himself a standard of composition too exactingly and too unnecessarily high. Strether's powers of reaction and his capacity for expression are, as we have seen, taxed to the utmost to prevent the unity of impression from passing into monotony. Our writer's method has a reaction also on the dialogue which deserves to be noted since it concerns the whole series of the novels. His people talk well, and for the most part naturally, in short crisp sentences which bear no difficulty for the reader who has penetrated to the heart of the situation. If adverse comment is to be made it is that the conversations are too firmly under control. I am well aware that many novelists of distinction err in the other direction, and try to get more results out of dialogue than it is capable of giving. It offers more temptations for brilliance and more occasion for ornamentation than the blocks of narrative, description or reflection that are, as it were, the solid masonry out of which the novel is built. The dinner-party conversations of "Diana," and the sayings at large of Meredith's epigrammatic tribe illustrate at once the temptation and the danger. Let us glance for a moment at the practice of the three novelists whom as masters of the craft James most admired. Balzac, to whom especially he acknowledges his deep indebtedness, kept his dialogue in due subordination. Its function with him is to illumine a situation and to reveal character, though Heaven knows he takes full advantage elsewhere in his books of the author's privilege to vent his own opinions. Flaubert's mind was not rich in general views, and he had not the same temptation to make his characters talk at random and at large; yet his conversations repeatedly drift beyond the limits of the central situation. The apothecary Homais is a part of Emma's mean and narrow world, but his divagations have nothing whatever to do with her particular problem. Their sole yet ample justification is that they solidly establish the character and exhibit the vanity and pompous insincerity with which the author's ironic vision chose to endow him. Turgénief's range in dialogue is still freer from restraint. It does not usurp the function of narrative, but it does everything of which dialogue is legitimately capable. It marks character and illuminates a situation of course, but also it is a well grooved channel through which flows a brimming river of ideas. So long as the ideas are in character their utterance infringes no law of art, and Turgénief satisfied this condition by introducing into his books voluble talkers whose expansiveness is their temperamental sign. To return to James. While his conversations are generally as we say "in character," they still do not mark character so incisively as the conversations of Balzac, who constantly finds the unconscious revealing word that lays bare its most hidden tracts. Indeed it is often by reticence rather than speech that James's characters betray themselves to us, a peculiarity which is well exemplified in the pleasant game of hide and seek that we play throughout "The Golden Bowl." His reverence, too, for the dominant theme does not allow him even in the reflective passages the author's license of variegated comment in which Balzac so freely indulges himself, and I can think of no character like Flaubert's Homais who is permitted to reveal himself in terms and by actions that do not chime with the particular intention of the book. It is his solicitude for tone and atmosphere that has compelled this reserve, and James probably feels that the business he has in mind, the necessity of exhibiting the interrelations of his chosen group, is matter large enough to occupy and to repay his full attention. "The Tragic Muse" whose theme is art, and "Princess Casamassima" whose theme is socialism are the only full length novels in which, thanks to the subject matter, the conversations are allowed a flexible range.

It must not be inferred that James reconciles himself to any absolute sacrifice of variety in his chosen method. The variety is there, but how he secures it is his own secret, and is divined only by readers who consent to give him the courtesy of their intellectual co-operation. His seeming effortlessness is not divorced from labour, and an amazing amount of preparation lies beneath the harmonious beauty of the final result. Wherever the enlightened judgment of posterity may place him he will inevitably be regarded as the most artistic of our novelists, and his work will remain as a standing menace in the path of all the sloppy clever writers who indulge themselves in fiction because of the inviting facility of the form.

We do not know a novelist until we are familiar both with his world and his method. I have denied myself the pleasure of a journey through the world of Henry James. I cannot avail myself of the copious letters of introduction which would make me free of the society of its inhabitants and admit me on a footing of familiarity with a multitude of people whose friendship would so amply repay cultivation. But some further general observations on his method I may permit myself in conclusion, and I wish more especially to discover the extent of James's indebtedness to the writers for whose theory and practice he professed the most regard.

Though his own work seems to have few attachments with that of Balzac, he yet proclaimed himself in all modesty and admiration his disciple. What he most valued in him was "his unequalled power of putting people on their feet, placing them before us in their habit as they lived—a faculty nourished by observation as much as one will, but with the inner vision all the while wide-awake, the vision for which ideas are as living as facts and assume an equal intensity." Balzac then possessed the power of evocation to an unrivalled degree alike for his inanimate and human world, but he never contented himself with the mere act of representation. No object and no individual became fully alive beneath his hand until his mind could focus it in significant relation to the whole picture. His inventorial enthusiasm threatens often to swamp him, but if his boat rocks it still rides the waves. In such a closely woven book as *Eugénie Grandet* or *Père Goriot* we perceive abundance indeed, but no actual superfluity in the organisation of the environment. Balzac never admitted, as Arnold Bennett seems to do, that the naturalistic novelist's formula "une tranche de la vie" covers all the necessities of art. An indiscriminate slice cut at random from the loaf of life, however artfully buttered or stuffed with currants, is not his affair. A story is not a mere numerical series of happenings narrated with the highest regard for the circumstantial truth of the report and with commendable felicity in the delineation of the human participants. The loosest *picaresque* romance must, or should, have some organised centre of interest, if it is only the vagrant personality of the hero. In novels of a closer texture there is no room for sporadic cleverness, and the intensity which is aimed at by Balzac and James is secured by the most scrupulous selection and organisation of detail to the end that everything which happens (and properly considered an incident, an idea or a description are happenings) shall be charged with a significance that points beyond the mere event itself and is contributory to the main intention of the book.

No theorising on the novel is complete without a statement of Flaubert's position. His ideas and their practical application have been matter for constant discussion in France where the lists are always open for literary disputants, and the English world has heard echoes at least of the eager debate. That we cannot approach the questions at issue with a like degree of warmth is due to the fact that our literary developments are more equable because unconscious, and are not disturbed by violent coterie reactions from classicism to romanticism, from romanticism to realism, from realism to symbolism, and so round the whole face of the clock to the point of departure. Flaubert's sacred fury is to be explained from a real dislocation in his nature, whereby his judgment was in perpetual warfare with his inclinations. Extravagantly romantic by disposition he was born in an age when the hour of romanticism had struck; the literary vices he assailed were rooted in himself; and the blows he dealt were so many self-inflicted wounds. Romanticism had been vehemently partisan, he asserted the need of complete disinterestedness; romanticism had revelled in self-expression, he insisted on the absolute submergence of the author in the theme to be expressed; romanticism had attached itself to extraordinary characters, Flaubert restrained himself designedly within the limits of flat reality, confident in the efficacy of art to lift the subject out of the region of the commonplace.

With James we can approve of the general doctrine of disinterestedness enunciated by Flaubert, while recognising with him the almost fanatical exaggeration of the principle that Flaubert's practice reveals. Balzac was disinterested enough, that is to say he does not disturb the logic of events by thrusting his own preferences into the foreground. The finished, rounded, self-sustaining work is with him the dominant consideration as it was with Flaubert. But he never like the latter gives us the impression that the whole joy of creation resides in the process of execution. He reserved to himself the privilege also of establishing sympathetic relations with his subject, and his abundant delight in his own characters contrasts very much to Balzac's advantage with the cruelly ironic treatment that Flaubert's excessive detachment entailed. It seems to me that an author ties himself hand and foot whose habitual attitude to his theme prompted the phrase "Ça me pue au nez étrangément." James on the contrary loved his theme no less than he delighted in the art which its execution demanded and his serene impartiality was never obtained by the sacrifice of his sympathy.

The drift of realism in France has been largely in the direction of pessimism, and its most gifted authors write under the conviction that the truth is cruel. Their work is chiefly directed towards the exposition of human folly in a world where vice alone assumes heroic proportions. Only where vice is concerned are they willing to select extreme examples, and they prefer for the most part to confine their observation within the limits of mediocrity. James is not in the habit of launching characters of extraordinary power, but his fine-sighted Strethers and his sensitive Maggie Ververs are multiplied throughout his books, and we are not surprised that this pre-occupation of French writers with the commonplace evoked from him an energetic protest. In Fréderic Moreau Flaubert has presented us with one of his characteristically fatuous central figures. "Why," James queries, "did Flaubert choose, as special conduits of the life he proposed to depict, such inferior and in the case of Fréderic such abject human specimens? . . . . He wished in each case to make a picture of experience—middling experience it is true—and of the world close to him; but if he imagined nothing better for his purpose than such a heroine and such a hero, both such limited reflectors and registers, we are forced to believe it to have been by a defect of his mind." The author's preface to the "Princess Casamassima" assigns reasons for his own preference for personages who are forceful enough to produce and sensitive enough to appreciate the situations in which they are involved.

If we imagine human character as it were on a descending scale of complete awareness, half-awareness and un-awareness, we must assign James's principal figures to the first named category, not because they are necessarily extraordinary but because they are always exquisitely alive. It must be admitted that from book to book they somewhat too closely resemble one another in their intellectual organisation. It is only by the special situations, and not by peculiarities of mind or temperament that Milly Theale and Maggie Verver are differentiated, and Strether the American and Mr. Longdon the Englishman have a like identity. The advantage for James of their high competence is that they can absorb all the intellectual effort that he is capable of bestowing on them. He concentrates the full powers of his mind in registering their moods, their impressions and their opinions, and exercises his inventive faculty to the utmost in devising their appropriate environment and the conditions that call their activities into play. His secondary characters, his half-aware people as I may describe them, are not given the same ample opportunity of development. James does not consider that they would repay the trouble of elaboration. When leisure and luxury produce them he does not always scant their measure, and people of limited vision,—his Lady Julias, his Mrs. Newsomes, his Waymarshes and his Sarah Pococks have a frequent serviceability in providing the element of contrast. We must not conclude that James, though obviously without the inventive exuberance of Balzac and Dickens, was lacking in the ability to produce a variegated world. The subject of "Princess Casamassima" necessitated a dipping down into a stratum of society that he had never systematically explored, and he acquitted himself of his task with some success. The matter resolves itself after all into a question of tone, and one feels that if a butler or a footman came suddenly alive in a book of James there would be an irreparable breach in the suave continuity of the composition. Dickens's looser method admitted the irruption of a host of incidental characters into his books, Skimpoles, Jellabys, Jaggerses and the like, whose elimination would leave the story almost bare of interest, and his serving-people are allowed the fullest luxury of self-expression. James's books are bare of incidental characters, and he keeps his servants in rigid line at the hall entrance. A footman may not talk, but he may present a letter or a glass of sherry on a silver tray. And this is not because James is incapable of appreciating, but simply that he designedly neglects, the possibly intelligent and certainly amusing below-stairs version of the dramas enacted on the drawing-room floor.

Upon one rich tract of country, the region of unawareness, James never set his adventurous feet. Yet primitiveness is a rich mine for the artist who can bring its wealth to the surface. Dogberry, Verges, Slender, Silence and Shadow are a part of the treasure-trove, and Hardy's country-folk were created in the spirit of the same tradition. The proved incapacity of James to represent the unsophisticated strain in human nature is a defect which his admirers must admit. It is one of the penalties he pays for his refinement.

1776 and 1914, A Contrast in British Colonial Action

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(Read May Meeting, 1918)

The title is open to criticism, for the word "colony" is not now applied to Canada, Australia, New Zealand or South Africa. They are "the overseas Dominions," and this fact proves that during the period which has elapsed since the American Revolution British Imperial Policy has been transformed. Though for some years the use of the word "colony" as applied to these countries has been almost obsolete, the significance of the new policy of the British Empire was not realised by the world until the consentient action of the self-governing dominions in August, 1914, as well as of India and the dependencies, revealed the vitality and spirit of this multifarious but integrated Commonwealth. Holland was amazed at the action of South Africa, even the United States did not expect such spontaneous and effective co-operation, and of course Germany, whose public men had been comforting their people with assertions as to the incoherence of their rival's vaunted empire, was chagrined. To this day she cannot understand the intervention of Canadians, Australians, and Boers in a struggle with which in her judgment they should have had no essential concern. Probably she did not fear the material aid which they might bring, for towards everything Anglo-Saxon of military quality she was consistently contemptuous; but the presence in Europe of these sons of hers overseas, and of others of almost every race and religion, was an unwelcome proof of a power which she had been unable or unwilling to detect, because according to her own theory empire depended upon a rigid constitution with a central autocratic government, whereas London could not by order summon to her aid or control those far-off dominions. So in the first week of the war one of Germany's greatest delusions as to the basis of world power was shattered.

Even Britain herself was surprised. Ever since the war began she has thankfully admitted that she built better than she knew, and has been profoundly moved by the political and economic efficiency of the Empire, as well as by the confidence in the Motherland that has been manifested by each several portion. It is only partially correct to say that Britain built better than she knew, for most of the building was done by her sons who had left her shores on their own initiative to benefit their fortunes without any help from government. Though the Empire has come into being by an unpremeditated process, it is to Britain a token of her essential justice that issuing from this home, spring, and source, a spirit has interpenetrated the diverse parts and made them one. The Empire is not run by machinery. It is a body politic.

But what is it that creates the spirit of this Commonwealth? Why is the British Empire greater to-day than it was before the United States seceded? To answer these questions, it is necessary first to answer another. Why did the United States secede one hundred and forty years ago? In many respects Virginia had closer relations with Old England than with New England. The States would not unite even for their own interests. And yet in spite of intercolonial jealousies these communities combined to revolt from the Motherland, and that too under the leadership of Washington, who possessed the best qualities of an English gentleman, and is now regarded by British and Americans as an outstanding representative of the Anglo-Saxon race. Only very radical causes could have created a union for revolt out of such discordant States, especially as their action would not at that time seem to have been worldly-wise.

Of course no single motive is sufficient to explain this break from Great Britain. The character of the immigration, both the original and the later, was always a factor that produced dissidence from the ruling classes in England. The Puritan fathers of the northern colonists flung away from England under persecution, and doubtless their descendants had little sympathy with their overseas kinsfolk; a large and more recent immigration from Scotland and Ireland had brought with them the memory of grievances which persisted and caused them to harbour dislike for England as she was then governed. Moreover, the colonies had been losing their pure English quality as streams of German and Huguenot settlers had poured into new lands. Diverse though these elements were, soon a common system of education produced a type of average man different from the Englishman; and as time went on the American fashioned for himself powers of government and a political system unlike that which existed in England. Though the institutions within the several States did not resemble the British Parliament with its responsible government they gave rise to independence and self-reliance. There was no class in the Motherland which quite corresponded to the American colonist; those who governed England belonged to an order which for the most part could not understand him. It is not a matter for surprise that these peoples separated by the ocean, environment and social customs were time and again at cross-purposes, but unfortunately it too often happened that tactless governors or stiff officials took no pains to comprehend and alleviate complaints, which when mishandled turned into grievances.

The people, however, would have been content to remain as they were in the enjoyment of the privileges of their several States and sharing in the proud history of England without a thought of national independence, had it not been that the colonial policy of England at that time was in itself an alienating factor. The relations between England and her colonies were not what they ought to have been chiefly by reason of the illiberal ruling principle then in vogue, that the colonies were retained mainly for the commercial interest of the Mother-country. The outcome of this principle was that if the local assemblies passed any legislation which might interfere with her trade, Parliament or the King would immediately veto it. England did not follow her sons with enough generous regard, nor did she expect loyalty from them as from members of a family. "Colonies were not looked upon as homes for a surplus population simply because England was not overpopulated Hence emigration was not encouraged and there was no surer way to condemn a colony than to show that it tended to diminish the population of the Mother-country. Colonies were esteemed in the main solely for commercial purposes." (Beer) This selfish and material view of the mutual relations prevailed on both sides of the ocean; indeed it was so strong in the colonies that during the French war, which the English were waging, partly it is true on their own behalf but mainly for the benefit of the Americans, an illicit trade of such proportions sprang up between them and the enemy that the British generals often found themselves worse supplied with food than the French were, the war was thereby prolonged, and a root of bitterness was planted which continued to produce trouble. It was only natural that the English administration were amazed when the Americans gave them little support in arms and refused to take a share in the financial burden of a war, which they had made more expensive to the British taxpayer through their own illegitimate aid and comfort to the enemy. This was the deplorable result of commercialism.

But the Revolution would not have succeeded had the total grievances been a matter of trade. The interests of the colonies were too divergent to make that possible. Commercialism, however, challenged a principle which became clearer the longer it was challenged, and unfortunately in the northern colonies there was no inherited sympathy with the Mother-land to counsel patience with obstinate officials and endurance, until a party more friendly with them might succeed to power in England and redress their wrongs; though even Virginia took fire once the principle of civil liberty was struck hard. On being taxed by the British Parliament the colonies felt that if they submitted they would be guilty of renouncing their freedom. The question at issue was one of political status, the right not to be taxed without representation which they believed was the supreme privilege of Englishmen and was the touchstone of political liberty. "In nearly every respect (the Colonists) governed themselves under the shadow of the British dominion with a liberty which was hardly equalled in any other portion of the civilized globe. Political power was incomparably less corrupt than at home, and real constitutional liberty was flourishing in the English Colonies when nearly all European countries and all other Colonies were despotically governed." (Lecky). It was not a matter of the amount of money involved in the taxing; that was trivial indeed in comparison with the cost of a war, and to have shed blood for the aggregate value of the taxes would have been a crime of the first order from which a man like Washington would have shrunk in horror. Acton has remarked in one of his letters which have been recently published:—"No dogma in politics is more certain than this; Liberty was at the point of death in 1773, and it was America that gave it life . . . The problem presented by the Americans was at bottom this—Should the existence of one's country, one's family be risked, one's fortune be ruined and one's children exposed to death, blood be shed in floods, all that be renounced which has been established by authority and sanctified by custom for an idea which is nowhere written down, which is purely idealistic, speculative and new, in contradiction with the constitution, which has no religious sanction for itself, nor legal credit, which is unknown to all order and legislators. The affirmative answer is the Revolution, or as we say Liberalism."

Washington, "the Father of his country," was a conservative, who felt that the action of the King, Townshend, Grenville and North was a breach of law, that they were overturning the foundations of freedom and that the defence of the right was of necessity placed in the keeping of the colonists. This also was Burke's view: "Those who have and who hold to the foundations of common liberty whether on this or on your side of the ocean, we consider as the true and only Englishmen." The leadership of Washington reveals in large part the deepest motive in the Revolution. He belonged to Virginia, was an aristocrat, an Episcopalian, a wealthy slave-owner, without special sympathy for democracy, and possessing friends in the finest English society. He must have been strongly attached to England, nor was he disturbed by the trade difficulties between the northern Colonies and the Mother-land, for he was a great landowner in a State that gladly imported its manufactures from England and sent her tobacco in return. Neither incompatibility nor self-interest could have induced him to break away from England and join hands with democratic and puritan New England which hated Toryism and Episcopacy. Intensity of conviction alone carried him through years of great distress when he had to endure disappointments and disloyalty at the hands of various States and Congress. The winter at Valley Forge tested him to the utmost; again and again he saved the situation by his masterful character and dominating will. But his actions are not to be accounted for by mere stubbornness. He was really in spirit a great Englishman like Pym, Hampden, or Milton, who would take their country into war rather than abandon a principle of liberty, and his principle was similar to that of the English Civil War as stated by Ludlow: "The question in dispute between the King's party and us was, as I apprehended, whether the King should govern as a God by his will, and the nation be governed by force like beasts, or whether the people should be governed by laws made by themselves and live under a government derived from their own consent." (Quoted in Firth, *The Parallel Between the English and American Civil Wars*, p. 6). By the course of events the right of imposing taxation had come to be regarded as the supreme proof of a self-governing community, and until this right had been entrusted to them their státus as freemen was not complete.

We turn to the other half of the English-speaking world. The creation of the American Commonwealth of set purpose and with a rigid constitution to which the legislative action of Congress must conform, is quite different from the rise and character of the present British Empire.

When the thirteen colonies revolted England was ruled at home by incompetent politicians and led in the field by feeble generals. It seemed as though she must do the wrong thing on every occasion. It was the Colonists not the British Government who were defending a true principle of genuine English political development.

The years that followed were among the darkest of England's history. Many thought that her day was near its close. Her greatest poet, Wordsworth, read the causes of her trouble in domestic conditions; and yet in the worst moments he never lost hope in her because he knew that the heart of the people was sound, that in it was a power, a spirit,

"whether on the wing
Like the strong wind, or sleeping like the wind
Within its awful caves."

But he scores the leaders, writing many years afterwards in 1810:

"In the course of the last thirty years we have seen two wars waged against liberty—the American war and the war against the French people in the early stages of their Revolution—And for what belongs more especially to ourselves at this time we may affirm—that the same presumptuous irreverence of the principles of justice, and blank insensibility to the affections of human nature which determined the conduct of our government in these two great wars against liberty, have continued to accompany its exertions in the present struggle for liberty, and have rendered them fruitless" (Tract On the Convention of Cintra.)

The voices of Chatham, Burke and Wordsworth had their effect. They recalled England to her true self and she began to set her own home in order. Her patriot sons had struck a note which overpowered the lingering discords of the old imperial policy, though it did not become clear and resonant till well on in the nineteenth century. A sense of responsibility for a Commonwealth greater than that which she lost in the revolt of the American Colonies was making itself felt. A new theory of Empire arose.

During the nineteenth century Britain became democratic, and the process by which the franchise was widened and changes were effected so that expression might be given to the will of the people, has been a large factor in the creation of the new policy of Empire which has almost insensibly displaced the old. Imperialism had been associated for the most part with that side of politics which drew its strength from the families who supplied the great soldiers and sailors, and who assumed that the prestige of expanding dominions was a continuance of the prowess of Elizabethan days. But in truth the Empire is not thus Imperialistic as to origin or character. It is not the result either of premeditated conquest or of set colonizing purpose. It can only be understood by considering the quality of the emigration from Britain, and the causes that stimulated it. No ruling idea, or special creed, or practice drove our Canadian forefathers out, as was the case with many of those who went to the United States, nor did they flee from England to a new land in the hope of securing wider freedom. Unlike the New England and the Pennsylvanian emigrations our people did not come to our present home to escape from a condition of affairs that was oppressive. They parted in goodwill from those whom they left behind with their eye set on the new land where they and their children might better themselves in a worldly way, and often their hearts turned back in affection to their kinsfolk overseas. Even their children continued to talk of Britain as "Home," and when after a generation through the favour of fortune their sons visited the old land, they sought the place of their fathers and the branch of the family still living as the stock in the old soil.

To understand the new Empire it must be borne in mind that on the whole the population of Canada (apart from Quebec), Australia, and New Zealand was until recently fairly homogeneous, and that the incoming peoples were drawn from those classes in Britain which were by degrees receiving the franchise. These circles to whom the power of government was being entrusted were like the average type of person throughout the English-speaking world. In Australia even labour governments have been in power and New Zealand has surpassed all records in social experiment. But Canada was the first to make the endeavour to secure for herself the same privileges as her English and Scotch brothers enjoyed at home, and it was the striking success of this endeavour that has made the new Imperial structure possible. Responsible government has become a cohesive and vital principle, and Canada has a right to her primacy among the other young nations of the Commonwealth because within the old provinces of this Dominion that principle was first formulated and established.

Further the attachment to Britain was strengthened throughout the century by the frequent causes of trouble that arose between the Canadian provinces and the United States, even after the war of 1812, which were sometimes sufficiently serious to endanger the peace. The distinct individuality of the Canadian people cannot be understood unless their relationship towards the United States is taken into account. There never has been any serious trend towards annexation in any of the provinces, and many Americans assuming that there must be have been astonished to discover that their assumption was usually resented by Canadians. Most Americans understood very little about the character of Canada. During the past few years we have heard a great deal as to the part that Canada might play in bringing the United States and Britain together, but until the United States began to comprehend our national life and history, Canada would not have been an efficient interpreter. This fact is all the more surprising because there had been for many years an immense emigration from Canada into the United States. Ontario sent hundreds of thousands of her best sons and daughters into Ohio, Illinois, the middle West and California; and the Maritime Provinces were at times almost drained into the New England States; but the United States living to herself gave no thought to our difficulties or development, and Canadians were content to have it so. It is only within the last decade that a change became noticeable. Since the opening of the war, however, we have received an attention from our Southern kinsfolk which is almost beyond our deserts.

It is not to be supposed that during the first half century that elapsed after the American Revolution the ruling classes in Britain had awakened fully to the promise and potency of the Empire that still was theirs; they feared to extend self-government to the colonists lest they should with the taste of freedom demand separation. Some indeed believed them to be a drag in the wake of the ship of state and would have been willing at any time to cut the painter and let them go. Lord John Russell, who might have been supposed to look with favour on the granting of responsible government, disappointed the hopes of the Canadians, and his action drew forth a remarkable series of letters from the Hon. Joseph Howe in 1839, from which I take this extract:

"Can an Englishman, an Irishman or a Scotchman, be made to believe, by passing a month upon the sea, that the most stirring periods of his history are but a cheat and a delusion; that the scenes which he has been accustomed to tread with deep emotion are but mementoes of the folly and not, as he once fondly believed, of the wisdom and courage of his ancestors; that the principles of civil liberty, which from childhood he has been taught to cherish and to protect by forms of stringent responsibility, must, with the new light breaking in upon him on this side of the Atlantic, be cast aside as a useless incumbrance? No, my Lord, it is madness to suppose that these men, so remarkable for carrying their national characteristics into every part of the world where they penetrate, shall lose the most honourable of them all, merely by passing from one portion of the Empire to another . . . My Lord, my countrymen feel, as they have a right to feel, that the Atlantic, the great highway of communication with their brethren at home, should be no barrier to shut out the civil privileges and political rights, which more than anything else make them proud of the connection; and they feel also that there is nothing in their present position or their past conduct to warrant such exclusion . . . Many of the original settlers of this province emigrated from the old colonies when they were in a state of rebellion—not because they did not love freedom, but because they loved it under the old banner and the old forms; and many of their descendants have shed their blood on land and sea, to defend the honour of the Crown, and the integrity of the Empire. On some of the hardest fought fields of the Peninsula my countrymen died in the front rank with their faces to the foe. The proudest naval trophy of the last American War was brought by a Nova Scotian into the harbour of his native town; and the blood that flowed from Nelson's wound in the cock-pit of the *Victory* mingled with that of a Nova Scotian stripling beside him, struck down in the same glorious fight. Am I not, then, justified, my Lord, in claiming for my countrymen that constitution, which can be withheld from them by no plea but one unworthy of a British statesman—the tyrant's plea of power? I know that I am; and I feel also, that this is not the race that can be hoodwinked with sophistry, or made to submit to injustice without complaint. All suspicion of disloyalty we cast aside, as the product of ignorance or cupidity; we seek for nothing more than British subjects are entitled to; but we will be contented with nothing less."[1]

And this constitution the provinces got and kept, thanks to Lord Durham, Lord Sydenham and Lord Elgin. Never has any colony or dominion or dependency had three abler governors, and they became the architects not only of Canada but of the British Empire, which has just been proved to have been built on the most solid foundation, "natural affection, pride in their history, and participation in the benefits of a government combining executive power with individual liberty." (Howe).

The willingness to trust men of her own stock with liberty in the confidence that they would not mishandle such a priceless possession, has been the secret of Britain's success in the latter half of the 19th century as a colonizer and builder up of young nations. And this is a secret which most other nations have not learned and which they hardly realize that we possess. The battle having been fought in Canada was decided once for all, and the Empire was pervaded almost unconsciously by the new idea which created confidence in each part, and drew each to the Mother Country for which they had an antecedent affection.

The Imperial system, however, is not yet complete. We have for years been entrusted with our own fortunes within the Dominion of Canada. We enjoy provincial and dominion autonomy, but what about our relation to the outside world? This is now determined simply by our union with Britain. We cannot escape the dangers that beset her with her world-wide Empire. We know by experience that if she is at war we must be at war too. We would not, it is true, have it otherwise; at least those of us who belong to the English-speaking provinces. But hitherto we have had no voice in foreign policy. We have not had a representative even at Washington. Nor have we undertaken the obligations of our own protection, though in the present war indeed we have assumed a larger share of our defence than ever before. This condition cannot long remain so; the responsibilities of the future in a world so full of possible troubles are beginning

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[1]The Speeches and Public Letters of Joseph Howe, Vol. I. 263.

to weigh upon us, and evidently we must enter into fuller partnership with Britain as regards these matters. How that is to be done is the question of the near future. The one essential principle seems to be that in taking a share in Imperial foreign policy we must not become thereby less truly Canadian, but rather complete our nationality in assuming greater obligations. Nothing affects us more than the sacrifice of our own sons. This reaches the very hearths of our homeland, and a policy that calls for such sacrifice is the most intimate of all. Therefore we cannot do the full duty of Canadians by living to ourselves within the Dominion; only by realising the new idea of Empire in common with Britain and the other Dominions can we gain sufficient control even of our domestic destinies.

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The War and Science

By DR. A. STANLEY MACKENZIE, F.R.S.C.

(Delivered Tuesday, May 21, 1918.)

I know that the general subject upon which I have chosen to address you is one about which much has been said and written of late; but, notwithstanding this fact, and the further fact that I cannot hope to throw new light on the matter, I have felt justified in my temerity by the impression which has been steadily growing upon me that today Science has fallen upon the most momentous period of its history, and that this annual gathering of representative men of science of Canada might well afford to stop in its haste to deal with specific achievements and local advances on some narrow sectors of the field, in order to consider the major operations, and to try to understand how the whole front line is swinging and what is the strength of the latest forces which are now operating on it.

We may discuss this subject from two quite different points of view; we may point out that this is a war waged by science, and may elaborate the applications of new and old scientific principles in the most intricate and devilish engines of offense and the equally ingenious and effective devices of defense, or in the most gruesome new modes of death and agony and the equally wonderful methods of preventing death, disease and permanent disablement, and of soothing and alleviating pain and misery. Much has been said on this both moral and unmoral status of science; fostered by us as the great servant of civilization and the promoter of prosperity and comfort to men, it is equally potent for the horrors of war, and the same power that has banished diseases and ameliorated the terror of wounds has poured out the deadly gas and high explosive on innocent women and children. To the devoted adherent of Science this is a most fascinating line of thought, and I am sure any one of us would be voluble upon the part his special science, or corner of science, has played in winning this war—for win we shall. The physicist would like to tell you of the rapid progress he has made in the mastery of a new element, the air, and the theory of ærodynamics; what ingenious acoustic devices he has invented to locate and destroy the lurking submarine and the hidden monster gun; to what lengths he has pushed the applications of wireless waves, of electrical instruments of detection; of the new uses to which he has put old apparatus. The chemist could recount the triumphs in the making of explosives, and the improvement of processes in their making, the production of deadly gases and gas protectors, the making of dyes and optical glasses, the cheapening or simplifying of methods of production, and the discovery of substitutes for many products.

But though this would be most instructive, and most interesting, even the parts of the story which are not secret and can be told to-day, yet I have preferred to take up the second point of view, namely, the effect the war has had, and is having, and can have on Science.

Perhaps the first result of this war on Science in British countries has been the confidence it has given us in our standing today and in our own accomplishments in the past. In general we can assert that the challenge to British science to show what it could do to meet the array of scientific devices elaborated in long secret by the enemy has been brilliantly taken up by our own scientific men, and I think we can truthfully say, we have gone them one better. We have proved to ourselves that British men of science possess a knowledge and a resource certainly not inferior to the German; and we have always known that we have had more than our share in the discovery of the great underlying principles and ideas and theories in the application of which Germany has been so persistent and so successful. The conviction that our chemists and engineers can achieve by our liberal methods results which we have been told could not compete with German drill-sergeant, dogmatic and cast-iron methods, has been of the greatest service to us. For I think it is true that we have felt instinctively that rather than fall to his level and follow in his footsteps, we would accept our losses and retain our individual freedom; indeed I doubt that we could ever have driven our scientific students and our people to this form of wooden subserviency to rigid and autocratic system. We have learned that co-operation, coupled with the retention of our freedom of effort and power of initiative, can accomplish all we need in order to wrest the supremacy once for all for our own people. It is a great thing for our scientists and our manufacturers and our capitalists to have achieved confidence in our scientific ability and strength; in two years England accomplished in armament and explosives in all their ramifications in every department of Chemistry, Physics, Optics, etc., what Germany took forty years to do.

Forced by the stress of war to a realization of the desperate condition in which she stood, on account of her past neglect of scientific method, as an organized state, England called at last to her aid her ablest leaders of science as well as her leaders of industry, appreciating late in life that the latter, great though they might be, were incapable alone of meeting and countering the peril that confronted the country. At last it was realized that research and its keenest prosecution alone could hope to match the results of German devotion to the fullest application of every known invention and experimental evidence which the most excellently equipped laboratories could produce. And, though pitifully few in numbers, and handicapped by the paucity of great industrial laboratories, the scientific men of Britain, as I have said, nobly answered that call, and their achievements became patent to the lowest and highest classes alike; and this is the greatest result that the war has had for us as scientists. The word *Research*, long known only to a small group of enthusiasts, has come before our people as a new watch-word; but it has taken a whole world in arms to write it in large enough letters so that our British eyes could see and read it. Before the war it had gradually been appearing to him out of the mists of prejudice and stupid conservatism; it had begun to reach large groups of the community to whom earlier it was entirely unknown. The farmer almost grudgingly admitted that those college fellows' advice was valuable; and the wonders of the results of research in modern medicine and surgery came to every household. It was when it began to reach his home and his pocket that science and research were raised in the estimation of the average man. Three years of war has accomplished for science what thirty years of peace might not have done. It is now the task and duty of the scientific bodies to take full advantage of their position, and to see that these words Science and Research carry their proper signification, and that they shall continue to receive after the war the attention paid them today.

In time of peril to life we call in the doctor, but in after days of abounding health we wonder we were so foolish as to throw away money, when, as we now feel, a little time and rest would have restored us to our normal selves without any humbugging physician. "When the devil was well the devil a monk was he." It is the duty of scientific organizations to see to it that the state does not follow the example of the devil, and drift back to *laissez-faire* conditions. Advantage must be taken of the present psychological condition to see to it that the state subventions most liberally pure science and research; and even more liberally for a time industrial research also; but in the end industrial research will take care of itself, as men are convinced by use of the touchstone of gold that it pays. Again we must watch that the order of endeavor is not reversed; for if we liberally endow applied science only, to the neglect of pure science, both in the end will not prosper but must languish in spite of all. The encouragement and support of pure science would be the very best kind of a national investment; but no government can be expected to follow such a policy with any ardor without the constant backing of the whole scientific community.

I do not wish here to lay too much stress on the difference between so-called pure and applied science; they are but two developmental lines of a common purpose. Though their methods are the same, their spirit and springs of action are distinct. We must cultivate both, for only then are both most obviously essential. It is the interaction of the ideal and the practical or utilitarian that spells progress; each urges the other on to greater success and achievement. Whether as purely academic men of science or as constructive engineers, we must preach from two texts; 1st, cherish research for its own sake in every laboratory that exists, whether in university or industrial establishment; 2nd, instal a works and scientific laboratory in connection with every industrial establishment—to perfect its products, to eliminate its waste, to utilize its by-products, to develop new products, to devise new processes, to find new uses for its products, in other words to apply science to the industry. New science will bring new applications; new difficulties will evoke new science.

As members of this Royal Society we are particularly interested in the development of research in Canada, both research in pure science and industrial research. The meagre facilities we possess for conducting research, both in man-power and in laboratories, is a disgrace to a country of the population and wealth of Canada. Compared with countries like Norway, Sweden, Denmark, Holland, Belgium and Portugal, which are of the same order of magnitude of population, and which we do not like to place above ourselves in intelligence, education and progressiveness, we find that Canada in research is a very poor second. We have not a single university properly developed for general research, and only a very few developed even in some departments. We can give all sorts of excuses for this state of affairs, but they are excuses, and the fact is not to our credit, as a people aspiring to full nationhood, that we must go abroad beyond our own borders to be educated. Any one of the countries I have named could have had about as good an excuse, if all their advanced students went to Germany. Within the last few years a few works laboratories have been established in connection with some of our largest manufacturing concerns, but very little research is, as yet, being carried on in them. Canada has nothing of the nature of the National Physical Laboratory of England or the Bureau of Standards of Washington; it has nothing national in education and science of any kind, except perhaps in agriculture; and yet the fostering of science is an absolute national necessity. The Research Council of Canada has made a visit to the United States to study this problem, and has seen the Bureau of Standards, the Bureau of Chemistry, the Bureau of Mines, the Carnegie Institution, the National Canners' Association Laboratories, the Mellon Institute, the Philadelphia Commercial Museum, and more of the same general type; and Canada has nothing of the kind whatsoever. Add to these the dozens of great universities' laboratories, a score of even larger research laboratories of manufacturing corporations, and hundreds of smaller ones, and one begins to have forced upon him the extent of the inadequateness of our preparation to meet post-war industrial competition, and of our present position as a parasite on the research institutions of our friends and neighbors. It is surely the part of this Section to urge upon the Government that it immediately vote the money needed for the foundation of some sort of National Research Institution for Canada. The opportunity is now, while the war has made our legislators see the value of Science and Research; lack of pressure now may leave us in the parasitic stage. What we are looking for is a better understanding and a feeling of mutual dependence between science and industrial enterprise, and a reliance upon ourselves and our own resources for our progress and our place in the industrial world. No state hereafter can be satisfied to be dependent on another for the essential products, when they can be produced within its own borders. These things mean that research must be stimulated, that the state must give the stimulation, that it must provide generously endowed research stations where these problems can be studied for the general good of the state.

The effect of the war upon Science should then result in industrial revolution. Its first effect on Canada should be seen in the stoppage of wastefulness and of the rapid destruction of our really limited natural resources, which are the very antithesis of anything connoted by the word scientific. This in itself would be an industrial and scientific revolution, and were it accomplished we should know the whole battle would be won. But it can not be accomplished without great improvement in fundamental scientific education. The problem of teaching science so that it is real, without at the same time falling into the other extreme, of devitalizing it and making it merely rule-of-thumb utilitarianism, is one that seriously confronts us. This is the second of those things which I think this Section should do, or take the lead in doing, to form a committee of themselves and others to give an intensive study to this problem for Canada, and formulate a national curriculum of scientific education for the schools and colleges of the land. It is through the rising generation that the hope for success lies, and I do not believe there is any more important national work that this national society can do than the making of a thorough survey of our special defects and needs in scientific education, and the urging of their conclusions on the educational authorities throughout the country, for it is my own experience and the opinion of many of my friends that science is badly and inadequately taught in Canada today. If the war will force us to remedy that, it will have accomplished another good end. It does not mean at all a new controversy or struggle with the Humanities; there is room for all, if all are well done. If every college fostered research and provided for it, and every student were thus brought into actual contact with the living and growing organism of science and felt its vivifying infection, the virus would be carried by him into the school or into the workshop or on to the farm or into the forest as a scientist, so that the idea of research would be ever in his mind as an agent of final reference in all operations and difficulties. Research would then come naturally into its own. We must rid the minds of the average being of the wonder and admiration and awe of science, which the popular magazine and newspaper cater to, and substitute familiarity and commonplace and solid understanding. We do not and shall not ask for science in place of the liberal arts, but science along with the other factors of the basis of knowledge which goes to the acquiring of the true art of living.

Constitution of Certain Polynitro Compounds.

BY J. BISHOP TINGLE and WALTER ALBERT LAWRANCE.*

Presented by DR. R. F. RUTTAN, F.R.S.C.

(Read May Meeting, 1918.)

Bishop Tingle and Blank,[1] in the course of their investigation of the action of nitrating agents on a number of *N*-acyl anilines, obtained two compounds by the nitration of Picranilid and one by the action of Nitric Acid on Diphenylamine; they did not describe them.

Bishop Tingle and Burke [2] found all three to be tetranitrodiphenylamines; but they did not identify them.

The object of the present research was to identify these compounds.

I. The product obtained by the action of Nitric and Oxalic Acids on Picranilid is a bright lemon-yellow, granular powder, which, after recrystalizing twice from alcohol, melted at 215°·5. Analysis shows it to be a tetranitrodiphenylamine. All attempts to hydrolyze this compound failed. The 2,4,6,4′—tetranitrodiphenylamine was then prepared. This, after purifying with alcohol, had an M.P. of 216°. A mixture of these two melted at 216°; a proof of their identity. Thus the product of the above nitration is 2,4,6,4′—tetranitrodiphenylamine, $C_6H_2(NO_2)_3NH(C_6H_4NO_2)$.

II. Trichloracetic and Nitric Acids act upon Picranilid forming two compounds; (a) one which is soluble in Benzene and (b) a second soluble in Alcohol.

(a) The product soluble in Benzene was recrystallized twice from this solvent. It is a light-brown, crystalline substance melting at 190-1°, and is soluble in Sodium Hydroxide, developing a dark red colour when warmed. The melting point and colour reaction agree with those of the compound described in the literature as being probably symmetrical.[3], [4] It is identical with substances described under IIIb and IIIc.

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*Dissertation submitted in part requirement for the Master of Arts Degree by Walter Albert Lawrance, B.A., (McMaster).

[1] *Journal of the American Chemical Society, 30*, 1411.
[2] *Journal of the American Chemical Society, 31*, 1315.
[3] Austin, *Ber. 7*, 1247; Wedekind, *Ber. 33*, 432.
[4] *Beilstein, II*, 340.

(b) The compound obtained from the alcoholic extraction, when purified in this solvent twice, melts at 179-180°; it is a reddish-brown powder. The yield is not good. Its properties agree with those of the Bis—2,4—tetranitrodiphenylamine, described by Hager.[1] When dis solved in Sodium Hydroxide and warmed in the presence of Ammonium Hydroxide a scarlet-red colour is developed.

This colour reaction and similarity of melting point indicate undoubtedly that this compound is Bis—2,4—tetranitrodiphenylamine, $(NH(C_6H_3(NO_2)_2)_2$.

III. On nitrating diphenylamine three compounds were obtained.

(a) A portion of the nitrated products is soluble in hot nitrobenzene and is not deposited on cooling. Ethyl Alcohol, however, precipitates it as a light reddish-brown powder; the yield is poor. Analysis shows it to be a tetranitrodiphenylamine. Its melting point is above 250°, for at this temperature no signs of melting were visible. It is not described in the literature and is not identical with any known tetranitrodiphenylamines. All these were prepared and the mixed melting points taken, thus proving the lack of identity.

(b) Ethyl acetate dissolves part of the nitration products and from this solution a precipitate is obtained on adding Petroleum Ether (b.p. under 90°). When this precipitate has been boiled in Alcohol twice, it is a light-brown powder melting at 191-2°. This compound dissolves in Sodium Hydroxide, giving a red colour on warming, and is identical with the substance believed to be a symmetrical tetranitrodiphenylamine (cf. IIa).

(c) A portion recrystallized from Xylene twice, had a melting point of 190-1°. It is a reddish-brown powder which dissolves in Sodium Hydroxide and develops a red colouration on warming. Mixed melting points show this substance is identical with those described under IIa and IIIb.

(d) The remaining product of the nitration has a yellow-brown colour and is insoluble in Benzene, but is very soluble in Acetone. The yield of this compound is very poor, and as no solvent was found from which to recrystallize it, nothing further was done.

Experimental.

The materials used in the experiments described below were as follows: Sulphuric Acid sp.g. 1·84. Acetic Acid glacial (99·5 per cent). Nitric Acid sp.g. 1·46 (=80 per cent HNO_3). Oxalic Acid was anhydrous. Alcohol 95 per cent by volume. The Trichloracetic Acid was specially prepared from Trichloracetaldehyde and

[1] *Ber.* *17*, 2629.

fuming Nitric Acid (sp. g. 1·9). The Petroleum Ether all distilled below 95°C.

I. The 2,4,6,4′—tetranitrodiphenylamine was prepared by grinding up four molecular proportions of Oxalic Acid with one of Picranilid and gradually adding eighteen molecular proportions of nitric acid, at room temperature; oxides of nitrogen were evolved. After a few minutes standing the solution becomes thick and red; water is then added and a bright yellow precipitate forms. This was recrystallized from Alcohol twice. Its melting point was 215°·5. It is very soluble in Acetone; soluble in Acetic Anhydride and Chloroform; slightly soluble in Ether; insoluble in Carbon Tetrachloride and Petroleum Ether. Analysis showed it to be a tetranitro compound; found C. 41·05, calculated C. 41·29.

All attempts to hydrolize this substance failed.

Ten parts dilute sulphuric acid (1:1) to one part of the compound were boiled in a reflux apparatus. Twelve grams con. Sulphuric Acid failed to act on 1 gram of substance after standing at room temperature eight days; when kept at 35° for a few hours, complete solution was effected, but no hydrolysis occurred. Above this temperature excessive charring takes place. From the charred material, Ether extracted a small quantity of a yellowish substance which decomposes at 110°. Con. Sulphuric Acid containing 5 per cent glacial Acetic Acid also failed to accomplish the desired result. Acetic Acid (15 parts to 1 of the compound), in a sealed tube kept at 210° for 24 hours, charred considerably and produced no hydrolysis. Fourteen grams of Acetic Acid (to which three drops of water had been added) were placed in a sealed tube with one gram of tetranitrodiphenylamine and kept at 120° for 27 hours; neither charring nor hydrolysis occurred.

Warm Barium Hydroxide dissolves this substance giving an intense red colour. When the solution is acidified with Hydrochloric Acid the original compound is precipitated unchanged.

II. One molecular proportion of Picranilid and four molecular proportions of Trichloracetic Acid were intimately ground together, and fifteen molecular proportions of Nitric Acid were gradually added. It was found advisable to keep the beaker surrounded with cold water owing to the quantity of heat developed during the reaction. The mixture was allowed to stand overnight. When poured into water, a reddish-yellow precipitate formed. This precipitate, after washing well with warm water, was treated with boiling alcohol and the residue dissolved in Benzene.

(a) The portion soluble in Benzene, after recrystallizing twice, melted 190-1°. Mixed melting points show it to be identical with compounds obtained as described in IIIb and IIIc. Its solubilities are the same as these.

(b) The product recrystallized from Alcohol is a dark brown powder melting at 179-80°. It is soluble in Acetone, slightly soluble in Ether, but insoluble in Carbon Tetrachloride. The properties of this compound agree with those described of Bis.-2,4—tetranitrodiphenylamine.[1]

III. The nitration of diphenylamine was carried out with difficulty. One molecular proportion of diphenylamine was placed in a large beaker, surrounded by ice water, and eight molecular proportions of Nitric Acid were added. The acid was slowly poured in, stirring at intervals, thoroughly cooled, and water was then added. The product was washed with warm water until free from acid.

(a) The portion soluble in hot nitrobenzene was precipitated by the addition of Ethyl Alcohol to the solvent. It melts above 250°. It is slightly soluble in Ether, Acetone, Chloroform and Alcohol, insoluble in Petroleum Ether and Carbon Tetrachloride. Analysis shows it to be a tetranitrodiphenylamine; found C.41·20, calculated C.41·29. The 2,4,6,2′—and 2,4,6,3′—tetranitrodiphenylamines were prepared from Picryl Chloride and ortho- and meta-nitraniline respectively. "Beilstein" describes the 2,4,6,2′— compound as melting "near 220°"; we found it to be 233-4° (approximately as given by Richter). The melting points of a mixture of each of these compounds with the above substance proved that the latter is not identical with either.

(b) (c) One of the products of nitration is soluble in Ethyl Acetate and can be precipitated from this solvent by Petroleum Ether. Xylene extracts a substance which is identical with that soluble in Ethyl Acetate. These two are identical with that described under IIa. The melting points of the several mixtures are as follows:

Alone: IIa 190-1°, IIIb, 191-2°, IIIc, 190-1°.
Mixed: IIa+IIIb, 191-2°. IIa+IIIc, 191°.
IIIb+IIIc, 191°.
IIa+IIIb+IIIc, 191°.

All three compounds give the same red colour reaction with warm Sodium Hydroxide. All are insoluble in Ether, Petroleum Ether and Carbon Tetrachloride; slightly soluble in Alcohol and Chloroform; soluble in Acetone.

(d) The remaining portion is insoluble in Xylene, Ether and Carbon Tetrachloride, it is slightly soluble, however, in both Acetic Anhydride and Ethyl Alcohol. The yield was poor, and time did not

[1]Hager, *Ber. 17*, 2629.

allow further investigation on this substance, which was neither pure nor stable enough to permit the obtaining of a definite melting point.

Summary:

1. The product of nitration of Picranilid with Nitric and Oxalic Acids is 2,4,6,4'—tetranitrodiphenylamine.

2. When Trichloracetic Acid is substituted for Oxalic Acid a Bis.—2,4—and a symmetrical tetranitrodiphenylamine are obtained.

3. By nitrating Diphenylamine with Nitric Acid, under conditions described above, the main product is symmetrical tetranitrodiphenylamine, together with a small quantity of a tetranitrodiphenylamine not described in the literature, and a compound unidentified.

Chemical Laboratory,
McMaster University,
Toronto, May 1st, 1918.

Stearic and Palmitic Esters of the Isomeric Propylene Glycols.

By L. ISABEL HOWE.

Presented by DR. R. F. RUTTAN.

(Read May Meeting, 1918.)

Historical.—The fat acid esters of ethylene glycol were prepared by Ruttan and Roebuck[1] in 1915, and their physical and chemical constants were described. It was found that they could best be prepared by the direct union of the acid with the glycol at a comparatively high temperature, with constant stirring, and that the separation of the mono and di-derivatives could only be effected by prolonged fractional crystallization.

Previous to this only one glycol ester had been prepared namely, the distearate of ethylene glycol in 1895 by Würtz. He used the silver salt of the acid with ethylene bromide, but this gave only the di-compound, and although many attempts were made by Ruttan and Roebuck it was found quite impossible to obtain any trace of the mono derivative. To prepare the silver salt of the fat acid, a solution of the acid in alcohol was saturated with dry ammonia, and an equivalent proportion of an alcoholic solution of silver nitrate added. After the ammonia and some of the alcohol had been distilled, the salt precipitated out in fine needles. However, this process is very tedious and has now been replaced by the direct esterification method.

In this paper are described the preparation and properties of the fat acid esters of the two isomeric propylene glycols, namely, 1. 2. di hydroxy propane, and 1. 3. di hydroxy propane or trimethylene glycol, and their chemistry compared with that of the ethylene glycol esters.

Experimental.—Only the very purest materials were employed in the following experiments, and these were carefully tested before use. The charge, consisting of the glycol with the fat acid, was esterified at a constant temperature for several hours in the electric oven, the mixture being constantly agitated by a platinum stirrer, which was run by a small electric motor. At the comparatively high temperature employed the water formed during the reaction was driven off. A hard cake of fat was obtained, which was melted

[1]Trans. Royal Society of Canada—1915—Vol. IX. Series 3.

and washed with hot water to remove the excess of glycol. The uncombined acid present in this mixture was determined and the calculated amount of sodium bicarbonate added to neutralize the free acid. This was fused in a porcelain dish on the water bath for one hour. The ester was washed out with hot ether, using a hot filter. This was allowed to crystallise at room temperature, and filtered, the residue dissolved in 95% alcohol and crystallized at about 0°C. From their relative solubilities these crystals could be separated into the di and mono compounds for purification. A series of fractional recrystallisations were made until the mono and di esters were obtained pure, as shown by their constant melting points. When these esters had been prepared by this method and purified, their physical properties were determined.

The melting points were taken in the usual way.

The refractive indices were determined by the Abbe Zeiss refractometer at various temperatures, slightly above the melting points of the esters, and from these the refractive index at the melting point was calculated.

The solubility of each of the purified fats was found by saturating a solution of absolute alcohol at a temperature slightly above that at which the solubility was wanted. These saturated solutions were kept for sixteen hours first at a constant temperature of 15°C. About 10 c.c. of the clear supernatant solution were drawn off by means of a warm pipette and weighed accurately in a closed weighing bottle. After the alcohol had been evaporated very slowly on a hot plate, the residue was dried to constant weight at 95°C. The rest of the saturated solution was placed in a mixture of melting ice and kept at zero in a refrigerator for several hours, when the solubility at this temperature was determined in a similar way.

The specific gravity of a solid fat was determined by the dilatometric method which was found to be most satisfactory as well as very exact. The dilatometer was first carefully calibrated with pure mercury. To fill it with the fat to be studied the tube was heated in the electric oven, and then suspended in hot water and the melted fat was drawn in through a very fine capillary, with aid of a suction pump. When the bulb of the dilatometer was filled with the fat, the whole apparatus was quickly transferred to the inner tube of a double walled glass vessel. To prevent the fat from solidifying, this tube was previously heated by boiling in the outer jacket, connected to a reflux condenser, some pure liquid such as ethyl alcohol, chloroform or benzol, whose boiling point was above the melting point of the fat. A number of readings were taken; in most cases it required about two hours for the temperature and also the reading on the dilatometer to become constant. The dilatometer was cooled in an evacuated dessicator and weighed; from this the weight of a carefully measured volume of the fat would be obtained. In the case of the distearate of trimethylene glycol, methyl alcohol, ethyl alcohol, benzol and trichlorethylene were the constant boiling liquids used to give a series of readings as follows:—

Trichlorethylene	B.P.	87·2°C.	Specific Gravity	0·8500
Benzol	"	78·8°C.	" "	0·8525
Ethyl Alcohol	"	77·6°C.	" "	0·8540
Methyl Alcohol	"	69·0°C.	" "	0·8570

These points were plotted and by extrapolation the specific gravity at the melting point of the fat could be found, which in this case, was 64·7°C., and the specific gravity was found to be 0·8586.

The following is a detailed description of the preparation of these fats. It was found that the temperature at which the esterification took place was most essential, and the best temperature could only be determined by experiment.

Stearic Esters of Propylene Glycol 1, 2. The Propylene Glycol ($CH_3CHOH\ CH_2OH$—B.P.188° – 189°C.) was esterified with stearic acid at various temperatures from 154°C. to 162°C. for seven or eight hours. The amount of free acid varied from 26·6 – 34·4%. When the temperature was slightly over 160°C. there was less free acid, namely, 16·6%, and a relatively larger amount of ester was obtained. The crystals obtained from these charges were in the form of fine white sheet-like masses.

The Mono-Stearate so prepared was a pure white crystalline solid, with a melting point of 59·5°C. and a refractive index at 60°C. of 1·4424. These crystals of irregular shape were bright and shiny plates.

Solubility in 100 grms. of absolute alcohol.

at 15°C. 0·034 grms..
at 0°C. 0·021 "

The formula $CH_3CHOH\ CH_2\ (C_{18}H_{35}O_2)$ was shown by the following analysis,—

Saponification value	162·4	% Stearic Acid	82·45
Theory	163·8	Theory	83·0

The position of the Stearic acid group, whether 1 or 2 could not be determined as the supply of the glycol was limited.

Di-Stearate was a white crystalline solid, melting point 72·3°C. and refractive index at 75°C. was 1·4366. The di-stearate formed large crystals, which were very bright and flaky. This was found to be less soluble than the mono.

Solubility in 100 grms. of absolute alcohol.

at 15°C.	0·0063	grms.
at 0°C.	0·0012	"

The formula $CH_3CH(C_{18}H_{35}O_2)CH_2(C_{18}H_{35}O_2)$ was shown by the following analysis:—

Saponification value	184·1	% Stearic Acid	93·4
Theory	184·2	Theory	93·4

Stearic Esters of Trimethylene Glycol 1, 3. The trimethylene glycol (CH_2OH CH_2 CH_2OH) employed had a boiling point of 214—216°C. It was always necessary to have a large excess of the glycol in order to obtain any of the mono derivative. The temperature necessary for a complete reaction was 180°C. and at this temperature there was only 6% of free acid, while at 178°C. there was 8·19% free acid.

Mono-Stearate of trimethylene glycol was obtained in the form of irregular white scale-like crystals. The melting point was 60·5°C. and the refractive index at 60°C. was 1·4437.

Solubility in 100 grms. absolute alcohol.

at 15°C.	0·0305	grms.
at 0°C.	0·01431	"

The formula CH_2OH CH_2CH_2 $(C_{18}H_{35}O_2)$ was shown by the following analysis:—

Saponification value	165·0;164·4	% Stearic Acid	83·75;83·3
Theory	163·8	Theory	83·0

Di-Stearate—crystallised in small pure white shining plates which had a melting point of 64·7°C. and a refractive index at 75°C. of 1·4397. This crystallised in smaller crystals than the corresponding ester of Propylene Glycol.

Solubility in 100 grms. absolute alcohol.

at 15°C.	0·00381	grms.
at 0°C.	0·00126	"

The formula $CH_2(C_{18}H_{35}O_2(CH_2$ $CH_2(C_{18}H_{35}O_2)$ was shown by the following analysis:—

Saponification value	184·0; 184·5	% Stearic Acid	93·5; 93·3
Theory	184·2	Theory	93·4

Palmitic Esters of Propylene Glycol 1, 2. The Palmitates of propylene glycol were prepared by heating 25·6 grammes of palmitic acid with 12 grammes of the glycol for eight hours at temperatures from 157 to 167°C. The free acid varied from 26·6 to 36·6%. It was found that the highest temperature gave the best results. This cake of fat contained less free acid, namely, 26% and more of the monpalmitate crystals.

Mono-Palmitate crystallised in white shiny crystals. It had a melting point of 54·2°C. and a refractive index at 60°C. of 1·4405.

Solubility in 100 grms. absolute alcohol.

at 15°C.	0·0907 grms.
at 0°C.	0·0193 "

The formula $CH_3CHOH\ CH_2(C_{16}H_{31}O_2)$ was shown by the following analysis:—

Saponification value	178·0	% Palmitic Acid	81·4
Theory	178·25	Theory	81·5

The very limited supply of the glycol available would not permit of a determination of the position of the Palmitic Acid group in the glycol, i.e. whether in positions 1 or 2

Di-Palmitate had a melting point of 68·8°C. and a refractive index at 75°C. of 1·4364. The white crystals obtained were large and shiny. The di-compound always had a melting point higher than the mono.

Solubility in 100 grms. absolute alcohol.

at 15°C.	0·0115 grms.
at 0°C.	0·00516 "

The formula $CH_3CH(C_{16}H_{31}O_2)CH_2(C_{16}H_{31}O_2)$ was shown by the following analysis:—

Saponification value	202·5	% Palmitic Acid	92·62
Theory	202·9	Theory	92·75

Palmitic Esters of Trimethylene Glycol 1, 3. The temperature of esterification for the palmitates was 171°C., but as the fat obtained had a very high percentage of free acid, namely, 14%, this temperature was about four degrees too low. It was impossible to repeat the experiment as the supply of glycol was exhausted, and no more could be obtained. Only the di-palmitate was crystallised from this charge.

Di-Palmitate was a white crystalline solid with a melting point of 56·2°C. and a refractive index at 75°C. of 1·4374.

Solubility in 100 grms. of absolute alcohol.

at 15°C.	0·0517 grms.
at 0°C.	0·0244 "

The formula $CH_2(C_{16}H_{31}O_2)CH_2CH_2(C_{16}H_{31}O_2)$ was shown by the following analysis:—

Saponification value	202·6; 203·1	%Palmitic Acid	92·7; 92·8
Theory	202·9	Theory	92·75

The solubility of the palmitates was found to be greater than that of the stearates.

Comparison of the Fat Esters of the Glycols. The esters of ethylene glycol had a habit of crystallisation very similar to the esters of propylene and trimethylene glycol. They all resembled the true glycerol esters by crystallising in thin shiny plates of irregular outline, their leaf-like crystals often arranging themselves in rose-like masses. The stearates of the three series had a higher melting point than the corresponding palmitates and the saturated esters were higher than the corresponding mono-derivatives.

There was a marked difference in the melting points and the solubility of the esters of the two isomeric propylene glycols. The mono-derivatives were more soluble than the di, and the palmitates much more so than the stearates. The optimum temperatures of Esterification were lower for the ethylene glycols than for the propylene alcohols. The principal properties of these glycol esters of stearic and palmitic acids are tabulated below for easy comparison.

Ester	M.P.	Refractive Index	Solubility at O°C.	in Grammes 15°C.
Ethylene Glycol—				
Mono Stearate	58·5°	1·4310	0·670	2·0
Di Stearate	75·0	1·4385	0·010	0·020
Mono Palmitate	51·5	1·4411	1·62	10·0
Di Palmitate	68·7	1·4378	0·018	0·055
Propylene Glycol—				
Mono Stearate	59·5	1·4424	0·0211	0·034
Di Stearate	72·3	1·4366	0·0012	0·0063
Mono Palmitate	54·3	1·4405	0·0193	0·0907
Di Palmitate	68·8	1·4364	0·00516	0·0115
Trimethylene Glycol—				
Mono Stearate	60·5	1·4437	0·01431	0·0305
Di Stearate	64·7	1·4397	0·00126	0·00381
Di Palmitate	56·2	1·4374	0·0244	0·0517

The writer wishes to thank Professor Ruttan for kind suggestions and assistance.

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The Compounds of Phenol and the Cresols with Pyridine (Abstract)

By F. W. SKIRROW and T. V. BINMORE

Presented by DR. R. F. RUTTAN, F.R.S.C.

(Read May Meeting, 1918.)

In continuation of the work of Hatcher and Skirrow (Journ. Amer. Chem. Soc. XXXIX, 9, 1939, 1917) the authors have studied the effect of excess of phenol and of pyridine respectively on the dissociation of pyridine phenate $C_6H_5OH\ C_5H_5N$ in benzene solution, the dissociation being calculated from depression of freezing point data on each of the four assumptions as to the simultaneous association of the components and of the compound that were made in the earlier paper. It is shown that on any of these assumptions the effect of excess of phenol on the dissociation is much greater than the effect of excess of pyridine, and thus that the equilibrium

$$C_6H_5OH\ C_5H_5N \rightleftarrows C_6H_5OH + C_5H_5N \qquad (1)$$

can not be dominant.

It is further pointed out that the form of the two curves representing the effect of excess of pyridine and excess of phenol on the dissociation closely resembles the form of the two curves obtained previously for the effect of excess of pyridine on the percentage extraction of phenol by sodium hydroxide, and for the effect of excess of phenol on the percentage extraction of pyridine by dilute sulphuric acid.

It was shown in the earlier paper that phenol and pyridine also form a second compound $(C_6H_5OH)_2\ C_5H_5N$.
The dissociation

$$(C_6H_5OH)_2\ C_5H_5N \rightleftarrows 2C_6H_5OH + C_5H_5N \qquad (2)$$

was therefore next studied on lines similar to the above and the effect of excess of phenol and of excess of pyridine on the dissociation determined. If this equilibrium was dominant we should expect that the effect of pyridine on the dissociation would be proportional to the concentration of the pyridine whilst the effect of excess of phenol would be proportional to the square of the concentration of the phenol, and the curves obtained should resemble those actually obtained for equilibrium (1).

It is found, however, that this is not the case, the effect of small excesses of pyridine being actually greater than the effect of corresponding small excesses of phenol, whilst the effect of larger excesses of phenol is greater than the effect of correspondingly larger excesses of pyridine. Thus the equilibrium

$$(C_6H_5OH)_2\ C_5H_5N \rightleftarrows 2C_6H_5OH + C_5H_5N \qquad (2)$$

can not be dominant either.

The effect of excess of pyridine and of phenol on the extraction of these bodies from benzene solution by aqueous acid and alkali respectively which is described in the earlier paper, as well as the effect of similar excesses on the apparent dissociation of the pyridine phenate in benzene solution described in this paper can be satisfactorily explained as follows:

If we start with the compound $C_6H_5OH\ C_5H_5N$

this dissociates as follows:

$$C_6H_5OH\ C_5H_5N \rightleftarrows C_6H_5OH + C_5H_5N \qquad (1)$$

Excess of pyridine will depress this dissociation in a normal manner and the effect of the excess will be proportional to the amount of pyridine added. Excess of phenol will in the first instance behave similarly to excess of pyridine, but in this case the excess will also promote a second reaction

$$C_6H_5OH + C_6H_5OH\ C_5H_5N \rightleftarrows (C_6H_5OH)_2\ C_5H_5N$$

and thus the excess not only depresses dissociation (1), but also removes the compound $C_6H_5OH\ C_5H_5N$ from the right hand side of equilibrium (1) thus tending still further to diminish the concentration of the free pyridine. Thus the effect of excess of phenol will be much greater than the effect of excess of pyridine.

It was further shown that on increasing dilution of the benzene solution the differences in the effect of addition of excess of phenol and of excess of pyridine on the extraction efficiency tend to become less and to disappear.

On an Electrical Method of Determining the Lime Requirement of Soils

By C. J. LYNDE, Ph. D.

Presented by DR. F. T. SHUTT, F.R.S.C.

(Read May Meeting, 1918.)

INTRODUCTION

When a given weight of soil is shaken with a given volume of water for a certain time, a soil solution is obtained which has a certain electrical conductivity.

If an equal weight of the soil is shaken for an equal time with an equal volume of a dilute fertilizer solution of known electrical conductivity, a soil-fertilizer solution is obtained which has a different electrical conductivity.

If we assume that the conductivity of the soil solution is the same in both solutions, we can calculate the conductivity of the fertilizer solution in the soil-fertilizer solution. If this calculated conductivity is less than the conductivity of the original fertilizer solution, we may assume that part of the fertilizer has been absorbed by the soil; if it is greater, we may assume that soluble salts have been dissolved from the soil.

Theory

The theory upon which this series of experiments is based is as follows:

If a soil lacks a certain fertilizer, for example K, P, Ca or N, it is probable that it will absorb this fertilizer from solution, and the greater the lack the greater the absorption.

If this is true, then by measuring the amount of these fertilizers absorbed by the soil we should be able to foretell what fertilizer the soil needs and how much.

The Experiment

The simplest method of making a trial of the above theory seemed to be that of comparing the lime requirements of a number of soils found by the Rothamstead method with those found by the electrical method described below. The results given in the present paper are those obtained in this trial.

Method.

The term Lime Requirement as used in this paper means the number of pounds of lime per acre required to neutralize the soil acidity.

The Rothamstead method.[1] A $Ca(HCO_3)_2$ solution was made as follows: An excess of $CaCO_3$ (20 g.) was placed in a 10 liter bottle with 6 liters of distilled water and a stream of CO_2 was passed through the solution for 48 hours or more, the bottle being thoroughly shaken from time to time. The solution was allowed to settle and was titrated with O.1NHC1.

To determine the lime requirement of a soil, 10 g. of the soil was placed in a liter flask with 150 cc. of the Ca $(HCO_3)_2$ solution and a stream of CO_2 was passed through to displace the air. The flask was then closed with a rubber stopper and was shaken at intervals of 20 minutes for 3 hours. The solution was then filtered and titrated with O.1N.HCl. The lime requirement in lb. per acre was calculated on the basis that 1 cc. of O.1N.HCl neutralizes 5 mg. of $CaCo_3$ and that 1 acre of soil 6 in. deep weighs 2,000,000 lb.

The Electrical Method. The steps in this method, made in duplicate, were as follows:—

(1) *Soil Solution.* A 10 g. sample of each soil was placed in a shaker bottle with 150 cc. of distilled water and shaken for 3 hours. The solution was then allowed to settle over night and the electrical resistance, r_1, (the reciprocal of the conductivity) was measured with a Kohlrausch bridge.

(2) *Fertilizer Solution.* The resistance, r_2, of the original Ca $(HCO_3)_2$ solution was measured in the same way.

(3) *Soil-Fertilizer Solution.* The resistance was measured of the solution formed (in the Rothamstead test) by shaking 10 g. of soil with 150 cc. of $Ca(HCO_3)_2$ solution.
This is the observed resistance OR.

(4) *Calculated Resistance.* If we let

$r_1 =$ the resistance of the soil solution.

$c_1 =$ the conductivity " " "

OR = the observed resistance of the soil-fertilizer sol'n.

OC = the " conductivity " " " " "

$r =$ the calculated resistance of the $Ca(HCO_3)_2$ solution, that is, the resistance this solution must have, after being shaken with the soil, in order to give the observed resistance OR, assuming that the resistance of the soil solution remains constant.

$c =$ the corresponding conductivity.

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[1]Hutchison and MacLennan, *Journal of Agricultural Science*, Vol. VII., Part I, March, 1915, p. 91.

Then $c_1 + c = OC$

or $c = OC - c_1$

$$\text{or } \frac{1}{r} = \frac{1}{OR} - \frac{1}{r_1}$$

$$\text{or } r = \frac{r_1 \times OR}{r_1 - OR}$$

If this calculated resistance, r, is greater than the original resistance, r_2, of the Ca $(HCO_3)_2$ solution, it would seem that $CaCO_3$ has been absorbed by the soil and that the soil is acid.

If the calculated resistance, r, is less than the resistance, r_2, it would seem that something has been dissolved from the soil and since there is an excess of CO_2 in the solution it would seem likely that the substance dissolved is a carbonate and that the soil is alkaline.

(5) *The Ratio.* If we divide the calculated resistance, r, by the resistance, r_2, we obtain a ratio which should give us a measure of the alkalinity or acidity of the soil.

Results

Of the twelve soils used in the work, eight were taken from different fields of Macdonald College farm, namely, D 1, D 2, D 3, D 4, M 1, M 2, M 3, M 4. They are all clay loams and have been manured in the regular rotation but have not been limed. They were found to be alkaline or slightly acid.

The remaining four soils were received from the experimental farm at Charlottetown, P.E.I. Previous to 1915 they had received neither manure nor fertilizer, but in 1915 they were fertilized at the following rates:

Plot	*Application*
48	15 tons manure
49	7½ tons manure +175 lbs. mixed fertilizer
50 (check)	No manure, no fertilizer.
52	15 tons manure +175 lbs. mixed fertilizer.

The mixed fertilizer contained:

75 lbs. sodium nitrate.
160½ lbs. acid phosphate.
160½ " 7% Basic Slag.
112½ " 40% Potassium chloride.

These soils are light sandy loams with a high iron content. They were found to be decidedly acid.

TABLE I.

Giving the Lime Requirement in lb. per acre of soils D1, D2, D3, D4, M1, M2, M3, M4.

7·05 cc. of O.1N.HCl were required to neutralize 50 cc. Ca $(HCO_3)_2$ Soln.

Soil	O.1N.HCl	Average	Lime Requirement
D 1 A	7·95 cc.	7·93	—2640
" 1 B	7·9 "		
" 2 A	6·95	6·98	+ 210
" 2 B	7·00		
" 3 A	7·1	7·25	— 600
" 3 B	7·4		
" 4 A	6·9	7·0	+ 150
" 4 B	7·1		
M 1 A	7·25	7·25	— 600
" 1 B	7·25		
" 2 A	7·25	7·3	— 750
" 2 B	7·35		
" 3 A	7·5	7·5	—1350
" 3 B	7·5		
" 4 A	8·0	8·0	—2850
" 4 B	8·0		

TABLE 2.

Giving the Lime Requirement in lb. per acre of the soils 48, 49, 50 and 52.

8 cc. of O.1N.HCl were required to neutralize 50 cc. of $Ca(HCO_3)_2$ Soln.

Soil	O.1N.HCl	Average	Lime Requirement
48 A	5·90 cc.	5·93 cc.	5175 lb.
48 B	5·95 "		
49 A	5·85 "	5·83 "	5450 "
49 B	5·80 "		
50 A	6·00 "	6·08 "	4800 "
50 B	6·15 "		
52 A	5·90 "	5·90 "	5250 "
52 B	5·90 "		

Note. In these tests 10 g. of soil were shaken with 125 cc. of $Ca(HCO_3)_2$ solution instead of with 150 cc. as in the tests above.

The following table gives

r_1, the resistance of the soil solution
r_2, " " " $Ca(HCO_3)_2$ solution.
r, " calculated resistance
OR, the observed resistance
$\frac{r}{r_2}$ the ratio obtained by dividing the calculated resistance, r, by the resistance, r_2, of the original $Ca(HCO_3)_2$ solution.

TABLE 3.

Giving r_1 the resistance of the soil solution; OR, the observed resistance; r, the calculated resistance; r_2, the resistance of the original $Ca(HCO_3)_2$ solution; and $\frac{r}{r_2}$ the ratio.

Soil	r	Average r	OR	Average OR	r	r_2	$\frac{r}{r_2}$
D I A	1420	1490	102	101·5	109·0	117	·937
D I B	1560	....	101				
D 2 A	2200	2350	112	112·5	118·4	"	1·012
D 2 B	2300	....	113				
D 3 A	1600	1670	180	108·0	115·4	"	·986
D 3 B	1740	....	108				
D 4 A	2240	2270	112	112·0	117·8	"	1·006
D 4 B	2300		112				
M I A	2100	2110	115	116·0	122·7	116	1·057
M 1 B	2120		117				
M 2 A	1540	1575	108	109·0	117·1	"	1·009
M 2 B	1610		110				
M 3 A	1780	1755	108	107·5	114·4	"	·986
M 3 B	1730		107				
M 4 A	1300	1400	99	99·5	107·1	"	·923
M 4 B	1500		100				
48 A	5800	5900	133	131·0	133·9	102·5	1·306
" B	6000		129				
49 A	5000	4900	133	134·0	137·9	"	1·345
" B	4800		135				
50 A	6300	6100	128	129·0	131·7	"	1·284
" B	5900		130				
52 A	4200	4350	135	135·0	139·3	"	1·359
" B	4500	....	135				

TABLE 4.

Comparing the Lime Requirement as determined by the Rothamstead method with the ratio of the resistances.

Soil	Lime Required Rothamstead	Ratio of Resistances
M 4	−2850	·923
D 1	−2640	·937
M 3	−1350	·986
D 3	− 600	·986
D 4	+ 150	1·006
M 2	− 750	1·009
D 2	+ 210	1·012
M 1	− 600	1·057
M 1	− 600	1·057
50	4800	1·284
48	5175	1·306
49	5450	1·345
52	5250	1·359

Discussion. It will be noticed that if the ratio is ·986 or under, the soils are alkaline and the lower the ratio the greater the alkalinity. Also if the ratio is 1·284 or above, the soils are acid and the greater the ratio the greater the acidity. This suggests that if a sufficient number of soils were tested a ratio might be found, in the neighbourhood of 1·10, such that if a soil gave a lower or higher ratio we should know that it was alkaline or acid and to what extent.

It was noticed during the course of these experiments that a soil solution had the same electrical resistance when cloudy that it had when cleared by centrifuging. This would indicate that the electrical method might be used to find the lime requirement of soils when the solutions were too cloudy to be titrated by the Rothamstead method.

Conclusion.

The results obtained in the experiments described above indicate that it may be possible to work out an electrical method of determining the lime requirement of soils.

The Composition of Bran and Shorts as milled under Regulations of the Canada Food Board.

By FRANK T. SHUTT, M.A., D.Sc., and ROY L. DORRANCE, B.A.

(Summary)

(Read May Meeting, 1918.)

The recent regulations of the Canada Food Board with respect to the milling of wheat have raised the percentage of extraction, approximately, 4 per cent. Thus in the manufacture of "Government Standard Flour" (the only grade of flour allowed subsequently to April, 1918) 196 lbs. of flour must be milled from 258 lbs. of spring wheat, whereas prior to this date the practice of Canadian millers was to make 196 lbs. of flour from about 270 lbs. of wheat, 10 lbs. of this flour being generally used in connection with the finer shorts and sold as middlings.

The work set forth in this paper had for its more immediate object the determination of the composition of the bran and shorts as produced under the new milling regulations, and to deduce from the analytical data so obtained their nutritive values as compared with those of the bran and shorts of pre-regulation times. (It may be noted, in passing, that the making of middlings is not permitted under the new regulations and that the amount of offal—bran and shorts—by the increase in the percentage of extraction is reduced about 25 per cent.)

The facts above noted would warrant the conjecture that the more complete extraction of the floury particles (essentially starch) would more particularly increase the percentages of protein and fibre in the present day bran and shorts, for these are characteristic constituents of the bran coats of wheat. This surmise has been confirmed by the analysis.

For the purposes of comparison we shall include two series of these feeds, the one analysed in 1903, the other in the autumn of 1917, both being of a representative character.

The series of brans and shorts milled under the recent regulations were obtained direct from the mills of a number of the leading firms.

The data presented are averages, but the maxima and minima—the limits of variation within each series—will be briefly discussed.

Average Composition of Bran and Shorts.

	Date	Moisture	Protein	Fat	Carbohydrates	Fibre	Ash
Bran	1903	11·07	14·52	4·37	54·19	10·14	5·71
"	1917	9·51	15·09	4·38	55·73	9·62	5·69
" (76% extraction)	1918	7·13	15·83	4·98	55·20	11·51	5·35
Shorts	1903	10·34	15·93	5·24	59·58	5·23	3·68
"	1917	9·81	16·03	4·97	58·04	6·90	4·25
" (76% extraction)	1918	7·22	17·67	5·16	57·25	8·52	4·18

Comparing the series of 1903 with that of 1917, the differences in composition are not on the whole such as to call for extended comment, though the somewhat higher protein content of the bran and the decidedly higher percentage of fibre in the shorts, appear to be significant of certain milling changes that had taken place during the thirteen year period.

The data for the 1918 (new regulations) series, compared with those of the bran and shorts previously manufactured, permit the following deductions.

1. That the bran milled under the 1918 regulations is approximately ·75% richer in protein, ·5 per cent richer in fat and contains 1·5% more fibre.

2. That the shorts milled under the 1918 regulations are approximately 1·75% richer in protein and contain about 2·5% more fibre.

No digestion experiments have as yet been made with the new bran and shorts and therefore no data can be given as to their exact nutritive value compared with those products of pre-regulation times, but it seems very probable, as far as cattle are concerned, that the differences will be slight. The somewhat higher protein content may be largely offset by the larger percentage of fibre. In the case of young pigs and calves, however, we may fairly conclude that the "regulation" shorts, owing to their more fibrous character, will not be so nutritious or suitable.

An interesting feature revealed by this study is the fact that the samples of bran and shorts of the 1918 series show less variation in composition than those of the two preceding series. This will be apparent from the following table:

Limits of Variation

	1903	1917	1918
Bran, Protein	2·06	3·52	·34
Fat	1·59	2·28	·24
Fibre	1·69	4·24	1·10
Shorts, Protein	2·17	3·02	1·57
Fat	2·25	2·24	·88
Fibre	3·69	3·49	·89

These results clearly indicate a closer standardization of the milling process under the new regulations, in so far as the bran and shorts are concerned.

In order to be accounted genuine the composition of bran and shorts must conform to the following standards fixed by law:

Standards of Bran and Shorts

	Bran	Shorts
Protein, not less than	14·%	15%
Fat, " " "	3·	4·
Fibre, " more than	10·	8·

If the samples collected as milled under the new regulations may be regarded as typical and representative of these feeds now upon the market, it will be evident that the above standards should be modified, the percentages of protein, fat and fibre all being raised. Our analyses would indicate the following limits, which are tentatively suggested as fairly meeting the case:

	Bran	Shorts
Protein, not less than	15· %	16·5%
Fat, " " "	4·5	4·5
Fibre, not more than	12·0	9·0

Some Notes on The Halifax Explosion

By HOWARD L. BRONSON, Ph.D., F.R.S.C.

(Read May Meeting, 1918.)

The explosion which wrecked Halifax on December 6, 1917, undoubtedly far surpassed all previous explosions both in its destructive effects and in the quantities of explosives involved. Although facts and figures concerning the explosion are necessarily incomplete and in many instances not very reliable, still it seems desirable to gather together and place on record such information as is available. The thermo-chemical and other theoretical and experimental data used in this article were obtained from Marshall's "Explosives," Brunswig's "Explosives," Molinari's "Chemistry," and from Mr. W. C. Cope, explosives chemist of the E. I. duPont-deNemours and Company. Mr. Cope was called to Halifax as the explosives expert at the investigation into the disaster, and was good enough to furnish me certain facts and figures.

The following is a brief account of the events leading up to the explosion. The munition ship *Mont Blanc*, loaded with some 2,500 tons of high explosives and with a deck load of monochlorbenzene, was about to enter the Narrows of Halifax Harbour when she collided with the *Imo* in such a way that the bow of the *Imo* was driven well into her side. The heat developed by the collision was sufficient to ignite either the monochlorbenzene or the picric acid, the latter being the more probable according to Mr. Cope. The fire burned for nearly 20 minutes, during which time the *Mont Blanc* drifted close to pier 6 on the Halifax side of the harbour and apparently grounded just before the explosion. During this time and previous to the final explosion there were at least three small explosions, apparently caused in the drums of monochlorbenzene.

Before describing or discussing the effects of the explosion, it would seem of interest to consider with some care the magnitude of the explosion in terms of the amount of energy liberated and the volume of gas formed, together with the probable temperature and pressure of the gas. In order to determine these various quantities the following assumptions have been made: (1) that the entire cargo of explosives entered into the detonation. This was evidently not the case, for it was burning 17 minutes previous to the explosion, and, as we shall see later, there is some evidence to indicate that part of the cargo sank without exploding. (2) That the products of detonation for this enormous unconfined mass of explosives are the same as those due to small masses in a bomb calorimeter. (3) That the specific heats of gases at high temperatures can be represented by the formula $C = A + Bt$.

The cargo of the *Mont Blanc* consisted of the following high explosives:

(1) 2,114,000 kilograms picric acid.
(2) 204,000 kilograms trinitrotoluene.
(3) 56,000 kilograms gun cotton.

The decomposition of these explosives is represented by the following equations:

(1) $2\ C_6H_2(NO_2)_3OH = 8\ CO + 3\ CO_2 + 3\ H_2 + 3N_2 + C.$
(2) $2\ C_7H_5(NO_2)_3 = 12\ CO + 5\ H_2 + 3\ N_2 + 2C.$
(3) $2\ C_{24}H_{29}O_{20}(NO_2)_{11} = 24\ CO + 24\ CO_2 + 17\ H_2 + 11\ N_2 + 12H_20.$

From these equations and thermo-chemical data from Marshall's "Explosives" the following approximate results can be obtained:

Substance	Vo	Q	t°	P
Picric Acid	828	875	2800	9640
Trinitrotoluene	983	680	2380	9870
Gun cotton	859	1045	2670	9570

Vo is the volume in liters, at 0° and 76 cm. pressure, of the gas liberated by 1 kg. of explosive. Q is the heat of explosion in large calories per kg. of explosive. P is the pressure in kg. per cm^2 developed by the explosion of 1 kg. in the volume of 1 liter. t° and P were calculated as follows:

$$t = \frac{Q}{C} \text{ where } C = A + Bt \qquad P = \frac{1 \cdot 033 \times Vo \times (273 + t)}{273}$$

We thus see that the gases formed had a volume at N.T.P. of about 2×10^9 liters and that the total energy liberated was about $8 \cdot 7 \times 10^{11}$ kilogram-meters. This energy was at first stored in the gases at high temperatures and under enormous pressures. It distributed itself rapidly through the air, water and earth to the surrounding region. All the evidence points to the fact that the air was the principal factor in the transfer of this energy. Within a radius of four or five miles the earth wave was distinctly felt and was followed by the concussion of the air which caused all the damage. The experience of the writer confirms this point and indicates in a rough way the relative magnitudes of the earth and air shock. At the time of the explosion, I was standing in my laboratory on the second floor of the

Dalhousie University Science Building, about 3,500 meters from the explosion. I first felt a shaking of the building no greater than that caused by heavy blasting in the railroad cut, but it seemed to be directly under the building and I started for the boiler room, fearing an explosion there. I had gone less than 30 feet when the crash came which completely destroyed the windows and sashes on three sides of the building, broke heavy doors and locks, and even shifted partitions. The comparatively slight earth shock can be explained by the fact that the explosion was practically on the water, even though the ship was touching ground. Unfortunately I find it difficult to make any satisfactory estimate of the time between the arrival of the two shocks, but should estimate it between 6 and 10 seconds, which would not indicate a very high velocity for the air wave, or explosion impulse as it is generally called.

It is a well-established fact that the velocity of the explosion impulse is much greater than the normal velocity of sound. The wave probably starts out with about the same velocity as that of the detonation of the explosive, which may be above 5,000 meters per sec. The velocity decreases very rapidly with the distance, especially at first, and is said to reach the normal velocity of sound at about the distance that windows cease to be broken. The velocity at any distance apparently depends both on the quantity and nature of the explosive, though the initial velocity seems to be independent of the quantity. All three of the above explosives, and especially picric acid, have exceedingly high detonation velocities. The terrible destruction caused by the air concussion was undoubtedly due to this intense compression impulse travelling with high velocity.

Whether the above correctly interprets the phenomena or not, there is no question about the terrible destructive effect of the explosion impulse. In a general way it can be said that buildings within a radius of half a mile of the explosion were totally destroyed and that up to one mile they were very largely rendered uninhabitable and dangerous. No section of Halifax city escaped serious damage to doors, windows and plaster. The damage to the Dalhousie Science Building, already referred to, was quite characteristic of those sections of the city farthest from the explosion. More or less severe damage was caused as far away as Sackville and Windsor Junction, 9 or 10 miles N.E. of the explosion, and for a similar distance in the opposite direction. At Truro, 62 miles, and New Glasgow, 78 miles, the shock was sufficient to jar buildings very appreciably, and even to shake articles off from shelves. Even as far away as Charlottetown, 135 miles, and North Cape Breton, 225 miles, the explosion was distinctly felt or heard.

It is interesting to notice how closely the experience of this explosion, as regards the distance at which damage was done, fits in with the results of past explosions, and with experiments. If d is the maximum distance in meters from the explosion to points at which definite damage is done, and m is the mass of explosive in kilograms, then the expression $d = K\sqrt{m}$ has been found to agree pretty well with the observed facts. K is a constant which depends on the nature of the explosive and is about 10 in the case of high explosives. Applying this formula to the Halifax explosion, where m = 2,370,000 kg., d came out to be 15,400 meters. This distance is in satisfactory agreement with such information as I have thus far gathered regarding the maximum distances at which real damage was done.

It seems to be the generally accepted opinion that the intense compressional wave is followed by a wave of rarefaction of much less intensity. Whether this is the true explanation of the phenomena or not, it is certainly true that windows, doors and walls sometimes fell in toward the explosion though much more frequently away from it. One of the most interesting illustrations of this was seen about half a mile from the explosion on the Dartmouth side of the harbour. At a point nearly opposite the point of explosion, the highway was lined by a row of fir trees from six to twelve inches in diameter. These were uprooted and pointed away from the explosion centre where there was no obstruction between them and the explosion, but along that part of the road where there is a forest of these trees between the road and the harbour, the uprooted trees fell towards the explosion.

Further confirmation on this point, and other interesting information, was obtained from several barograph records, two of which the writer has in his possession. Both instruments were located near the centre of the city, about 3,000 meters from the explosion. The motion of the pens was so rapid and so great that there is uncertainty regarding the magnitude of the motion, and it seems quite possible that both pens went off the paper entirely. However, it can be safely said that the positive motion was much greater than the negative. The record from the Halifax Club shows at least a motion of + 1·25 in. and − ·45 in. and the one from the Halifax Nautical Instrument Co. shows at least + ·75 in. and − ·45 in. There were at least two other barograph records obtained in the city; one at the Dockyard within 300 meters of the explosion and the other on the cable ship *Minia*, about 3,000 meters from the explosion. The needle of the latter instrument went completely off the paper and did not return to its previous position. The record at the Dockyard has been lost, but the observer reports that the change in pressure was very small, not over an eighth of an inch. It seems probable that this must have been due to a failure to record.

There is another type of phenomenon, quite common within half a mile of the explosion, which deserves especial notice. The fact is thoroughly well-established that persons and many heavy objects were picked up from the ground and carried considerable distances. In one case a man was taken from the roof of a high building, about three-quarters of a mile from the explosion, and gently deposited on the ground. One of the best examples of this type of phenomenon occurred on the ship *Picton*, which was at its wharf about 250 meters from the explosion. A great boulder, weighing more than a ton, was picked up from somewhere and dropped on the ship. It crashed through the upper deck and still lies on the deck below. The surface of the boulder is worn smooth, suggesting that it must have come from the beach or the harbour bottom, but it was certainly not washed on board for no water came over the vessel. Such phenomena show that the air disturbance was something more than an intense compressional wave travelling out in a straight line. There must also have been some kind of vortex motion, such as occurs in cyclones.

The seismograph record of the explosion obtained at Dalhousie University is of more than passing interest, because three distinct shocks are recorded. The first occurred at about 9:05, the second five minutes later, and the third an hour after the first. The explosion was almost directly north of the instrument and unfortunately the N.-S. pendulum caught at the extremity of the first swing, which made it impossible to attempt any energy calculations from it. The E.-W. record is not purely seismic but exhibits oscillations of the pendulum. The three records on this component have much the same character and are of practically the same magnitude. The natural conclusion is that there must have been three explosions, though the two later ones were neither seen nor felt by the public. The only explanation so far suggested is that the entire mass of explosive was not detonated at first and that small quantities exploded later on the bottom of the harbour. In this case it must have been so confined as not to produce any air concussion and the slight motion of the earth might have escaped notice. This explanation has many serious objections and Mr. Cope considers it untenable.

The writer regrets the fragmentary nature of the data contained in this paper and hopes that it may be possible to supplement at it at some future time.

The Transmission of Earthquake Waves

By OTTO KLOTZ, LL.D., F.R.S.C.

(Read May Meeting, 1918.)

As this is the first time I believe that this subject has been brought before our Section, a few preliminary remarks in the new science of seismology before we present the result of an investigation, may be permissible.

In every earthquake are recognized three distinct types of waves, which, in the order of their arrival at any point, are known as longitudinal waves, waves of compression and rarefaction analogous to sound waves; next transverse waves, waves of distortion and which may be likened to light waves; and lastly surface or undulatory waves. The first two are transmitted as spherical waves through the earth, while the last is confined to the crust.

From theoretical considerations it is obvious that the speed or velocity of propagation is dependent upon the physical properties of the material through which the propagation takes place, and it further follows that the path of any ray for the longitudinal and transverse waves will not be a straight line, but a curve concave to the surface, due to the changing density, elasticity and rigidity, as we penetrate the earth. The path or curve will be the shortest time path, or as technically known—the brachistochronic curve. We might have reasoned *à priori* that with increased depth a greater velocity would prevail, which, however, has been abundantly proved by direct observation for distances up to or approaching a quadrant of the earth, which would mean a depth of about 1,000 miles. This is about the limit of our reliable information, for it must be remembered that the more distant the quake, the less effective will be the horizontal component of the longitude wave, the first to arrive; so that for distant quakes the record of this wave is frequently absent. However, for quakes under 10,000 km. distant we have a goodly supply of seismograms, although not all of the same quality—and for various reasons.

From the known geographic position of quakes such as Messina, California, India and Japan and the seismograms at distant stations, velocity curves have been constructed and interpolated for 10 km. intervals, so that inversely when an earthquake occurs in the ocean or in uninhabited regions, from a good seismogram showing the various phases, the distance to the hearth or epicentre can be found. As was stated the longitudinal and transverse waves suffer variable velocity, dependent upon the depth of path traversed, while the long or undulatory waves confined to the crust, which although not homogeneous, are practically constant, and not a function of the distance. These last waves have a velocity of about 3·8 km. per second or say 230 km. per minute, a determination made from several hundred seismograms obtained at Ottawa. It may be observed that when the quake is particularly violent and deep-seated we obtain not only a record of the long waves on the shorter arc to the observing station, but also by the supplementary arc completing the great circle or circumference of the Earth. Even a third wave has been recorded. These successive waves give us a measure of the co-efficient of absorption which is of the order ·0003, which means that for the distance of some 2,500 km. the energy has decreased one-half. ($e^{-.00028\Delta} = \frac{1}{2}$). It is obvious that were there no absorption we would have an earthquake at the anti-epicentre of equal intensity as the original one. Perhaps it may be interesting to remind one of this expansion and concentration of energy passing over the surface of the earth in concentric waves, the case of the violent explosion in the Sunda straits between Sumatra and Java of Krakatoa in August, 1883, when on the self-recording mercurial barometer at the meteorological office in Toronto several impulses of the atmospheric waves, direct and rebound, were recorded.

The surface or long waves of an earthquake have an average period of about 20 seconds; at the beginning of their appearance they are frequently longer and gradually decrease to a period of about 12 seconds, so that we may put their length as lying approximately between 40 and 80 kilometres, and with a fairly uniform velocity of propagation of 230 km. per minute. After the long waves are well launched on the seismogram there are practically no complications in the record, differing in this respect from the longitudinal and transverse waves which we shall presently note. The rate of propagation of the longitudinal waves is conditioned by the expression $V_p = \sqrt{\frac{\lambda + 2\mu}{\rho}}$, and that of the transverse waves by $V_s = \sqrt{\frac{\mu}{\rho}}$, where μ and ρ are the usual symbols for rigidity and density, and $\lambda = \kappa - \frac{2}{3}\mu$, in which κ = modulus of cubical compression.

These two waves are propagated as spherical waves, so that at a station from a single impulse from the epicentral region we would have the P wave arrive first, then a quiescence followed by the S wave. However, following Huygen's principle each spherical wave as it reaches the surface becomes again the centre of a disturbance from which issue P and S waves, so that our seismogram does not show this period of quiescence above referred to, but becomes a medley of waves, in which we sometimes can distinguish the reflected waves following P and S. As already intimated the velocity of the P and S waves increases with distance due to the increased depth of their path. P increases from about 6·6 km. per second to nearly 14 kilometres per second at 12,000 km. arcual distance. For the S waves the velocity would be ·58 of the preceding on the assumption that Poisson's ratio σ is ·25, that is the ratio of transverse contraction to longitudinal expansion, a value which experience shows to be within narrow limits of observation.

From the preliminary remarks it may be inferred that the seismograms present a rather complicated series of disturbances due to the motion of the earth particles. Added to this are the unavoidable movements of the pendulum of the seismograph itself. Theoretically the bob or heavy mass of the pendulum is supposed quiescent, the reverse of the ordinary functions of a pendulum, and it is the earth—the pier—that makes the oscillations.

However, it is not the intention to present a general paper on seismology, but rather to give the result of an investigation of a definite problem carried out at the Dominion Observatory.

In my paper, "Velocity of L waves," published in the Bulletin of the Seismological Society of America last June, it was stated that "it is not unreasonable to believe that with high-class seismographs and expert readings of their records we would not only be able to obtain the average position of the epicentre but also the position and direction of the fault line itself." The problem then was the location of a fault line along which the disturbance or readjustment of the stresses and strains took place, for an earthquake is always such a readjustment. No stresses, no strains, no earthquakes. The location of an earthquake is evidently a matter of the utilization of the times of "Transmission of Earthquake Waves," the title of this paper.

The Dominion Astronomical Observatory publishes annually the geographical position of epicentres for the preceding year, derived from seismograms of the Observatory and those of other stations. The records of every earthquake do not always lend themselves to a definite location, mostly due to the lack of the phases of the P and S waves, the important factors in determining the distance. If only one phase of a quake is recorded it is always of the L or long waves, but they never alone give satisfactory data for location of an epicentre.

On May 1, 1915, a severe earthquake was universally recorded, the position of its epicentre was determined principally from the seismograms of Eskdalemuir and Ottawa and published as being in

Lat. 49 North, Long. 159·9 East, being south of Onekotan Island, off the southern extremity of the peninsula of Kamtchatka and on the margin of the Kurile Deep. It may be stated that in plotting by the stereographic method and using the Klotz Tables the intersection of the various arcs from the several stations used did not all intersect exactly at the same point; however, the weighted intersection had the above geographical co-ordinates. A year after the above published value a photographic copy of the seismogram of the above earthquake was received from Perth, Australia, a beautiful record with sharply defined P and S which cannot be mistaken. From this gram the deduced distance to the epicentre was found to be 9,280 km. Combining the distances of Perth, Zi-Ka-Wei and Honolulu, the last two the nearest stations to the seismic regions, we obtain an epicentre off the Island of Urup, *i.e.*, in or along the Kurile Deep. The evidence seems irrefutable that we have an epicentre off Onekatan and one off Urup, both on or in the Kurile Deep. Re-reading and measuring on the 30-inch globe the various distances of other stations giving good records to the nearest point along the line joining the above two epicentres, better accordances are secured than if we tried to join them all to one point—to one epicentre. The conclusion is forced on one that we have to deal here with a breakdown along a fault line 500 km. long, running in a North-east-South-west direction, the trend of the well-known Kurile Deep, and the seat of much seismic action. Perth lies approximately on the great circle passing through the Kurile Deep.

It is believed that this is the first instance of an attempt at locating a submarine fault. There is no reason to doubt that in time submarine faults along which seismic disturbances occur will be definitely located in all the oceans. This knowledge will have a thoroughly practical bearing on submarine cables, in determining the position of breaks, which is determined electrically by the cable itself as explained in the article "Cable Laying." pp. 404-407, by the writer in the volume, "Annals and Aims of the Pacific Cable," 1903; and also in future cable laying in pointing out danger lines to be avoided for the cable route.

With reliable seismograms and more particularly with accurate and correct interpretation a wide panorama of interesting and valuable results looms up. The location of epicentres will expand to location of fault lines, and furthermore, when our absolute times of record are reliable within a second we will have the means of following the breakdown from beginning to end. At present we deal with earthquakes on the assumption that it is one sudden break at a point or along the line or surface of adjustment of stresses. If this is not the case the comparison of seismograms from different stations well distributed about the seismic area will tell the story of what happened, when it happened, how and where, as well as how much energy was released in the adjustment.

It is believed that there is already a great deal of material on hand in the form of seismograms that if brought together and dealt with by a master hand would reveal much of the interior of the earth, would furnish us material for improving and extending our tables and velocity curves, so that we would reach the stage of detecting along certain paths of the seismic rays anomalies in density, elasticity and rigidity, thereby extending a helping hand to the investigator of gravity anomalies. At present co-ordination and collaboration are required.

It may be pointed out there is a check on the deduced distances from various seismograms, for from them it is possible to deduce the actual time of occurrence of the earthquake, which is always expressed in Greenwich Mean Time, and this time we designate by the symbol O. The time deduced involves of course the accurate time of a station. It is not infrequent that the O's deduced from the more reliable stations will agree within a few seconds, although our tables for transmission times of the various seismic waves are not perfect. The accordance in the determination of O for a good tectonic quake is certainly very gratifying, whether the seismic convulsion be in Asia, in America, or in the depths of the Pacific.

In closing this brief note it may be pointed out that when the earthquake is one sudden breakdown from a restricted hearth then the O's for all stations must theoretically be the same. But the epicentre deduced from various pairs or groups of stations, when the displacement occurs along a fault line of considerable extent, will then not necessarily be the same, in fact cannot be the same. The P and S at each station would come from the nearest part of the fault line, which as we have seen was so well shown in the one of the Kurile Deep.

Seismology is slowly gaining a permanent footing in the field of science, and the harvest looks most promising.

The Application of Wireless by the Dominion Observatory for Longitude Determinations

By R. M. STEWART, M.A.

Presented by OTTO KLOTZ, LL.D., F.R.S.C.

(Read May Meeting, 1918.)

As no account has been given of the application of wireless telegraphy to the determination of longitudes in Canada, it seemed that a short description of the work done and the methods used by the Dominion Observatory might be of interest.

In the telegraphic method, the function of the telegraph line is the making of a direct comparison between the observing clocks at the two stations; in practice this is done by connecting the telegraph line to the chronograph at each station and sending a certain number of arbitrary signals in each direction over the line; the signals are recorded on both chronographs, together with the beats of the respective clocks; this affords the comparison desired.

When it is desired to use wireless telegraphy a different procedure is required, since wireless signals cannot readily be recorded on a chronograph. It is hence necessary to resort to the method of coincidence of beats, a method of comparison which may be made very nearly, if not quite, as accurate as a comparison by chronograph.

When the necessity arose in the spring of 1914 for the determination of longitudes of several stations in Quebec which were inaccessible by telegraph, it was decided to inaugurate the use of wireless telegraphy for the purpose. Two courses were then open. It was possible to make use of the wireless time-signals sent out by the U.S. naval station at Arlington, near Washington, for distribution of time at sea; on the other hand, special signals might be sent out when required from one or other of the Canadian Government stations. The Arlington signals are sent out every night from 9.55 to 10; they are controlled by a clock beating seconds, the 29th second and the last five seconds of each minute being omitted for identification; the duration of individual beats is ¼ second or less.

Preliminary experiments had shown that beats of about ½ second duration, with only one beat per minute omitted, were preferable for our purpose; also the time available (5 minutes) was not considered sufficient for accurate results. It was therefore decided to attempt to make use of the Canadian station at Kingston for the transmission of such signals as were required; the only point in doubt was whether the range of the station was sufficient to reach the points required. Upon further experiment this unfortunately turned out not to be the case, and it was necessary to fall back upon Arlington.

Since the Arlington signals are controlled by a mean time clock it is not feasible to make a direct comparison with a sidereal chronometer by the method of coincidence of beats, since it would frequently happen that a coincidence would not occur during the five minutes for which the signals continue. It was therefore necessary to introduce an intermediary chronometer having a large rate; at the outset this was rated to gain ten minutes per day on mean time; the difference of rate was later increased to fifteen minutes per day, giving a coincidence every 96 seconds approximately; three coincidences during the five minutes were thus assured, and owing to their spacing it was impossible that more than one of these should fall in the silent space at the end of the minute.

To make the comparison, a circuit derived from the chronometer, and including a suitable inductance, is led close to the cord attached to the head-piece of the receiving set; when properly adjusted this causes a sharp click in the telephone on the opening of the chronometer circuit, while the subsequent closing of the circuit is almost inaudible. Owing to the difference in rate, these chronometer clicks gradually gain on and pass through the wireless beats; the beat when the click coincides with the beginning of the wireless signal is the moment of coincidence. The chronometer times of the coincidences having been noted, as well as the time (to the nearest half second) of one or more Arlington even minutes, the comparison between Arlington and the chronometer is established; this is bridged over to the sidereal observing chronometer by a chronographic comparison before and after the receipt of signals.

We have now a comparison, at a particular instant, between Arlington time and the observing clock at one station. It is obvious that if a similar comparison has been made at another station, we can deduce the difference of time by the two clocks, which completes the longitude "exchange." All the other operations incidental to a determination of longitude are carried on in the usual way.

It is to be noted that the deduced longitude does not depend at all on the correctness of the time signals used, so long as their rate is correct; thus any other set of rhythmic signals would serve the purpose equally well. As a matter of fact there is a systematic discordance of approximately a tenth of a second between Arlington signals and our standard time; the longitudes deduced by the above method are nevertheless based on Ottawa.

The probable error of a comparison between Arlington and the intermediary chronometer is $\pm \cdot 01$ sec. for a single coincidence; that of the complete comparison between the sidereal chronometers at the two stations may therefore be taken as from $\pm \cdot 01$ sec. to $\pm \cdot 02$ sec., and is of the same order as for an exchange by telegraph; the time of transmission of the signals is practically negligible, since they travel with the velocity of light. It has been found, however, that there is a small personal equation in the receipt of signals which must be measured and taken into account; the values obtained (difference between observers) for the seasons of 1914, 1915 and 1916 were ·013 sec., ·008 sec. and ·010 sec. respectively. It may be worth noting here that a method has now been devised[1] by which even this small personal equation is almost wholly eliminated. It has been tested at the Observatory and found to have decided advantages, coupled also, however, with some slight disadvantages.

The field aerials used have been from four to five hundred feet in length and fifty to seventy feet in height; two wires are used, carried on spreaders of eight to ten feet in length; these are supported on trees, which have always been found available, though sometimes with difficulty; it has consequently never been necessary to erect artificial masts; wherever possible, a ground connection has been made in a small lake or stream; failing this, an iron rod driven into moist earth will usually suffice. The strength of signals naturally varies considerably with the nature of the country and with the efficiency of the aerial it has been found possible to erect; usually, however, unless on exceptional nights, it has been possible to make satisfactory comparisons; one of the favorable features is that signals are usually strongest at night.

The instrument used for the transit observations is of a small, compact and very portable type; this is important, since most of the stations occupied have been accessible only by canoe. Fourteen stations have been occupied by this method up to the present; it seems probable that it will find increasing application in the future.

The average precision of the longitudes determined has been very little inferior to that of those determined by wire; considering the fact that the telescope is considerably smaller and that the observers

[1] Monthly Notices, March 1917.

were less experienced, the conclusion appears warranted that the wireless method is as accurate as the more usual one. Its field of profitable application, however, will probably remain limited in the main to stations not accessible by telegraph, since the trouble and expense of installing an aerial at each station will turn the scale against it.

*Air and the Law of Corresponding States**

By DR. A. L. CLARK, F.R.S.C.

(Read May Meeting, 1918.)

The equation of van der Waals, $\left(P + \frac{a}{v^2}\right)(v - b) = R\,T$, contains only three constants; consequently, it leads at once to the values of the critical constants. We may derive these by writing the equation in the form $(v - v_c)^3 = O$ at the critical point and equating the coefficients of like powers of *v* in the two equations. We may arrive at the same results by taking account of the fact that there is a horizontal inflexional tangent at the critical point which requires that $\frac{dP}{dv} = O$ and $\frac{d^2P}{dv^2} = O$. These derived equations and the original equation lead to the values

$$v_c = 3\,b, \qquad P_c = \frac{a}{27\,b^2} \quad \text{and} \quad R\,T_c = \frac{8\,a}{27\,b}.$$

Substitution of $v = \frac{v}{v_c}$, $P = \frac{P}{P_c}$ and $T = \frac{T}{T_c}$, the reduced values of v, P and T, in van der Waals' equation leads to

$$\left(P + \frac{3}{v}\right)(3\,v - 1) = 8\,T.$$

the reduced equation of state, which is independent of the nature of the substance. In this equation, the units employed for any substance are the critical values of v, P and T. Two substances are in corresponding states when the reduced pressures, volumes and temperatures have the same values. Their properties are then similar. The great advantage of van der Waals' equation, besides its simplicity and applicability to representation of a great variety of substances, is the fact that it leads to a reduced equation of state, and hence the law of corresponding states.

Further, the ratio $\frac{R\,T_c}{P_c v_c} = \frac{8}{3}$ is a constant for all gases obeying the equation of van der Waals. The departure of this critical coefficient for any substance from the theoretical value may be taken as a measure of the degree of approximation with which it is represented by the equation of van der Waals. We may group substances according to the values of their critical coefficients. In the case of helium, whose molecules approximate the ideal structure imagined by van der Waals, the critical coefficient is $2 \cdot 68$[1], a very close agreement with the theoretical value.

While, strictly speaking, it is not proper to apply the method of corresponding states to mixtures, the application may be justified in the case of air, since its components are not very unlike. We should avoid the critical region of any mixture, however.

Previous work[2] on the critical phenomena of air has shown that the temperature and pressure of the plait-point are $-140 \cdot 73°$ and $37 \cdot 25$ atmospheres respectively, and that this point is situated very nearly on the straight line joining the critical points of pure oxygen and nitrogen. Also, the density $\cdot 36$ at the plait-point is almost what the centre-of-mass law would give. Further, the critical point of contact, or highest temperature and corresponding pressure at which liquid is possible is very near the plait-point, so that we may take the data at the plait-point for calculation of the critical coefficient. The value thus obtained is $3 \cdot 46$. This value lies between $3 \cdot 42$ and $3 \cdot 59$, the values for ethylene and carbon dioxide respectively. This suggests the comparison of the isotherms of air with these two gases.

It was discovered very early in the study of the isotherm that the curves for various substances were of the same general form. Amagat[3] showed that if scales proportioned according to the critical pressures and volumes were used, the isotherms of different substances fell into the same family. When the proper scale has been determined, the critical data of a gas may be estimated from those of any other substances.

The method used by Raveau[4] is a distinct improvement for the purpose of determining critical constants. Instead of plotting the isotherms in terms of P and v, he used log P and log v. Thus the isotherms of one substance may be laid on those of the other and shifted until they come into agreement, the co-ordinate axes being kept parallel. Just as Amagat found the Pv, P diagram more convenient than the P, v diagram for studying the departure of the isotherm from the simple gas law, so the log Pv, log P diagram is more convenient than the log P, log v diagram, being more compact. The $\log \frac{Pv}{T}$, log P diagram is still more compact and has

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[1] Onnes, Communication from the Physical Laboratory of Leiden, 119 (b), 1911.

[2] Communications, Leiden, 150b, 1917.

Transactions of the Royal Society of Canada (III), XI, 1917.

[3] Amagat, Statique Expérimentale des Fluides, Rapport présentés au Congrès International de Physique, Tome 1, 551, 1900.

[4] Raveau, Compt-Rend., 123, 109, 1896. Jour. de Physique (3), 6, 432, 1897.

an advantage if the temperatures are not too far from the critical temperature, where the curves fall too close together.

On account of the fact that air behaves like a simple substance when not too near the critical region, Professor Kamerlingh Onnes suggested that we determine the critical date for air by comparison with carbon dioxide and other gases. It is interesting to note that the method gives the correct values of critical temperature and pressure with a higher degree of accuracy than that of most previous work.

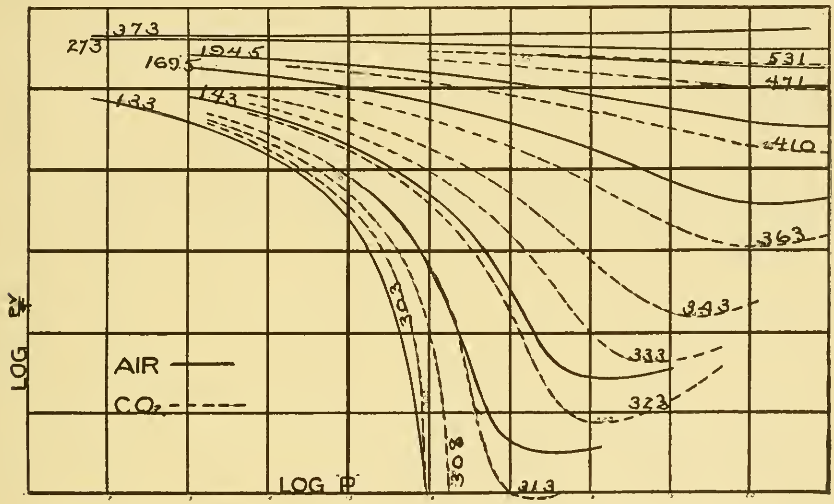

Figure 1

We have excellent, though not extensive, data for air in the observations of Witkowski,[1] and for carbon dioxide and ethylene in the papers of Amagat.[2] The air isotherms in terms of log $\frac{Pv}{T}$ and log P were drawn on a large scale on heavy paper. The isotherms of the other substances were drawn to the same scale on thin transparent paper and placed on the air curves. Then, by shifting the carbon dioxide or ethylene curves on the air curves they were brought into corresponding states. Taking the critical pressure and temperature of carbon dioxide as 31·1°C. and 75 atmospheres respectively, and of ethylene 10·1°C. and 51 atmospheres respectively, the mean of a number of trials gives the critical temperature of air,

[1] Witkowski: Philosophical Magazine (5) 41, 288, 1896.

[2] Amagat: See Barus, The Laws of Gases, for a collection of papers by Amagat.

$-140 \cdot 2°$ and $141-0°$ respectively. The values of the critical pressure are $37 \cdot 8$ and $40 \cdot 7$ atmospheres respectively. The averages are $-140 \cdot 6°$C. and $39 \cdot 2$ atmospheres, which is nearer the correct values than those given by the earlier observers.

After the position of best agreement between the air and carbon dioxide isotherms was found, the curves were redrawn in the approximately correct position. Figure 1 shows the result. It will be seen that, except in the critical region, the results are very satisfactory. The curves for temperature below the critical temperature are not drawn, as the agreement between a simple substance and a mixture is bound to be poor. In the two phase state of a mixture, the pressure is not independent of the volume and the distortion of the curves persists into the single phase state of liquid or vapor at these temperatures.

The same method was attempted using the data for argon given by Onnes and Crommelin,[1] but the agreement between the two families of isotherms is not good, owing, no doubt, to the fact that the critical coefficient is much lower, viz. $3 \cdot 28$.[2]

[1] Onnes and Crommelin, Communications, Leiden, 118 (b), 1910.
[2] Onnes and Crommelin, Communications, Leiden, 121 (b), 1911.

The Angle of Contact on Glass Made by Mercury when Covered with Another Liquid.

By DR. A. L. CLARK, F.R.S.C.

(Read May Meeting, 1918).

Quincke[1] has measured the angle of contact between mercury and glass in air and has found that the value is about 148° for a freshly prepared surface of mercury and clean glass, but is somewhat smaller after a time. Pockels[2] has measured the angle of contact between glass and various liquids. Her success seems to depend on her method of cleaning and testing the cleanliness of the glass. For many liquids the angle made with glass is zero.

Some experiments on mercury in glass tubes, when covered with acidulated water, indicated that the angle of contact is, in many cases, zero. Lippmann[3] states that for pure water and mercury in contact with glass, the angle is not zero, but for a H_2SO_4 solution, the value drops to zero. Experiments had been undertaken to determine the validity of the conclusion reached from study of such surfaces before Lippmann's remark was noticed. No quantitative measurements have been discovered, so the results are here recorded.

A large drop of double distilled mercury was placed in a cleaned watch-glass which rested on a steady platform. A spectrometer was fastened to a rigid support with the axis horizontal and so arranged that a small, silvered mirror mounted on its table was just above the mercury drop. The light from a distant high-power tungsten lamp fell on a large stationary mirror, placed higher up over the drop and arranged so that a strong beam fell on the edge of the drop. A third mirror, also stationary, placed below the apparatus, received the light from the rotating mirror and reflected it through a small tube provided with cross wires at each end.

A cover glass cleaned in boiling HNO_3, KOH, distilled water, and finally by heating in the flame of a spirit lamp, was placed on top of the drop of mercury and the light and mirror arranged so that the reflection of the light occurred at the boundary of the glass and the mercury. The spectrometer reading was taken and then the small mirror rotated till the reflection took place from the convex surface of the drop. The

[1] Quicke, Pogg. Ann. 105. Weid. Ann. 2, 152, 1877.
[2] Pockels, Phys. Zeit. XV, 39, 1914.
[3] Lippmann, Ann. de Chim. et Phys. (5), 494, 1875.

angle through which the mirror is turned is the supplement of the angle of contact of the mercury and glass or the value of the angle measured in the air or the other liquid.

Measurements on mercury and glass with air as the third substance yielded somewhat discordant results, as such results usually are. The following taken at different times gives the results for freshly prepared surfaces:

147° 36′ 144° 5′ 146° 19′ 143° 29′ 144° 10′ 142° 59′

These readings represent angles in the mercury.

Next readings with pure distilled water on the mercury were taken. Here a small weight was placed on the cover glass to prevent its floating off. With pure distilled water and clean glass, there is an angle of contact. The following are results for glass, mercury and water:

4° 7′ 5° 45′ 5° 13′ 5° 11′ 4° 46′

with occasionally other results rising as high as 11° which are evidently due to traces of dirt. These angles are measured in the water.

With a strong sulphuric acid solution, the observations are easy and always yield an angle O. Starting with a 25 per cent solution, observations were taken with constantly diminishing concentration with the following results:

Above 2 per cent	0			
2 per cent	5° 59′	6°	very small	0

With the 2 per cent solution the observations are very difficult. There is not the easy decision as in the higher concentration. Somewhere between a 2 per cent concentration and pure water, the angle passes from 0° to about 5°. The exact point of change from zero angle has not been determined but is probably for a concentration of less than ½ per cent.

In the case of three pure liquids in contact along a line, it has been shown that the Neumann triangle is impossible, but, with a solid and two liquids, equilibrium is possible and there may be an angle of contact. In the case of a mercury-water surface in contact with glass, for example, there is an angle as shown above. If T_1 is the surface tension of the water-mercury surface; T_2 of the glass-mercury surface and T_3 of the glass-water surface, the equation of equilibrium is

$$T_3 + T_1 \cos \theta = T_2, \text{ so } \cos \theta = \frac{T_2 - T_3.}{T_1}$$

If $T_3 - T_2 > T_1$, equilibrium is impossible and the angle of contact has become zero. This, in general, represents a condition of instability. For the water and mercury on glass we have stability With the acid-mercury surface, at least for all but the smallest concentrations, the condition is one of instability. In this case, the acid tends to creep between the glass and mercury, being opposed by the hydrostatic pressure and perhaps by other things.

Experiments undertaken to discover the presence of this creeping, show that it exists. A large number of glass tubes were cleaned and dried and sealed at one end. These were about 8 mm. in diameter and 10 cms. long. Some freshly distilled mercury was poured into the tubes and H_2SO_4 solutions of different concentrations were poured on top of the mercury. The tubes were put in a quiet place for observation. The acid solution could be seen creeping down between the mercury and the glass and while there are irregularities the stronger solutions creep more rapidly.

Periodic Precipitation

By MISS A. W. FOSTER, M.A.

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Presented by PROFESSOR E. F. BURTON, Ph.D., F.R.S.C.

(Read May Meeting, 1918.)

One of the most interesting physical properties of colloidal particles in hydrosols (aqueous colloidal solutions) is the possession of an electrical charge. When an emulsoid such as gelatine is added to the hydrosol the particles still retain their peculiar charges, as is shown by their motion in an electric field. On addition of electrolytes to the hydrosol (without added gelatine), the charge on the particles is lessened and coagulation of the particles takes place. This discharge of the particles is thought to be due to the absorption by the charged colloidal particles of the added ions, which bear a charge opposite in sign to that on the colloidal particle.

The purpose in undertaking the experiments detailed herewith was to find whether colloidal particles in a matrix of solid gelatine still absorbed ions in the same way. The phenomenon of Liesegang rings was chosen in order to demonstrate the results.

The Liesegang phenomenon is the name given to periodic precipitates in some sort of gel produced by the diffusion of some reagent placed upon the gel. The first mention of the phenomenon has been attributed to Runge and also to Boehm, but it is due to Liesegang that the subject has come into prominence. Chemical precipitates of many different substances possessing a certain periodicity have been obtained by the diffusion of different reagents in gels containing various solutes.

In the present experiments the Liesegang rings were formed by the action of silver nitrate on a thin sheet of solid gelatine, which has been impregnated with a small quantity of potassium chromate. To a 4% gelatine solution was added potassium chromate to make up 1/200 gram molecular weight per litre. Two ccs. of this solution was poured on a glass plate ($3\frac{1}{4}'' \times 4\frac{1}{4}''$) kept perfectly level and after the gel had set, that is, at the expiration of an hour or more, a drop of 10 gram molecular weight per litre of silver nitrate solution was dropped on the centre of the gelatine film. The resulting ring formation is shown in Fig. 1, with magnification 1½ times, and in Fig. II (mag. 25).

The colloidal solution chosen for these experiments was a Bredig copper hydrosol formed by making an arc under pure water with two copper wires in series with a resistance in a 110 volt circuit. As these copper particles bear a positive charge they would absorb from a solution of potassium chromate some of the chromate (negatively charged) ions.

Any theory explanatory of the Liesegang rings presupposes that the potassium chromate is originally equally distributed through the gelatine. The addition of copper colloidal solution to the gelatine containing traces of potassium chromate would alter the continuity of this distribution, if the copper particles strongly absorb the chromate ions. One would expect under these circumstances that the rings would not form.

Gelatine solutions were made up similar to those used to produce the rings shown in Figs. I and II, with the exception that a quantity of copper colloidal solution was used in place of water. If the gelatine solution was poured out as soon as the copper colloidal solution was added, concentric rings like those shown in Figs. I and II were produced in films made from both these preparations, but if the films were made several hours after the addition of the colloidal copper, the precipitate was in the form of microscopic quantities scattered over the plate around the central portion, some being gathered into piles, so that the whole area presented a blotchy appearance under the low power microscope. (Fig. III.)

It is evident from these results that the positively charged copper particles, as would be expected, do combine with the negatively charged chromate ions, for the nature of the precipitate is entirely changed when they are present. These results would also indicate that a certain interval of time is necessary for the diffusion of the copper particles through the gelatine solution and the formation of the copper-chromate aggregates.

The same idea was carried out with agar solutions. The agar was prepared by washing and boiling and straining, and the solutions were made up as were those containing gelatine. The phenomena observed are shown by micrographs. Fig. IV shows the outer boundary of the precipitates formed by the diffusion of a drop of a solution of ten gram molecular weight of silver nitrate per litre in a 1% agar solution containing one one-hundredth gram molecular weight potassium chromate per litre, and Fig. V shows the formation when copper colloidal particles are present in the same chromate-bearing agar solution. Some films containing only chromate showed a slight border, but the corresponding films containing copper gave a much more marked effect. It may be that the agar solution reaches, on account of its increased rate of solidifying, a state in which further diffusion is prevented more quickly than the simple chromate agar solution, thus causing a concentration of the silver chromate precipitate at the diffusion boundary. It would appear that the protective action of the agar on the chromate is such that the presence of the positively charged copper particle does not change the character of the precipitate as it does in the gelatine.

References: Liesegang: Zs. phys. chem. 88, 1914.
Ostwald: Zs. phys. chem. 32, 1897.
Morse and Pierce: Zs. phys. chem. 45, 1903.
Stansfield: "Retarded Diffusion and Rhythmic Precipitation," *Am. Jour. Sci.*, Vol. XLIII, Jan. 1917, pp. 1-26.

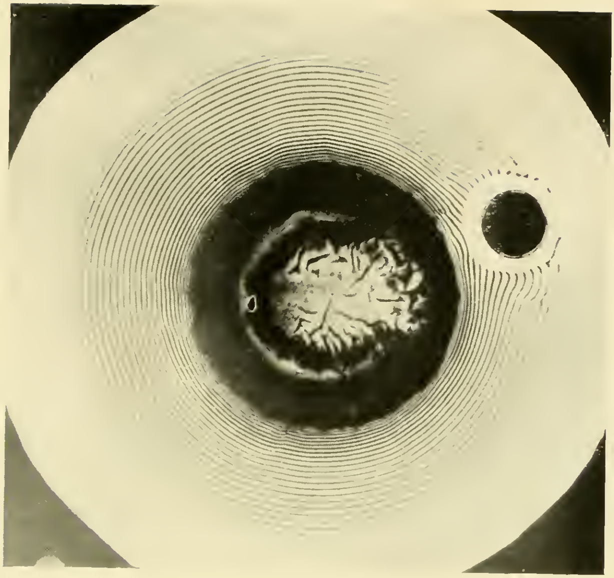

Figure 1. Rings formed by Silver Nitrate diffusing into gelatine containing Potassium Chromate.

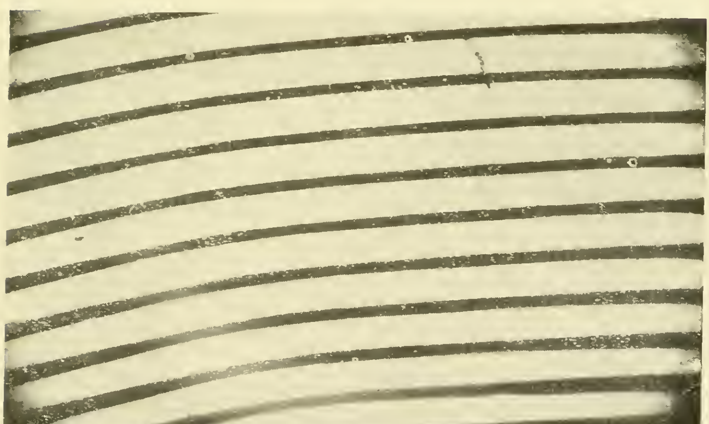

Figure 2. Part of figure 1 with higher magnification.

Figure 3. Precipitate formed in gelatine which had been impregnated with Copper colloidal solution.

Figure 4. Precipitate formed by same chemicals as above in agar-agar.

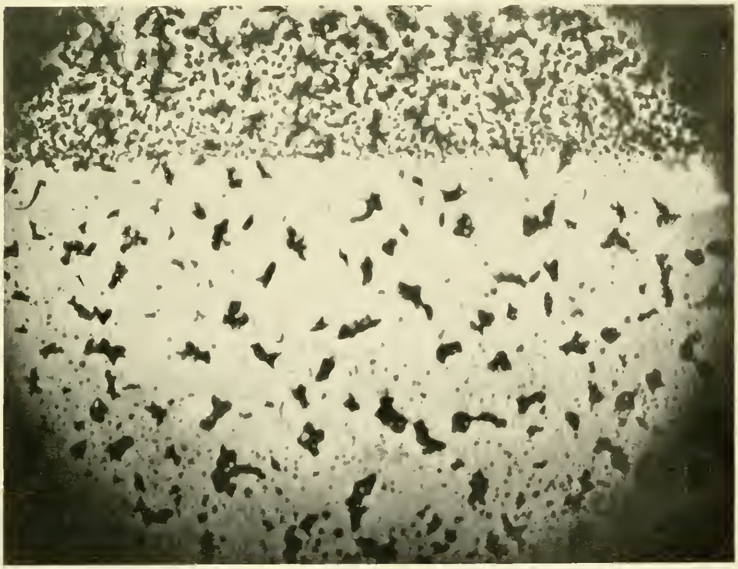

Figure 5. Same as figure 4 except that the agar-agar had been impregnated with copper colloidal solution.

Regularities in the Spectra of Lead and Tin.

By R. V. ZUMSTEIN, M.A.

University of Toronto.

Presented by PROFESSOR E. F. BURTON, Ph.D., F.R.S.C.

(Read May Meeting, 1918).

Lead and tin belong to a group in Mendeleeff's table in which series of spectral lines have not been recognised.

Kayser and Runge,[1] who made the first exact measurements on the lead arc, pointed out that a group of ten lines repeated itself three times in the spectrum with constant frequency difference. They will be denoted as Kayser and Runge's I, II, and III groups. The frequency differences are 1081·08, and 2832·0. Seven additional lines have recently been added to these groups by Saunders.[2]

On carefully examining the work of Kayser and Runge, and some unpublished researches of Fuller and Ainslie of this laboratory, it was found that a symmetrical group of three lines repeated itself five times in the spectrum. This gives five groups with constant frequency difference.

TABLE I.

SPECTRUM OF LEAD.

I	II	III	IV	V
7229·30	4057·97	3683·60	3639·71	2833·17
3220·68	2388·89	2254·02	2237·52	1904·20
3119·09	2332·97	2204·18	2187·99	1868·58

The frequency difference between:
I and II is 1081·2.
II and III is 2504·5.
III and IV is 327·3.
IV and V is 8147·1.

[1] H. Kayser, Handb. der Spect., p. 574 (1902).
[2] F. A. Saunders, Ast. Journal, 43, p. 240 (1916).

Since 2504·5+327·3=2831·8, we see groups I, II, and IV are respectively Kayser and Runge's, I, II, and III groups, the III and V groups being new.

The lines 2332·96, 2204·18 and 1868·59 were obtained by Saunders with a lead vacuum arc and a vacuum grating spectroscope. The line 1904·2 was found by Fuller and Ainslie with a lead vacuum arc and a fluorite vacuum spectroscope. Saunders has also pointed out that the lines 5201, 5005, 4340 form part of a group additional to those of Kayser and Runge. This bears no relation to the grouping here proposed.

An attempt was made to see if the five groups are in reality five series, the corrresponding members of which have constant frequency difference.

In looking for new series we are guided by three facts:—

(1) the analogy which exists with other elements in the same group of the Mendeleeff table.

(2) All members of a series show the same Zeeman effect.

(3) The heads of series are the lines which are fundamental for that element. They are usually the only lines which appear in the flame and absorption spectra. They alone are observed when the metallic vapour is bombarded by electrons having the requisite speed. When we examine the light from the electric spark in solutions of the metal with increasing dilution, they remain long after other lines in the arc have disappeared.

In the case of lead we cannot derive aid from the first method, for no series have been discovered in germanium, tin, lead, or the other elements of this group.

Purvis[1] is the only one who has studied the Zeeman effect with lead. He found two lines, 3740, 2873, were broken up into four components, the remainder into triplets.

We have thus only the third method available for this element. In the flame it was formerly supposed that lead always gave a band spectrum which was attributed to lead oxide. Later, under certain conditions, a flame spectrum was observed consisting of three lines, 4057·97, 3683·60, and 3639·71.

Spectrograms were taken of the flame of a Mecker burner, into which was fed the vapour of lead from a small globule of lead supported by the gauze at the top of the burner. The above three lines always appeared, but there was no trace of the band spectrum.

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[1] J. E. Purvis, Camb. Phil. Soc. Proc., Vol. 14, p. 216 (1907).

In table II are arranged these results, together with the results of Hartly (with the pure metal in an oxy-hydrogen flame), Eder and Valenta (with lead chloride), and de Watteville (with lead nitrate).

TABLE II.

Zumstein........	....	....	4058	....	3684	3640	....		
Hartly..........	4455	....	4058	....	3684	3640	....	....	2833
Eder & Valenta..	....	4062	4058	....	3684	3640	3573		
de Watteville....	....	....	4058	3740	3684	3640	3573	2873	2833

The continued appearance of the lines 4058, 3684 and 3640 indicates that these lines are fundamental.

Table III is made up from Eder and Valenta's spectrum charts, showing the lead lines which occur when lead is contained as an impurity in other metals.

TABLE III.

Element	Lead Lines as Impurities					
Cadmium. .	4058	....	3684	3640		
Zinc.......	4058	....	3684	....	2833	
Antimony .	4058	3740	3684	3640	2833	
Bismuth...	4058	3740	3684	3640		
Telurium .	4058	3740	3684	3640	2833	2802
Gold.......	4058					

This again shows the prominence of the lead lines 4058, 3684, 3640, as well as 2833.

Experiments on the absorption due to Lead vapor in a carbon arc showed that these lines were absorbed in addition to some others. This was tested in two ways. Spectrograms were taken of (1) a lead spark the light from which traversed a carbon arc containing lead vapor, and (2) the glowing filament of a Nernst lamp, the light from which traversed a carbon arc containing lead vapor.

The plates used were not sensitive to the line 7229·30, so no test was applied which succeeded in linking this line up with the others.

The results of these experiments point to the possibility of the lines 7229·30, 4057·97, 3683·60, 3639·71 and 2833·17 being similarly related to the lead spectrum—being in fact, the heads of analogous groups of lines.

Regularities in The Spectrum of Tin.

As tin falls in the same group with lead in the periodic table we should expect similarities in their spectra, as has been often recorded. Kayser and Runge[1] found a group of thirteen lines which repeated itself with the same frequency difference, three times through the spectrum. The frequency differences were 5187·03 and 1736·73.

In the work on lead it was pointed out that a group of three lines existed which repeated itself five times with constant frequency difference. This was immediately found for tin when looked for. The five groups are:

I	II	III	IV	V
3801·16*	3175·12*	3009·24*	2863·41*	2840·06*
2785·14	2433·53*	2334·89	2246·15	2231·80
2524·05	2231·85	2148·59	2073·01	2061·00

The marked lines are absorbed in the tin-carbon arc.
The line 2061·00 has not yet been observed.
The frequency difference between:
I and II is 5186·2
II and III is 1736·1.
III and IV is 1692·4.
IV and V is 288·1.

From this we see that I, II and III are included under Kayser and Runge's first three groups. This was in agreement with the work on lead which suggests a series of quintets. The flame spectrum of tin in the Mecker burner was photographed to see if the heads of the five series 3801·16, 3175·12, 3009·24, 2863·41, 2840·06 appeared. However, in no case was a line spectrum obtained; the band spectrum always appeared.

Only two experimenters have observed a line spectrum from the flame fed by a tin salt.

De Watteville[2] used the protochloride of tin, Eder and Valenta observed a few lines along with the band spectrum. The work of these two is here given.

[1] Loc. cit.
[2] loc.cit.

Intensity in arc	de Watteville flame	Eder & Valenta flame
8	4524·92	4524·92
6	3801·16	3801·16
8	3175·12	
10	3034·21	3034·21
10	3009·24	3009·24
10	2863·41	
10	2840·06	

Those underlined are the heads of the five groups. This would suggest that the five lines are fundamental. Tin is seldom present as an impurity in other metals used in spectroscopic work.

This work was carried out under the direction of Professor E. F. Burton.

New Lines in the Extreme Ultra-Violet of Certain Metals.

By D. S. AINSLIE, M.A., and D. S. FULLER, M.A.

University of Toronto.

Presented by PROFESSOR E. F. BURTON, Ph.D., F.R.S.C.

(Read May Meeting, 1918.)

The experiments described below form an extension of the recent work of Lyman,[1] Handke,[2] Wolff,[3] and Saunders[4], on the extreme ultra-violet region.

By using a fluorite vacuum spectroscope and a vacuum arc lamp, photographs of spectral lines were obtained free from the disturbance due to the absorption of the light by glass, quartz or air. The arc could be manipulated from the outside of the case of the spectrograph; the current ranged from four to fifteen amperes, according to the metal used.

For the hard metals with high melting points the terminals of the arc were made of the metal; when a soft metal was used, the terminals were made of iron and were hollowed out in a cup-shaped cavity in which the metal sample was placed.

The whole apparatus was connected up by a lead pipe to a set of trimount oil pumps in series, so that it could be quickly evacuated. The vacuum was tested by having a discharge tube sealed in by a side connection. The vacuum used when photographs were being taken was that which gives a dark, green discharge.

A hydrogen discharge tube fitted with a fluorite window was arranged in the apparatus, so that on one and the same plate there could be obtained both the hydrogen spectrum and the spectrum of any given metal in the same region. By adjusting the cover slit, a photograph of the gas spectrum could be obtained on the bottom of the plate, and then, without moving the plate, the cover slit could be readjusted, the discharge tube could be replaced by the vacuum arc lamp, and thus the spectrum of the metal could be thrown on the same plate just above the hydrogen spectrum. This afforded a means of comparing each metal spectrum with that of the gas.

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[1] Lyman: Spectroscopy of the Extreme Ultraviolet (Longmans).

[2] Handke: Inaug. Diss. Berlin., Aug. 1909.

[3] Wolff: Ann. de. Phys. 42 p. 825, 1913.

[4] Saunders: Astro phys. Jour. 43, p. 234, 1916.

It is important to notice that in obtaining the spectra of metals, the secondary gas spectrum is always present. Thus, by having the gas spectrum immediately above, and on the same plate, the lines due to the gas that might otherwise be attributed to the metal, could be easily picked out. When an intermittent arc, obtained by using a small current, was used, the time of exposure was longer and the secondary spectrum always came up strong, while when a high current was used, the arc remained much more steady and the secondary spectrum was much weaker relatively to that of the metal.

The length of the exposure ranged from 5 to 10 minutes for the metals. The steadier the arc remained, the shorter the time required. When being used, the arc could always be observed through a glass window sealed in the end of the casing of the arc.

The apparatus was connected up to a hydrogen tank, so that when not in use it could be filled with hydrogen gas. The hydrogen gas, together with phosphorous pentoxide kept the interior free from moisture.

Results.

With the apparatus described above, the vacuum arc spectra of lead, tin, iron, nickel, cobalt, and thallium were investigated; also the spectra of copper, aluminium, zinc, and carbon, which were studied by Ainslie last year, were repeated, and the wave lengths of lines carefully measured again.

In calculating the wave lengths of the lines of these different spectra, certain lines previously determined were used as standards. From these lines, by means of graphical interpolation, the various lines were carefully measured. In working with a prism spectroscope it is necessary to use quite a large number of lines as standards, in order to get accurate results by graphical means. It is impossible to get results with this instrument by referring to a few standard lines, such as Saunders did in using a grating spectroscope. For the region from 1850 down, hydrogen and aluminium lines measured by Lyman, and for the region above 1850, carbon monoxide by Lyman, and copper and thallium lines by Eder and Valenta, were used.

Copper.

The copper vacuum arc spectrum was obtained by using a current of about 9 amperes. With this current the arc was almost continuous. The results obtained agree fairly well with those of Eder and Valenta for the region covered by their work and from λ 1750 down they agree with the values of Handke[1] obtained by using a copper spark.

[1] Lyman, Spectroscopy of the Extreme Ultra-Viotet, p. 122.

Intensity	Wave Length	$1/\lambda$	E. & V. λ	Handke
4	2370·0	42194	2369·94	
4	2297·0	43529		
4	2267·0	44111		
10	2247·0	44504	2247·08	
4	2231·5	44813		
6	2221·0	45025		
6	2213·0	45209		
8	2195·8	45541	2195·87	
8	2182·2	45825	2181·80	
			{2151·95	
4	2151·1	46488	{2149·05	
6	2137·5	46784	2136·05	
4	2125·8	47041	2125·26	
4	2112·5	47337	2112·19	
4	2104·8	47510	2104·88	
4	2055·4	48652	2055·05	
6	2044·0	48924	2043·84	
6	2037·3	49084	2037·24	
4	2026·2	49353	2025·53	
4	2001·0	49975	....	
4	1979·6	50515	1979·26	{1749·9
4	1748·6	57189	....	{1747·1
				{1739·0
4	1739·7	57481	....	{1741·0
6	1721·8	58080	....	1721·9
4	1708·5	58531	....	1708·5
2	1704·9	58654	....	1705·0
4	1693·4	59053	....	
1	1692·5	59084	....	1692·3
4	1686·7	59301	....	1686·6
2	1684·6	59361	....	1684·3
				{1681·2
1	1681·7	59428	....	{1681·9
2	1679·1	59556	....	1679·0
2	1674·6	59680	....	1674·5
2	1671·5	59826	....	1671·6
2	1670·1	59877	....	1669·8
2	1651·9	60536	....	1651·9
8	1642·1	60898	....	1641·8
8	1594·2	62727	....	1594·2
Intensity	..	..	E. & V.	Handke

Aluminium.

The vacuum arc spectrum for aluminium was obtained by using aluminium alone as terminals in the arc lamp. The arc remained steady for short periods but was mostly intermittent. For the intermittent arc the current was about eight amperes when the terminals touched together, but when separated the current quickly dropped to zero, and therefore it was necessary to separate and touch the terminals continually in order to obtain a photograph.

Intensity	λ	1/λ	λ
10	2367·5	42239	2367·2 E & V.
10	2139·5	46740	
7	2061·5	48508	
6	2026·0	49358	
14	1990·0	50251	1989·9 "
4	1935·1	51677	1935·3 "
10	1930·4	51803	1930·4 "
32	1862·7	53685	1862·8 L
32	1854·8	53914	1854·7 "
			{1766·9 H
4	1766·6	56606	{1766·0 "
10	1762·0	56754	1761·9 L
10	1724·3	57995	1725·0 L
8	1720·7	58116	1721·2 "
4	1718·5	58190	1719·3 "
4	1670·6	59859	1670·6 "
14	1611·7	62046	1611·8 "
12	1605·6	62282	1605·6 "

ZINC.

The vacuum arc spectrum of zinc was obtained by putting zinc in iron terminals in the arc lamp. The current used was 6 amperes which gave a fairly continuous and intense arc. The lines obtained do not agree with the values given by Handke[1] for a zinc spark.

Int.	λ	1/λ	λ
2	2372·5	42149	
2	2336·0	42808	
10	2287·5*	43715	
6	2265·0*	44150	2265·08 E. & V.
2	2205·5	45341	
1	2171·5	46051	
16	2139·5	46739	2139·27 S
2	2104·8	47510	2104·98 "
4	2100·5	47608	2100·53 "
2	2096·5	47698	2097·44 "
6	2087·3	47908	2087·66 "
1	2079·8	48082	2079·57 "
2	2065·0	48426	2064·93 "
6	2062·5	48485	2062·57 "
16	2025·5	49370	2026·19 "
3	1821·8	54890	
10	1589·6	62909	1589·76 W
1	1510·4	66207	
1	1491·5	67047	
6	1486·2	67286	1486·20 W
2	1478·5	67636	
4	1477·6	67923	
4	1457·9	68592	1457·9 W
4	1457·5	68658	1457·56 "
4	1451·1	69913	1450·82 "
3	1445·0	69204	
Int.	..	..	..

S. Saunders, Astrophysical Journal Vol. 43, p. 239, 1916. W. Wolff-Lyman, Spectroscopy of the Extreme Ultra-Violet, p. 123.

[1] These two lines may be due to cadmium but they appear to be zinc.

Carbon.

The carbon vacuum arc spectrum was obtained by using carbon alone as terminals in the vacuum arc lamp. A continuous arc was obtained by using a current of about 10 amperes. In addition to the lines given below a large number of broad and poorly defined bands occur which seem to correspond to those of the carbon monoxide spectrum. Upon measuring some of the more prominent ones, it was found that their wave lengths were different from those of the carbon monoxide spectrum obtained from the discharge tube. This may be due to the fact that the carbon arc is at a very high temperature compared to that of the discharge tube.

The lines of the spectra of copper, aluminium, zinc and carbon were measured last year by Ainslie, using the same apparatus but without the hydrogen comparison spectrum. The measurements were not very accurate and were repeated this year, using standard gas lines for comparison.

The carbon line spectrum is very strong in this region and the lines 1548·5, 1550·7 (1560·5, 1561·2, 1562·0) and 1656·9 correspond apparently to 1548·2, 1550·8, 1561·2 and 1656·8, given by Lyman as lines of certain origin. The line at 1561 appeared as a poorly defined triplet and was found in the spectra of all the metals worked with except zinc.

Line Spectrum of Carbon

Int.	λ	$1/\lambda$	λ
2	2307·5	43337	
9	2298·0	43516	2296·94 E. & V.
2	2219·0	45065	
5	2088·5	47876	
15	1930·5	51827	1930·12 "
9	1758·1	56879	
5	1749·7	57152	
10	1656·9	60354	
9	1562·0	64020	
9	1561·2	64053	
9	1560·5	64082	
2	1550·7	64487	
3	1548·5	64591	
5	1482·8	67439	
6	1464·5	68282	

Band Spectrum of Carbon

Intensity	λ	Int.	λ
3	2194·5	4	1811·7
4	2142·3	2	1806·8
4	2115·3	4	1793·6
4	2088·0	2	1774·6
3	2067·0	1	1748·0
2	2047·5	5	1729·9
2	2037·0	2	1725·0
1	2030·7	2	1721·3
4	1993·2	4	1712·7
3	1973·3	4	1706·5
2	1953·5	2	1670·6
2	1900·2	3	1653·4
1	1843·1	3	1649·1
1	1827·0	4	1630·7
2	1825·1	4	1597·9
1	1819·8	3	1576·6

Iron

The vacuum arc spectrum of iron was obtained by using iron terminals in the vacuum arc lamp. A current of 15 amperes was used, but even with this high current the arc was intermittent and not very bright, which made it difficult to get a good photograph of the spectrum.

Int.	λ	1/λ	λ
5	2394·5	41762	2394·68 E. & V.
5	2380·2	42013	
4	2360·0	42373	
4	2346·0	42626	2345·48 "
2	2097·5	47666	2097·20 "
4	2078·8	48105	
3	2061·5	48508	
2	1926·0	51921	1925·60 B.
4	1913·8	52252	1913·40 "
3	1894·3	52790	1894·90 "

B. Bloch, Journal de Physique, 5 Série, p. 628, 1914.

TIN.

To obtain the vacuum arc spectrum of tin, some pure tin metal was put in iron terminals in the vacuum arc lamp, the current was 5 amperes, which gave an intense intermittent arc. Lines were found in this spectrum to extend far down in the ultra-violet region.

Int.	λ	1/λ	E. & V. λ	Saunders λ
6	2334·0	42845	2334·87	2335·53
6	2317·8	43144	2217·38	2317·93
3	2287·0	43725	2286·8	2287·28
8	2268·8	44075	2269·02	2269·65
6	2247·0	44504	2246·11	2246·73
6	2211·0	45228	....	2210·38
5	2199·5	45465	{2199·68 {2199·4	2199·93
12	2152·5	46457	2151·62	2152·08
2	2041·2	48990		
1	1941·0	51520		
20	1899·8	52637	1899·8	
6	1831·4	54603		
20	1811·2	55212		1811·29
16	1756·6	56928		
1	1741·3	57428		
20	1699·5	58841		
6	1489·2	67150		
9	1475·2	67787		
4	1438·3	69526		
4	1437·3	69574		
4	1402·4	71303		
4	1400·5	71402		

THALLIUM.

The thallium vacuum arc spectrum was obtained by putting thallium in iron terminals. The current used was about 6 amperes which gave a continuous and intense arc. There is considerable variation in these results from those of Saunders. This may be due to the fact that Saunders used standard aluminium and zinc lines, while in this work the gas lines measured by Lyman were used as standards.

Int.	λ	$^1/\lambda$	λ Saunders	λ E. & V.
4	2394·7	41759	....	2394·72
4	2379·5	42043	2380·34	2379·68
2	2316·0	43178	....	2316·14
8	2298·5	43506	2298·05	2298·25
2	2238·0	44683	2238·59	
2	2210·7	45235	2210·46	
2	2168·5	46115		
2	2139·5	46740	2139·98	2139·44
14	1907·8	52416	1908·68	
6	1891·8	52860	1892·72	
2	1827·3	54725	1828·00	
6	1814·2	55121	1814·72	
8	1792·2	55797		
6	1660·0	60241		
6	1653·8	60467		
8	1561·8	64029		
16	1559·0	64144		
5	1538·5	64998		
4	1508·2	66304		
6	1499·8	66676		
2	1491·0	67069		
4	1478·0	67659		

Lead.

The lead vacuum arc spectrum was obtained by putting lead in iron terminals in the vacuum arc lamp. The arc was almost continuous and very intense, being sustained by a current of 4 amperes. As it was not possible to obtain chemically pure lead, a sample of ordinary lead was used. Hence some of the lines recorded here may be due to impurities.

Int.	λ	$1/\lambda$	λ Saunders
4	2430·5	41144	
5	2403·0	41515	2402·62
7	2394·0	41771	2394·52
5	2246·2	44520	2247·53
12	2204·4	45360	2204·18
8	2170·5	46072	2170·60
8	2060·5	48532	
2	1925·8	51926	
4	1913·7	52255	
2	1904·2	52527	1904·88
2	1898·7	52668	
2	1895·5	52756	
14	1821·7	54894	1822·06
10	1796·5	55664	1796·53
1	1744·2	57333	
2	1741·1	57435	
10	1726·2	57930	
12	1682·5	59435	1682·54
12	1671·6	59823	
3	1597·6	62594	
12	1555·8	64276	
4	1511·7	66150	
1	1494·7	66903	
1	1492·7	66993	
5	1434·0	69735	
5	1431·9	69837	

NICKEL.

The vacuum arc spectrum of nickel was obtained in a similar manner to that of iron. Nickel alone was put in the terminals of the vacuum arc lamp. The current used was 7 amperes, when the curcuit was closed. This gave a strong intermittent arc. A large number of sharp and well-defined lines appear in the nickel spectrum in this region.

Int.	λ	$^1/\lambda$	λ E.&V.
4	2394·0	41771	2394·68
4	2375·0	42105	2375·51
2	2366·5	42257	2366·62
2	2356·5	42436	2356·49
6	2345·5	42636	2345·48
6	2335·0	42827	2334·68
12	2315·5	43187	2316·12
12	2303·5	43412	2303·10
12	2297·5	43526	2297·60
7	2288·0	43706	2287·74
8	2278·8	43884	2278·65
6	2271·0	44033	2270·33
6	2264·5	44160	2264·57
8	2255·0	44346	2253·94
8	2226·4	44916	2226·41
8	2218·3	45080	2206·81 }
4	2208·2	45286	2206·72 }
4	2203·3	45386	2201·51
3	2195·2	45554	
6	2187·5	45714	.....
8	2177·7	45920	.....
9	2168·5	46115	2169·19
2	2161·0	46275	2161·31
5	2129·3	46964	2128·67
6	2114·3	47297	2113·61
6	2108·3	47432	2108·04
1	2097·7	47671	2097·2
2	2030·0	49261	
4	2021·0	49480	
1	2005·0	49875	
6	1991·0	50226	
2	1982·0	50454	
4	1964·8	50895	
2	1902·3	52568	
4	1859·2	53786	
6	1854·5	53923	
5	1849·7	54063	
6	1846·7	54151	

Int.	λ	1/λ	λ E.&V.
6	1829·4	54663	
4	1822·5	54870	
4	1818·7	54984	
1	1806·7	55350	
4	1794·3	55732	
4	1790·5	55850	
4	1787·5	55944	
2	1781·2	56126	
9	1767·8	56568	
6	1763·2	56715	
1	1758·7	56860	
6	1750·8	57117	
6	1746·0	57274	
5	1740·2	57465	
5	1737·3	57561	
2	1732·3	57727	
3	1729·4	57824	
3	1722·2	58065	
5	1720·0	58140	
6	1714·8	58282	
6	1709·5	58497	
3	1707·3	58572	
2	1701·3	58779	
2	1698·3	58882	
8	1692·5	59084	
4	1687·9	59245	
2	1661·8	60176	
2	1656·5	60368	
6	1653·2	60489	
2	1650·1	60569	

Bloch has also measured the spectrum of Nickel down to λ1851[1]. He has measured a great number of lines not obtained in this work. The strong lines of his spectrum correspond fairly well with the strong lines measured above.

Cobalt.

The vacuum arc spectrum of Cobalt was obtained by putting cobalt in iron terminals. The current used was about 12 amperes when the circuit was closed. This gave an intense intermittent arc. The spectrum obtained was similar to that of iron and showed up lines that belonged to Carbon. Eder and Valenta's work covers the lines measured in this work down to λ2173·44. Bloch has also made

[1]Journal de Physique, 5 Série, p. 631, 1914.

measurements down to λ1872·94, but his results do not correspond closely with those given below. This may be due to the fact that he used a spark in air, rather than the vacuum arc as used in this work.

Intensity	λ	$^1/_λ$	
3	2387·5	41885	
3	2354·0	42481	
5	2347·0	42607	
4	2344·5	42653	
4	2325·5	43001	
7	2313·2	43230	
7	2308·0	43327	
2	2293·0	43611	
8	2286·5	43735	
4	2246·5	44534	
4	2138·7	46757	
2	2099·3	47635	
5	2061·5	48503	
7	2026·2	49354	
2	1939·5	51560	
9	1929·5	51827	
3	1912·2	52296	
4	1893·8	52804	
10	1861·4	53721	
10	1853·0	53966	
2	1819·8	54951	
1	1740·3	57461	
2	1710·9	58449	
7	1669·9	59884	

From λ2400 to λ2000 the experimental error is probably as much as one angstrom unit. This is due to the fact that the dispersion in this region is small, being about ·05mm. per angstrom unit; also the lines obtained on the photographic plate are not as well defined. These measurements are given for a guide for future research work with vacuum arc sources.

From λ2000 down, the probable error is on the average, well within half an angstrom unit. The dispersion varies from ·067mm. at λ2000 to ·20mm. at λ1400 per angstrom unit.

Summary of Results.

The vacuum arc spectra of copper, zinc, aluminium, carbon, iron, tin, lead, thallium, nickel and cobalt have been studied from λ2400 to λ1400. The vacuum arc spectra obtained for copper, zinc and aluminium were found to correspond with the results obtained for the spark spectra of these metals by previous observers. For tin, lead and thallium, Saunders has given measurements between about λ2400 and λ1800, which correspond fairly well with these results. Several new lines have been observed and measured between λ1800 and λ1400. For the arc spectra of iron, cobalt, nickel and carbon, several lines were obtained, and measured, some of which corresponded with results given in previous work.

This work was begun by Mr. Ainslie under the direction of Professor J. C. McLennan and continued by the joint authors under the direction of Professor E. F. Burton.

The Adsorption of Helium by Charcoal.

By STUART McLEAN, M.A.

University of Toronto

Presented by PROFESSOR E. F. BURTON, Ph.D., F.R.S.C.

(Read May Meeting, 1918.)

Sir James Dewar[1], investigating the efficiency of the use of charcoal in the production of high vacua, made an experiment with helium when the charcoal was cooled to the temperature of liquid hydrogen. He found that at a temperature of 20° absolute, charcoal is a good adsorbent of helium. By boiling the liquid hydrogen under exhaustion, he was able to obtain a temperature of 15° absolute. At this temperature, charcoal is a much better adsorbent of helium.

As the adsorption of helium at liquid air temperature is very small, it was impossible to investigate its adsorption as fully as for other gases. The following are the results of a series of experiments by Miss Homfray:[2]

P.	T.	V.	V. not adsorbed.	V. adsorbed.
48·4	17°C	4·64cc.	4·64 cc.	0·00 cc.
32·7	− 78	4·64	4·50	0·14
12·0	−190	4·64	3·64	1·00
70·4	14	6·71	6·71	0·00
17·1	−190	6·71	5·33	1·38
67·4	− 78	9·72	9·25	0·47
50·3	−128	9·72	9·22	0·50
23·5	−190	9·72	7·32	2·40
42·75	−190	17·80	14·34	3·46
70·50	—190	27·45	21·00	6·45

The amount of gas worked with is usually so small that measurements of volumes by observation of pressures in a comparatively large apparatus give very discordant results. The object of this

[1] Dewar: *Proc. Roy. Soc. Lon.*, 74, 1904, p. 122. *Chem. News*, 90, 1904, p. 145.

[2] Homfray: *Zs. f. phys. Chem.*, 74, 1910, p. 129.

research was to investigate the absolute amount of helium absorbed by a given amount of charcoal and how the amount absorbed depended on the quantity of helium put into the apparatus. Different quantities of helium were admitted into the apparatus, left for half an hour, and then all the gas not absorbed was pumped out; that is the equilibrium pressure was practically zero.

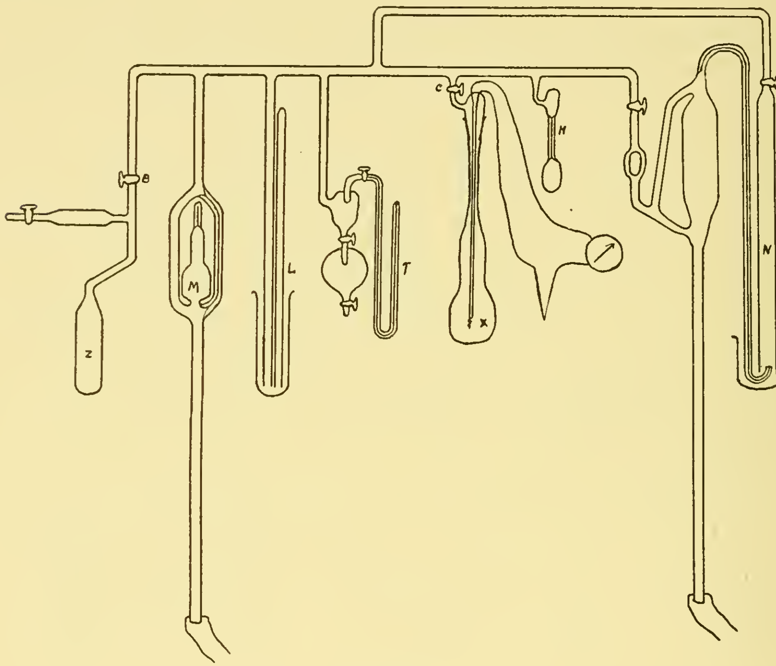


Figure 1

A diagram of the apparatus is shown in Fig. I. The charcoal (30 grams) is contained in the tube X, which may be shut off from the rest of the apparatus by means of the stop-cock C. Before each experiment, this tube was heated in an electrical resistance furnace to a temperature of 440° C and, while it was hot, the apparatus was exhausted. The charcoal tube Z was immersed in liquid air and used to complete the exhaustion. It could be shut off from the rest of the apparatus at B. The discharge tube H was used to test the vacuum.

A measured amount of gas was introduced at the Traver's siphon T or through the tube N. Its pressure was read on the McLeod gauge M or the barometer tube L. The stop-cock C was then opened and the gas allowed to remain in contact with the cold charcoal for at least thirty minutes. The unadsorbed gas was then pumped out and collected in tubes over mercury at K. The difference between the amount of gas introduced to the apparatus and that pumped out, was considered to be the amount adsorbed by the charcoal.

The following table gives the results of a series of experiments.

No.	Temperature	Volume	Volume not adsorbed	Volume adsorbed
1.	Liquid Air	8·50 cc.	8·36 cc.	0·14 cc.
2.	—	18·42	18·32	0·10
3.	—	18·52	18·37	0·15
4.	—	29·58	29·44	0·14
5.	—	34·97	34·73	0·24
6.	—	41·69	41·40	0·29
7.	—	41·98	41·87	0·11

These results go to show that a very small quantity of helium is adsorbed by charcoal at the temperature of liquid air.

This work was carried out under the direction of Professor E. F. Burton.

The "Alkali" Content of Soils as Related to Crop Growth

By FRANK T. SHUTT, M.A., D.Sc., AND E. A. SMITH, M.A.

(Summary).

(Read May Meeting, 1918)

INTRODUCTION.

The nature, concentration and distribution of "alkali" as occurring in soils of certain semi-arid districts of Western Canada have been studied during the past five years in the laboratories of the Experimental Farm system. This work has included the analysis of several hundreds of soil groups collected chiefly in tracts about to be placed under irrigation in Southern Alberta. The data so obtained have materially assisted the Government in the classification of the areas in question into irrigable and non-irrigable lands. For the purpose of applying these data American standards as regards safe limits of alkali have largely been used. The results presented in this paper are a contribution towards the establishment of standards more particularly adapted to Canadian conditions.

THE NATURE AND FORMATION OF SOILS IN GENERAL.

Arable soils are made up of two great classes of constituents: (1) mineral, as derived from the disintegration and partial decomposition of rock material; and (2) vegetable matter, the semi-decomposed remains of past generations of plant life, commonly known as humus. It is from the former that the stores of lime, phosphoric acid, potash, etc., present in the soil are furnished, while the latter supplies the nitrogen required for crop growth and at the same time acts as an important factor in supporting bacterial life and in regulating the temperature, the moisture-content and the aeration of the soil.

Soil formation is not merely a matter of the past; it is now going on. Under natural conditions, as in the forests, our soils are being constantly enriched in humus from decaying roots, fallen leaves—from the death and decay of vegetation generally, and, further, by physical changes and chemical reactions favored by warmth, moisture, carbonic acid of the atmosphere, &c., the rock elements of the soil are being continually, though slowly, disintegrated and decomposed, giving rise to soluble mineral compounds, some of which may be useful and others injurious to plant life.

The Formation of Alkali.

In humid districts, i.e., those enjoying a more or less generous rainfall, the mineral salts formed by these processes, known popularly as "weathering," are practically disposed of as produced. In part they are utilized by vegetation, and any remaining injurious salts leach downwards and drain away; the conditions are such that there can be no accumulation of them in the surface soil.

But such is not always or necessarily the case in arid or semi-arid districts. Here we find the scanty rainfall, while sufficient to promote the formation of these soluble mineral salts, quite inadequate to their removal by drainage. If they descend a few inches, or even a few feet, there is not enough flow of water through the soil to carry them right away and subsequent evaporation of the water that holds them in solution and the action of capillarity brings them to the surface, where they accumulate, forming the so-called alkali, and rendering the soil more or less unsuitable for agricultural purposes. The alkali may impregnate the sub-soil, the surface soil, or if evaporation greatly exceeds the rainfall, it may appear as an incrustation or efflorescence.

Alkali soils, therefore, are characteristic of arid or semi-arid districts only and these in Canada may be said to be restricted chiefly to certain areas in British Columbia, Southern Alberta and South-western Saskatchewan.

Nature of "Alkali."

The compounds known collectively as alkali comprise chiefly sodium sulphate, sodium carbonate, sodium chloride, magnesium sulphate, calcium sulphate (gypsum) when present in large quantities, and occasionally chlorides of calcium and magnesium. Sulphate and chloride of sodium and sulphate of magnesium and of calcium, when crystallized in the surface of the soil, appear as white substances and constitute what is known as "white alkali." "Black alkali" is characterized by the presence of sodium carbonate, though this compound is almost always associated with one or more of the sulphates mentioned above. Sodium carbonate is, as is well known, white, but from the fact that it acts upon and dissolves the decayed vegetable matter (humus) of the soil the incrustation is dark brown or black, hence the name. Water standing in pools on soils impregnated with sodium carbonate is invariably of a dark color resembling a strong infusion of coffee.

Effects of Alkali on Plants.

The soil water of lands impregnated with alkali is a more or less concentrated solution of these compounds. It is the soil moisture which assists in the germination of the seed and is the means of conveying food to the plant rootlets; for the performance of these important functions it is obvious that it should possess no injurious properties. The effect of a solution such as we find in alkali soils on the cells in the tissues of the roots is to extract or withdraw from them by osmosis their natural water. As a result the cells lose their turgidity, their protoplasmic contents shrink from the cell wall, the plant wilts and death may ensue. The higher the percentage of alkali—in other words, the more concentrated the solution—the more severe the effect in this direction. Chlorides are more injurious than sulphates.

"Black" alkali is much more injurious than "white" alkali. The sodium carbonate it contains is directly corrosive, causing injury at the base of the trunk or root crown of the plant, by cutting into and eating away the tissues. The bark of green herbaceous stems is usually turned to a brownish tinge for half an inch or more immediately above the surface of the ground, becoming soft and easily peeling off. The rough bark of trees is found to be almost black and the green layer underneath, brown. Very small quantities are sufficient to prevent seed germination or to destroy the tender rootlets of the seedling, if the young plant appears.

All kinds of alkali have a tendency to destroy a soil's tilth, but this is particularly marked in the case of black alkali. The soil readily puddles, flocculation, or the property of forming flakes, is destroyed and the land becomes in a large degree impervious to water. On drying hard refractory masses are formed and the soil is extremely difficult to work. Very frequently a hard, practically an impenetrable hard-pan forms under such soils, making it almost impossible to put in a system of tile sub-drainage.

Crops differ greatly in their susceptibility to alkali; some are so resistant that they may thrive and come to maturity on soils that for the majority of farm crops there can be no possible hope of success. Apart however, from this question of relative resistancy of crops, the composition, concentration and vertical distribution of the alkali and the physical character of the soil are all important matters in reaching a conclusion as to the desirability and safety of placing an affected area under irrigation. Injudicious or excessive application of irrigation water, to soils impregnated with alkali especially if the subsoil is of an impervious character and sub-drainage is not provided, may ruin, by bringing up alkali, what would otherwise be excellent land for cultivation under "dry-farming" methods. The irrigation of impregnated land without efficient drainage—natural or artificial—almost invariably gives rise to "rise of alkali"—and this in the past has been a fruitful cause of the ruination in the Western States of large areas of once cultivable, fertile soil.

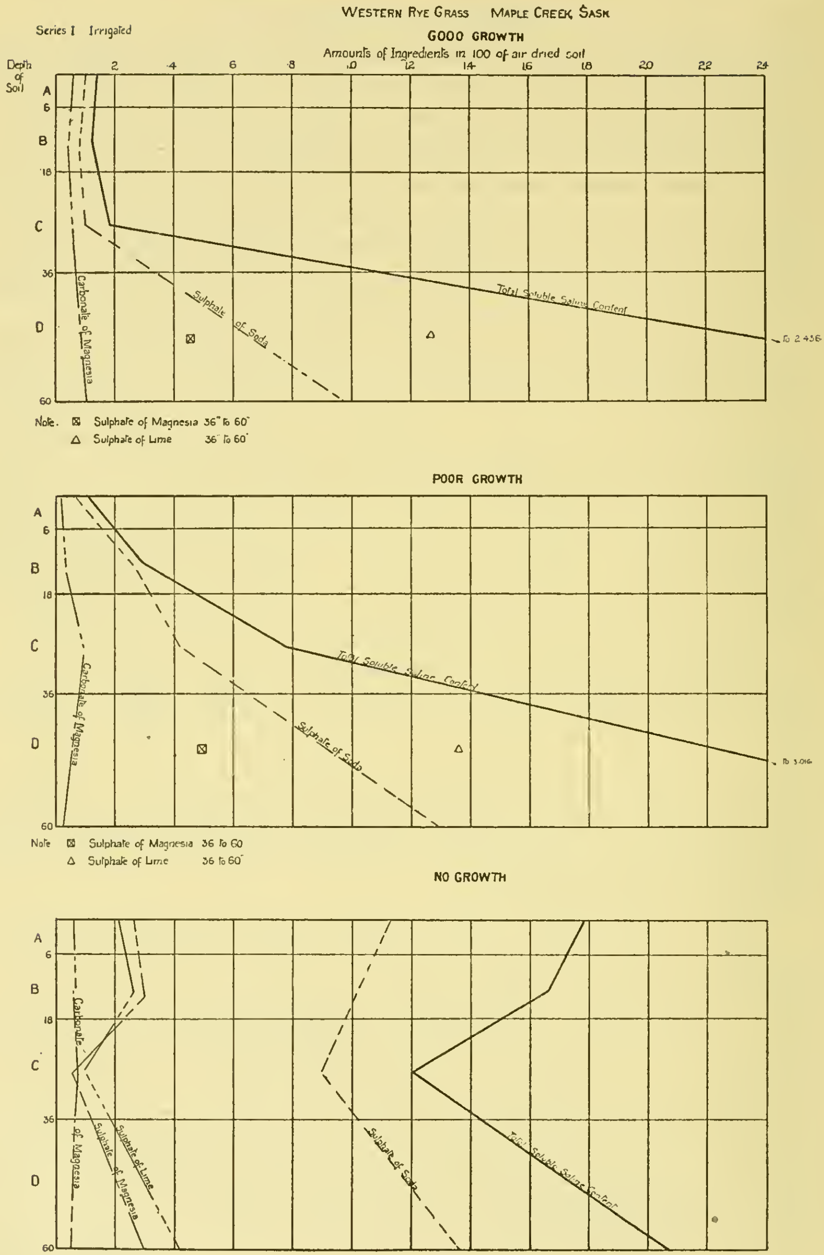


Fig 1 Distribution of Alkali Salts in Soil SEC 20, Tp 9 RGE 27 W 3rd M Samples taken July 4 1917

Limits of Toxicity.

The present paper records the results of the analysis of five series of soil groups, each series consisting of three groups representative of land upon which (1) there was fair or good growth, the concentration of the alkali, if present, being apparently and for practical purposes, negligible, (2) there was poor growth, the crop evidently being distressed by alkali, and (3) there was no growth, due to excess of alkali. Each series represents a separate tract of land (or field), the three groups being frequently collected within a short distance of one another. As in all our work in connection with the irrigation tracts each group consisted of five samples: A=0′·0−0′·5, B=0′·5−1′·5, C=1′·5−3′·0 and D−3′·0=5′·0.

Western Rye Grass.

Series I. Sec. 20. Tp. 9, R. 27. W. of 3rd Meridian.

Field of Western Rye grass about 18 miles south-west of Maple Creek, Sask. The land had been under irrigation for 6 years, during which time the bare alkali spots or patches had increased in size very considerably. Had been sown to wheat 1910, oats 1911, and seeded to Western Rye grass. Crop at time of visit, July 4th, 1917, was only fair on better parts of field, the plants being from 4 to 6 inches in height. Soil a dark brown, almost black, moderately light loam, of good quality; sub-soil of heavier character, a dark grey to yellow grey clay with a little sand. Water table, from 3 to 5 feet, according to contour of land. One group of samples taken from a bare spot, the second in sparse and meagre growth, about 15 feet distant, and the third in the best growth, about 80 feet from the same point of collection.

Western Rye Grass.

Series 1. Sec. 20, Tp. 9, Rg. 27, W. of 3rd Meridian.

Group No.	Depth	Growth	Na_2SO_4	Mg SO_4	$CaSO_4$	Total soluble Saline content
1603	0′·0−0′·5		·089			·128
	0′·5−1′·5	Fair	·073			·120
	1′·5−3′·0	to	·085			·168
	3′·0−5′·0	Good	·641	·504	1·307	2·436
1602	"	Poor	·117			·152
			·254			·300
			·618			·770
			·980	·580	1·376	3·016
1601	"	No.	1·109	·279	·233	1·748
			1·033	·309	·272	1·656
			·964	·066	·104	1·200
			1·189	·210	·304	1·756

Discussion of Results: The impregnation is white alkali, the chief constitutent being sodium sulphate. Magnesium sulphate is present in certain of the members, but chlorides are absent, save in traces, throughout the series. In samples D (3′·0—5′·0) of two of the groups calcium sulphate is present in considerable amounts. This compound cannot properly be classed as alkali, though it is somewhat open to question if it is altogether inert towards growing vegetation when present in amounts approaching 1 per cent.

Group 1603. Fair to good growth. The sodium sulphate content is very low and practically uniform to a depth of 3′·0, the amount in A. B. and C. being less than ·1 per cent, which is usually regarded as negligible[1].

In D (3′·0—5′·0) there is a serious increase of this salt, to ·641 per cent, accompanied by ·504 per cent magnesium sulphate. It is doubtful, if at this depth, this alkali markedly affects the grass crop, the danger of its presence lies in the possibility of its rise by irrigation.

Group 1602. Meagre and distressed growth. The percentages of sodium sulphate are considerably higher than in the corresponding members of the preceding group, ranging from ·117 per cent to ·980 per cent, the increase being steady and marked from A (0′·0—0′·5) to D (3′·0—5′0).

Judging from the sparse and meagre appearance of the crop we might conclude that in this group we closely approach, for Western Rye grass, the limits for tolerance.

Group 1601. No growth: Soil bare. The percentages of sodium sulphate throughout closely approximate 1·0, the concentration being fairly uniform from the surface to the depth of 5 feet. Notable amounts of magnesium sulphate are present in all the members of this group, save C (1′·5—3′·0).

The alkali impregnation of this group far exceeds the extreme limit of tolerance for ordinary farm crops.

Native Prairie Grass.

Series II. Sec. 9, Tp. 11, R. 25, W. of 3rd Meridian.

From irrigated field 7 miles south-east of Maple Creek, Sask. The land had been under irrigation for a number of years but had never been cultivated, the native grass being cut and cured as hay. The surface soil was a fairly good sandy loam, the sub-soil of heavier nature, containing a considerable proportion of clay. In the best

[1]Less than ·2 per cent sodium sulphate, unless concentrated in the first foot, is regarded by most American authorities as not injuriously affecting ordinary farm crops.

parts of the field the grass was of good growth. Samples collected July 6th, 1917.

NATIVE PRAIRIE GRASS.

Series II. Sec. 9, Tp. 11, R. 25, W. of 3rd Meridian.

Group No.	Depth	Growth	Na_2SO_4	Mg SO_4	Ca SO_4	Total Soluble Saline Content
1606	0′·0–0′·5	Good	·070			·136
	0′·5–1′·5		·641	·104	·128	·916
	1′·5–3′·0		·731	·109	·109	·960
	3′·0–5′·0		·541	·185	·136	·864
1605	"	Poor	·432		·110	·584
			1·001	·272	·136	1·428
			·765		·066	·920
			1·662		·825	2·696
1604	0′·0–0′·5	No.	2·407	·578		3·108
	0′·5–1′·5		2·175	·501	·216	2·768
	1′·5–2′·8		2·454	·378	·527	3·360

Discussion of Results. In this, as in Series I, the alkali is chiefly sodium sulphate, but magnesium sulphate is also present in notable amounts, especially in Group 1604, characterized by "no growth."

Group 1606. Good growth. The sodium sulphate in A (0′·0–0′·5) is present in negligible amounts, but in the lower members of this group it reaches percentages ranging from ·541 (in D) to ·731 (in C), accompanied by small amounts of magnesium sulphate.

It might be inferred from these facts that provided the alkali in the first 6 inches of soil were negligible and that it did not exceed ·7 per cent from 1′·5–5′·0 that native prairie grass might be expected to make a good growth, without any marked distress.

Group 1605. Poor and meagre growth. The concentration of sodium sulphate in A (0′·0–0′·5) is ·432 per cent, but increases markedly in the lower members of that group, amounting to 1·662 per cent in D.

This distribution of alkali probably represents the limits of tolerance for native prairie grass under irrigation. An amount approaching ·5 per cent in the first 6 inches, underlaid by soil containing 1 per cent or more of alkali would seem to be the extreme conditions under which the native grass might be expected to yield a crop. It is interesting to note, comparing the two series discussed, that the native prairie grasses are more alkali-resistant than Western Rye grass.

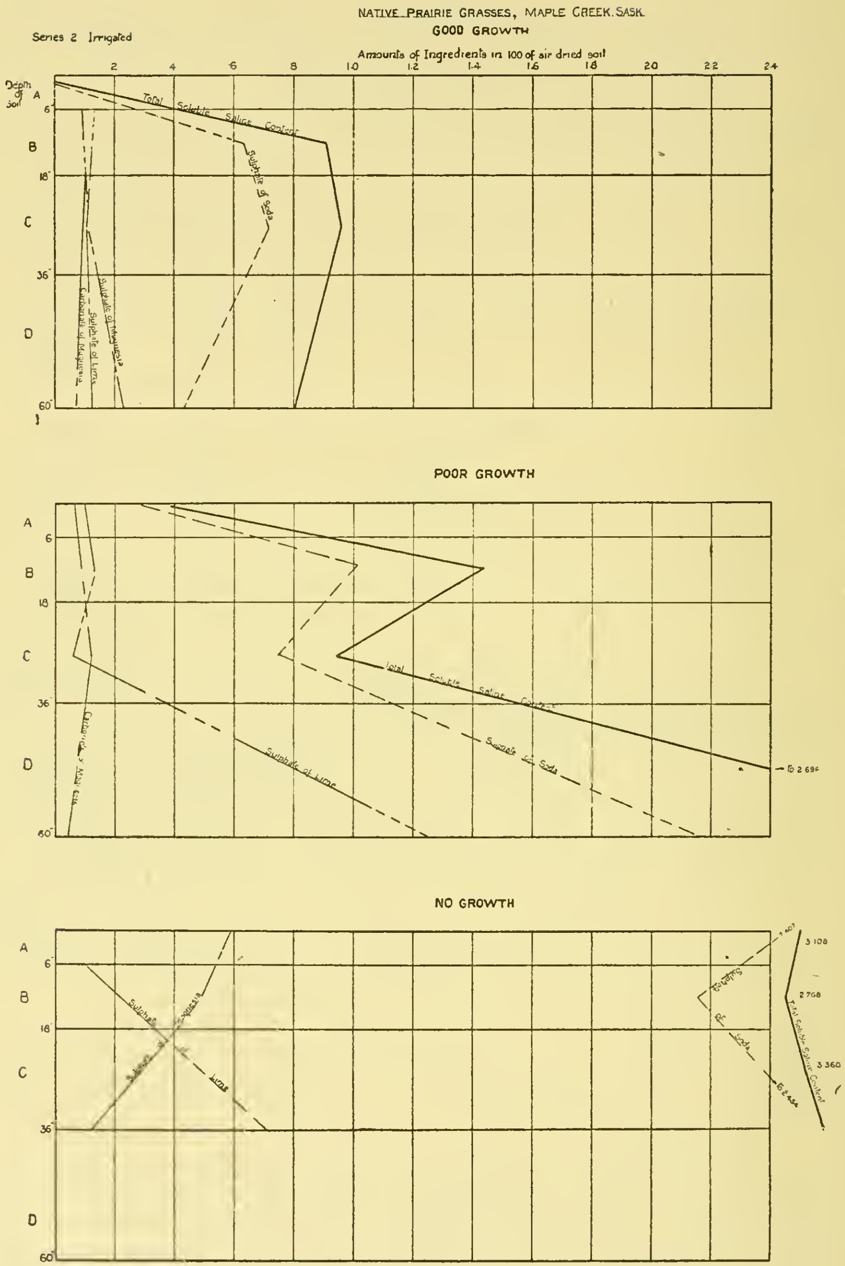


Fig. 2 Distribution of Alkali Salts in Soil, Sec. 9, Tp. 11 Rge. 25 W. 4 M. Samples taken July 6-1917

Group 1604. No growth. Soil bare. The percentages of sodium sulphate throughout this group exceed 2·0, an impregnation too high to permit of any growth.

(NOTE.—The samples in this group represent a depth only of 2′·8, collection below that depth being made impossible by the caving in of the sides of the sampling bore.)

OATS.

Series III. Sec. 17, Tp. 24, R 24, W. of 4th Meridian.

These three soil groups were collected on July 17th, 1917, from a field in oats on Farm No. 8, Namaka Colony, about 4½ miles north-east of Strathmore, Alberta. The area had been under irrigation for some years but water had not been applied in 1917. The soil was a sandy loam of good quality. The yield of oats on the best parts of the field would be probably 75 bushels per acre; the portions showing distressed growth the yield would probably be scarcely worth the harvesting.

OATS.

Series III. Sec. 17, Tp. 24, R. 24, W. of 4th Meridian.

Group No.	Depth	Growth	Na_2CO_3	Na_2SO_4	$Mg SO_4$	Total Soluble Saline Content
1620	0′·0–0′·5		·061			·128
	0′·5–1′·5	Good	·065			·112
	1′·5–3′·0		·065			·136
	3′·5–5′·0		·060			·132
1619	"	Poor	·212	·108	·087	·480
			·149		·138	·276
			·128		·096	·232
			·077		·066	·164
1618	"	No.	·340	·343	·087	·842
			·292		·087	·448
			·210		·090	·312
			·128		·077	·252

Discussion of Results. The alkali of this group is sodium carbonate, the characteristic salt of "black alkali," and, which, as already stated, is the most injurious of all saline impregnations. The limits of tolerance for most farm crops are usually placed by American authorities between ·05 and ·10 per cent.

The soil of group 1620 carried a good crop of oats and contained uniformly to a depth of 5 feet ·06 per cent of sodium carbonate, in addition to trifling amounts of other and less injurious saline matter. These results must not be interpreted as proving that this concentration of sodium carbonate is harmless, but they are of peculiar

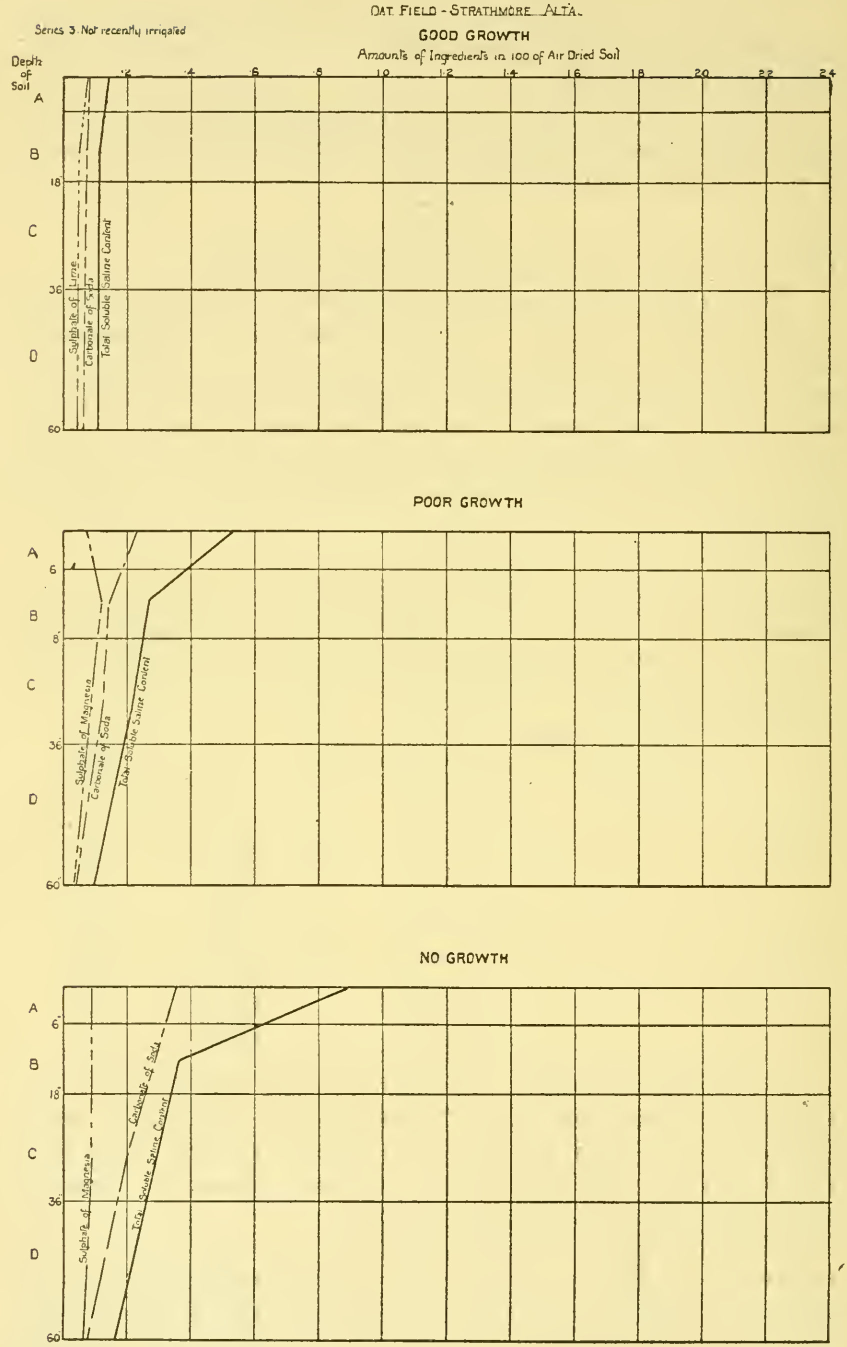


Fig 3 Distribution of Alkali Salts in Soil Sec 17, Tp. 24, Rge 24, W4 Samples taken July 17-1917

significance in showing that this impregnation does not appreciably distress the oat crop on a light sandy soil well supplied with humus.

In group 1619 the concentration of alkali is highest in the surface soil (A = ·212 per cent), decreasing steadily in the lower samples (D = ·077 per cent). The growth was very sparse and poor and it was evident that the limit of tolerance had been passed.

The samples of group 1918, taken from a location in the same field and absolutely bare of vegetation, show a very heavy impregnation of sodium carbonate, the highest concentration, ·340 per cent, being found in the surface soil A and decreasing with depth of sampling to ·128 per cent in D.

A feature worthy of note in connection with these two latter groups is that the alkali is strongest in the surface soil, decreasing steadily and more or less uniformly, to the depth of sampling, 5 feet.

Wheat.

Series IV. Sec. 33, Tp. 5, R 22, W. of 4th Meridian.

The samples of this series were collected in a wheat field three miles north of Magrath, Alberta. The area was not under irrigation. The yield for the field at the date of this visit, August 8th, 1917, was estimated at 15 bushels per acre; in 1916 the yield of wheat was stated at 55 bushels per acre. The surface soil was a brown loam of fairly good quality, the subsoil a rather heavy clay.

Wheat.

Series IV. Sec. 33, Tp. 5, R. 22, W. of 4th Meridian.

Group No.	Depth	Growth	Na_2SO_4	Mg SO_4	Ca SO_4	Total Soluble Saline Content
1634	0′·0–0′·5					
	0′·5–1′·5	Good	·178	·087	·163	·440
	1′·5–3′·0		·877	·132	·447	1·572
	3′·0–5′·0		·973	·563	2·926	4·640
1633	"	Poor	·123			·180
			·701	·247	·491	1·480
			·719	·309	·588	1·680
			·799	·062	·192	1·060
1632	"	No.	1·741	·900	·648	3·260
			1·001	·323	·364	1·700
			·701	·222	·220	1·164
			·579	·084	·192	·900

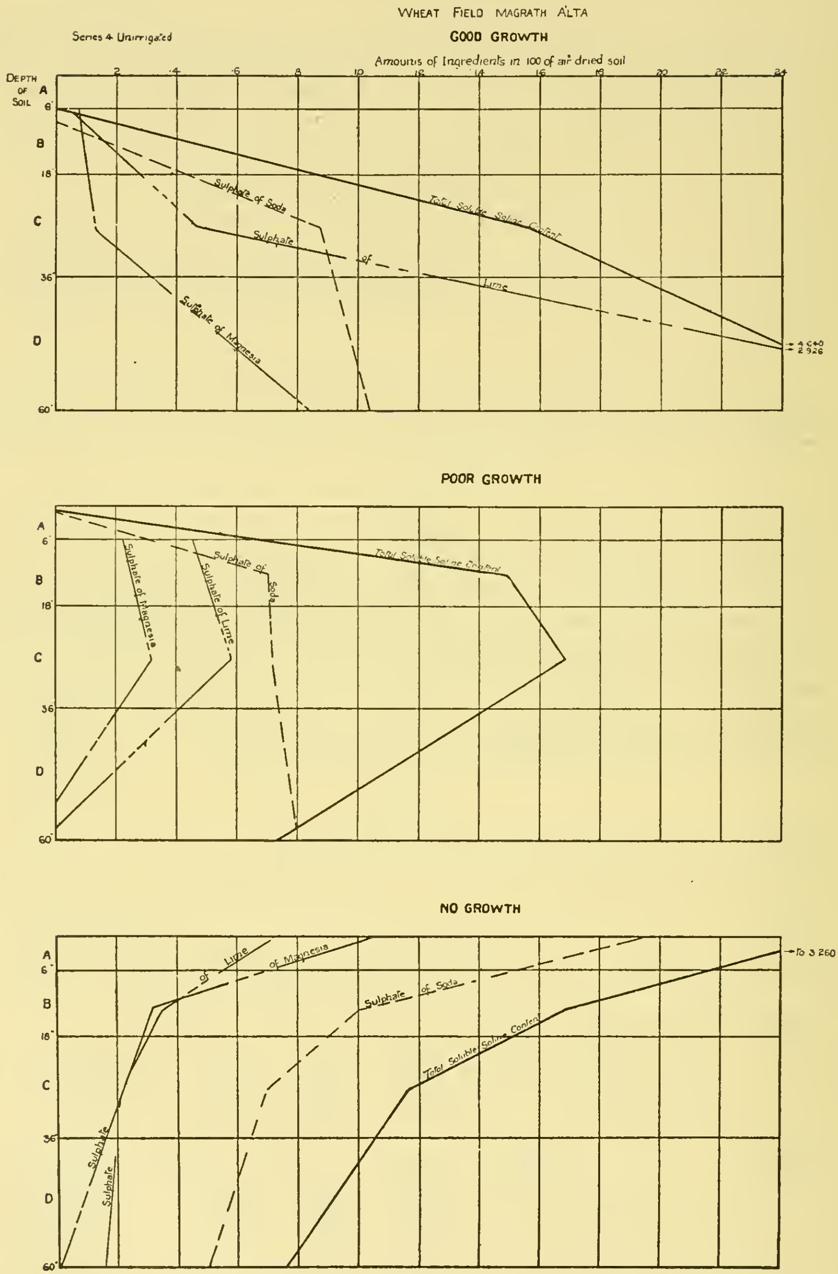


FIG. 4 Distribution of Alkali Salts in Soil Sec. 33, Tp. 5, Rge 22, W 4 M Samples taken August 1917

Discussion of Results. This is a case of white alkali, the percentages of sodium sulphate being accompanied with notable amounts of magnesium sulphate.

In group 1634—good growth—"A" representing the first 6 inches is free, or practically free, of alkali. "B" (0′·5–1′·5) contains a notable though not heavy impregnation, the percentage of sodium sulphate slightly exceeding, according to most authorities, the usual limit of tolerance for the vigorous growth of ordinary crops. In "C" and "D" the alkali content is very large.

Group 1633, representative of the area carrying a meagre and poor growth, is of particular interest in indicating probably the limit of tolerance for wheat. In the first 6 inches sodium sulphate is present in an amount that would no doubt cause some distress but would not inhibit all growth. But in B, C and D there is a very marked increase in this salt, accompanied by magnesium sulphate, the totals being such as to entirely prevent root extension. The crop is therefore limited as to its foraging ground to the immediate surface soil.

Group 1632 contains in A (O′·0–0′·5) 1·741 per cent sodium sulphate and ·900 per cent magnesium sulphate. This concentration of alkali is absolutely inhibitive for wheat and indeed renders the soil worthless for common crops. The salts gradually decrease in amount to the 5 foot depth, but in every instance the impregnation greatly exceeds the limit of tolerance.

ONIONS.—*Series V.* Lot 27–476, Summerland, B.C.

This series was taken from an onion field about 4 miles southwest of Summerland, Okanagan Valley, B.C. The area has been under irrigation for a number of years. The surface soil is a dark brown sandy loam, well supplied with vegetable matter, the subsoil a sand mixed with silty clay. Samples were collected August 25th, 1917.

ONIONS.—*Series V.* Lot 27-476, Summerland, B.C.

Group No.	Depth	Growth	Na_2CO_3	Total Soluble Saline Content
1628	0′·0–0′·5		·135	·180
	0′·5–1′·5	Good	·120	·160
	1′·5–3′·0		·072	·108
	3′·0–5′·0		·053	·108
1627	"	Poor	·224	·330
			·120	·138
			·087	·096
			·094	·098
1626	"	No.	·529	·640
			·424	·440
			·135	·172
			·085	·120

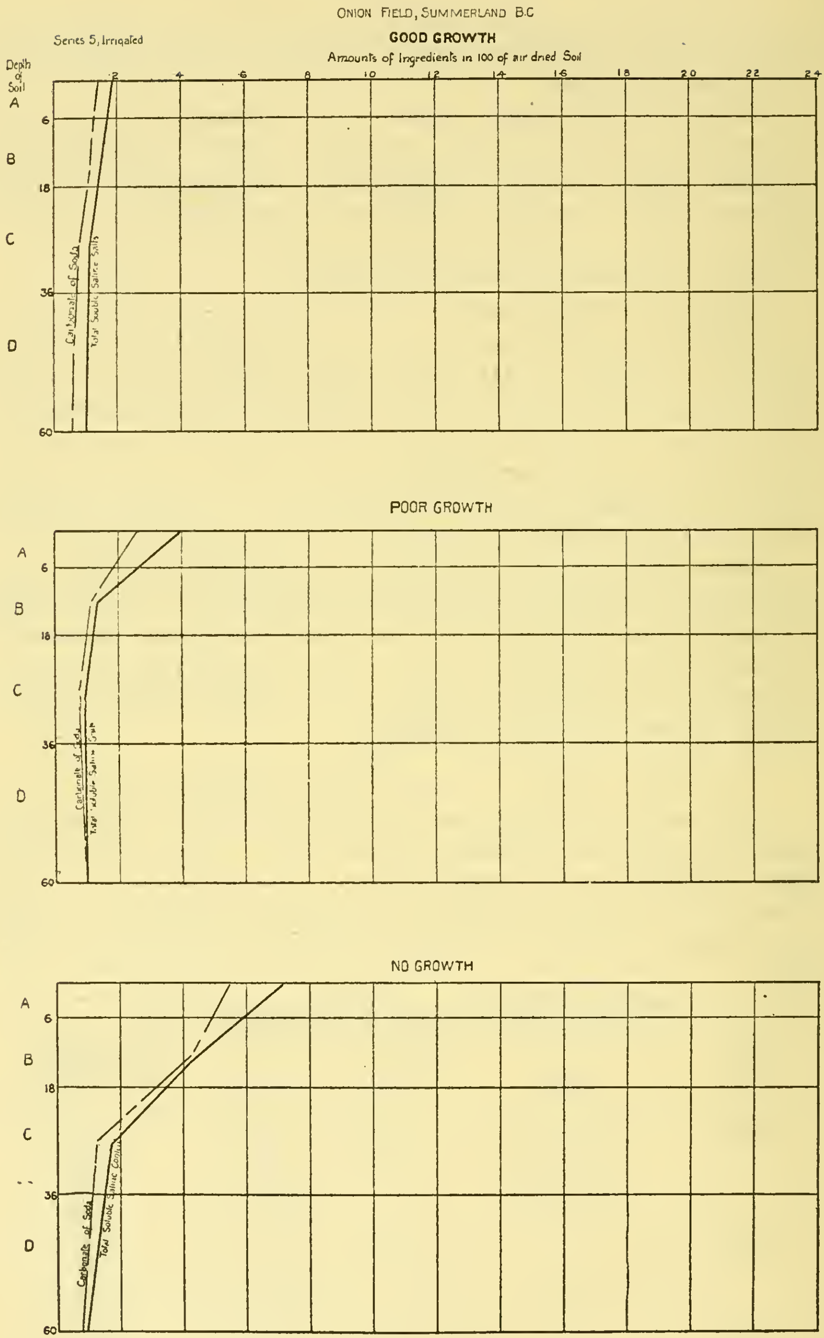


Fig. 5 Distribution of Alkali Salts in Soil, Lot 27/476 Samples taken August 25th 1917

The impregnation of this series is sodium carbonate, black alkali, other salts being present in traces only.

In group 1628, the best growth, the concentration of alkali in the first 6 inches amounts to ·135 per cent, which somewhat exceeds the usually accepted limit of tolerance for farm crops in general. It would seem, therefore, that onions might be classed with those crops which are more or less alkali resistant.

The concentration, as in the other groups of the series, diminishes with depth of sampling, evidently a characteristic of areas impregnated with black alkali.

Group 1627, representing the poor and distressed growth, probably marks the extreme limit of toxicity which this crop can bare. The amount in "A," ·224 per cent, is certainly much higher than crops in general could endure. In its lower members the alkali content corresponds very closely to that of group 1628, showing that it is the concentration in the immediate surface soil that is the crucial factor in determining growth.

The percentages of sodium carbonate in group 1626 are not much higher than in 1627, yet they are sufficient to inhibit all growth. In this series we have an illustration of the fact that in the case of black alkali slight differences in the concentration are of very considerable significance. With "white alkali" the differences which mark the limit of toxicity are of much greater magnitude.

It is proposed to continue these studies for a number of seasons, obtaining further evidence as to the limits of tolerance for various farm crops and at the same time ascertaining to what extent and in what manner the distribution of alkali is affected by irrigation with and without drainage. The work here recorded is to be regarded as merely the first step towards the establishment of standards for Canadian conditions.

A Comparative Study of Magnetic Declination at Agincourt and Meanook, During the Year 1917.

By W. E. W. Jackson, M.A.

Presented by Sir Frederick Stupart, Kt., F.R.S.C.

(Read May Meeting, 1918).

In July of 1916 there was established at Meanook, Alberta, a Magnetic Observatory for the purpose of securing a continuous photographic record of the Magnetic Declination. The first calendar year's record was completed on December 31st, 1917, and a preliminary analysis of the results obtained are here presented, together with a comparative analysis of the results obtained at Agincourt The Meanook station is located in Longitude 113° 21′ W and Latitude 54°37′N, and the Agincourt station in Longitude 79° 16′ W and Latitude 43° 47′ N.

At Meanook 105th Mean Time is used, at Agincourt 75th Mean Time, and the clocks are compared daily with chronometers whose errors are allowed to accumulate and whose rates are determined weekly by telegraph. By the addition or subtraction of small weights to the pendulum of the time clocks they are kept within a few seconds of the true standard time, and are provided with electrical contrivances to mark the hours on the photographic records.

The ordinates are measured for each hour of the day, and the mean of the 24 hourly values is taken as the mean for the day, and the mean of these means for each day of the month is the mean for the month. The base line values are determined from absolute Declination observations made weekly. The resultant mean Declination for each month of the year at each place is given in table I, Easterly Declination is called positive and Westerly Declination negative. Assuming that the non-cyclical variation progresses through the year uniformly, then by taking the difference between the values for December 1916 and December 1917 and distributing it uniformly we obtain the annual variation, which is also given in table I.

At Agincourt the annual Variation shows maximum Easterly movement in the summer and maximum Westerly movement in the winter, whilst at Meanook, the very opposite obtains, that is, there is a diverging of the lines of Force between the two places in the summer which could be produced by an annual pulsation in the earth magnet which carries the North Magnetic Pole nearer the surface along the magnetic axis in the summer. Is this due to the northern hemisphere being subjected more directly to the influence of the Sun during the summer?

The range of Declination throughout the year shows a very great variation from this annual pulsation. The difference between the maximum Easterly and Westerly movements as recorded in the various months are given in table II, columns 2 and 3. There is no periodicity apparent, nor is there any marked parallelism in the ranges at the two places, although generally larger ranges at one place correspond to larger ranges at the other.

If now we examine diurnal ranges, by which we mean the difference between the greatest East and West movement recorded in the 24 hours, we find that from day to day no periodicity is at once apparent in the amplitude. Days of greater disturbance have as a rule greater amplitudes. If, however, these ranges are meaned for each calendar month we get the result in table II, columns 4 and 5, in which a maximum occurs in summer and a minimum in winter and a certain amount of parallelism is apparent between Agincourt and Meanook, yet the summer values for Meanook are roughly double those of Agincourt, whilst the winter values are only very slightly greater. If the diurnal range is taken from the mean monthly curve obtained by meaning the values at each particular hour of the day, the irregularities due to individual days are greatly diminished and the ranges are then more regular in their progression from season to season at both places, see table II, columns 6 and 7. The winter values at both are of the same order and summer values at Meanook are only about $\frac{1}{3}$ greater than at Agincourt.

The diurnal variation for each month for each hour of the day for Agincourt and Meanook are given in tables III and IV. + signifies that the Magnet points to the East of its mean position and − to the west. In these tables the standard time at each observatory has been used. In order to show how the diurnal variation appears to be directly dependent on Sun time, the curves have been drawn on chart I for both places according to their Local Mean Times.

During the winter months, November to February inclusive, the curves agree very well with each other, but during the summer months, May to August inclusive, both the maximum Easterly value and the minimum Westerly value are reached about one hour later at Meanook. The amplitude of the Easterly swing is about one third greater at Meanook, but that of the Westerly is about the same at the two places. This may be partly due to the greater magnetic latitude of Meanook and possibly also to the longer daylight. For the four summer months—May, June, July and August—the sun is above the horizon each day an average of one hour and twenty-six minutes more at Meanook than Agincourt.

As these Diurnal curves are cyclical they may be expressed in Fourier Series of the form

$$F = a_1 \sin(\alpha_1 + t) + a_2 \sin(\alpha_2 + 2t) + a_3 \sin(\alpha_3 + 3t) + \ldots\ldots$$

where $a_1\ a_2 \ldots\ldots\ldots$, $\alpha_1\ \alpha_2 \ldots\ldots\ldots$ are constants and t is the time counted from 0 hours and expressed in degrees at the rate of one hour to fifteen degrees.

If sufficient terms are taken the error between the computed and observed curves may be reduced to less than any assigned quantity however small. The curves under consideration for the year 1917 have been grouped according to season for this analysis, winter comprising the four months November, December, January and February, equinox the four months, March, April, September and October and summer the remaining four months, May, June, July and August. The probable error on any individual hour between the computed and observed curve for the different seasons at Agincourt is less than $0{\cdot}2'$ and for Meanook is less than $0{\cdot}3'$ whilst the error for the mean of the day is less than $0{\cdot}03'$ for Agincourt and less than $0{\cdot}07'$ for Meanook.

The constants a_1, a_2, etc. are called the amplitudes and the constants α_1, α_2, etc. the phase angles. The values of these quantities are given in table V. The time of occurrence of maximum in each wave is obtained by making $(\alpha_1 + nt) = 90°$ or $450°$ since the sine has its maximum at $90° + 2n\pi$ and this time for the first maximum in each wave is also given.

In the 24-hour wave the phase at Meanook is 2h 33m later than at Agincourt in summer and 2h 8m later in winter, the winter times at both places being earlier than in summer. In the 12-hour and 8-hour waves the earlier phase is in the summer at both places, but in the 12-hour wave although Agincourt is 32 minutes ahead in summer it is 14 minutes behind in winter, whilst in the 8-hour wave Agincourt is only 9 minutes ahead in summer but 1 hour 7 minutes in winter. The 6-hour wave is more erratic in phase, particularly in summer, when its amplitude is very small, but at both places the phase is later in winter.

The amplitudes of the first two waves are the important ones at both places. If the amplitudes are expressed in percentages it is seen that the 24-hour and 8-hour waves are most effective at the equinoxes and that the 12-hour wave is most effective in summer and the 6-hour wave in winter. At Agincourt the 24-hour and 12-hour waves are of about equal value and account for about 80% of the amplitude, whilst in Meanook the 24-hour wave is about double the 12-hour wave and yet together they account for about 86% of the total ampitude. The Meanook diurnal curve approaches nearer a single sine-wave of 24-hours period than does the diurnal curve at Agincourt.

In plate II is shown graphically the seasonal Diurnal curves for each station in heavy line and the first four harmonics in light lines.

In addition to these regular daily movements there are also recorded what are known as magnetic disturbances. These do not occur at any apparent regular intervals in any year nor do they show similar movements at similar local times, but usually at the same absolute times the movements are more or less synchronous and in the larger storms obscure completely the daily movement.

In plate III examples of different types of disturbance are reproduced. In figures I and II that type of disturbance having a sudden commencement occurring at the same instant of absolute time is shown. A small westerly movement is followed by a much larger easterly movement at both stations, and the disturbance is immediately in full progress. In figure III at Agincourt there is a rather leisurely movement of the magnet whilst at Meanook we have a sudden increase at 8h 30m G.M.T. followed by a storm with very large and rapid fluctuations which on the average have carried the magnet in the opposite direction to the movement at Agincourt. In figures IV to VII is shown the type of disturbance which is usually of short duration and produces what is known as a bay in the magnetic curve. There is very often a recurrence of this bay on the following day at about the same time as shown in figure IV. Figure V shows the bay in the opposite direction at the two places. In figure VI the bay is westerly, but while a smooth curve is recorded at Agincourt, it is serrated at Meanook. In figure VII the bay is easterly. In figure VIII a magnetic storm of large amplitude is shown for Meanook with practically no corresponding movement at Agincourt.

TABLE I.

MEAN DECLINATION AT AGINCOURT AND MEANOOK FOR 1917 AND THE ANNUAL VARIATION.

		Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
		° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′	° ′
Ag	Mean D	−6 35·4	−6 35·4	−6 35·6	−6 35·8	−6 35·8	−6 34·8	−6 35·4	−6 36·5	−6 36·5	−6 37·0	−6 37·7	−6 37·9
	Corrected for non-cyclic change	−6 36·6	36·4	36·3	36·3	36·0	34·8	35·2	36·0	35·8	36·0	36·5	36·4
	Annual Variation	−0·6	−0·4	−0·3	−0·3	0·0	+1·2	+0·8	0·0	+0·2	0·0	−0·5	−0·4
Me	Mean D 27°+	49·0	48·6	45·9	45·6	43·8	44·2	45·3	45·5	47·0	46·7	45·9	46·0
	Corrected for non-cyclic change	48·5	48·2	45·6	45·4	43·7	44·2	45·4	45·7	47·3	47·1	46·4	46·7
	Annual Variation	+2·3	+2·0	−0·6	−0·8	−2·5	−2·0	−0·8	−0·5	+1·1	+0·9	+0·2	+0·5

TABLE II.

AGINCOURT AND MEANOOK DECLINATION RANGES IN THE YEAR 1917

Month 1917	Monthly	Range	Diurnal Range			
			Means of Extreme Daily values		Mean from Hourly ordinates	
	Ag	Me	Ag	Me	Ag	Me
	° ′	° ′	′	′	′	′
January	1 23·5	2 47·3	22·7	37·9	9·1	9·3
February	0 49·0	1 54·3	17·8	30·8	9·8	7·9
March	0 49·4	1 43·9	19·3	30·8	14·1	11·9
April	0 54·9	4 10·9	22·2	42·9	13·0	15·7
May	0 57·0	2 38·9	23·4	43·4	14·1	18·9
June	1 06·5	1 46·2	21·6	35·8	15·8	19·9
July	0 47·0	4 00·6	21·6	46·2	14·5	21·5
August	3 22·5	4 41·4	41·0	78·6	17·1	19·8
September	1 01·0	2 12·3	22·1	39·0	14·9	15·1
October	1 32·0	3 13·2	24·0	56·3	10·6	14·1
November	0 44·8	1 10·5	16·2	28·9	8·8	8·0
December	1 31·7	2 24·9	18·3	22·6	7·2	7·3

TABLE III.

DIURNAL VARIATION OF MAGNETIC DECLINATION AT AGINCOURT FOR EACH MONTH DURING THE YEAR 1917.

75th Mean Time	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Hour	′	′	′	′	′	′	′	′	′	′	′	′
1	+0·1	+1·9	+1·0	+1·4	+1·0	+0·5	+0·2	+0·3	+0·9	+0·8	+0·4	+0·8
2	−0·3	−0·6	+0·8	+1·6	+0·5	+0·3	+0·1	−2·5	+1·0	+1·2	+0·3	+0·0
3	+1·0	+0·4	+1·3	+2·7	+1·1	+0·5	+1·6	−1·9	+1·2	+0·8	+0·6	−0·6
4	+1·7	+0·9	+1·6	+1·8	−0·1	+0·9	+1·4	+1·6	+2·9	+1·4	+1·1	+0·0
5	+1·2	+0·4	+1·5	+2·1	+3·5	+3·0	+2·7	+3·8	+3·4	+2·1	+1·8	+0·8
6	+0·9	+1·7	+2·9	+3·7	+5·1	+5·4	+5·7	+6·0	+4·5	+1·4	+2·1	−0·0
7	+0·4	+1·8	+4·7	+4·2	+7·1	+7·9	+7·5	+8·4	+6·8	+3·3	+2·3	+1·6
8	+1·4	+3·2	+6·4	+5·4	+7·0	+8·1	+7·2	+8·4	+6·7	+4·1	+3·6	+1·6
9	+3·0	+3·9	+6·1	+4·8	+5·1	+7·0	+6·4	+5·7	+5·5	+4·6	+3·6	+3·0
10	+0·6	+3·1	+3·6	+2·0	+1·7	+3·1	+2·7	+1·0	+2·2	+2·1	+2·7	+3·2
11	−1·4	+1·2	−0·0	−2·4	−2·7	−1·8	−1·4	−3·8	−2·6	−1·1	−0·1	+0·9
12	−3·8	−1·9	−4·5	−6·0	−6·3	−5·3	−4·8	−7·1	−6·6	−4·5	−3·2	−1·1
13	−5·2	−4·6	−6·7	−7·2	−6·9	−7·3	−6·9	−8·7	−8·1	−6·0	−4·8	−3·0
14	−4·8	−5·9	−7·7	−7·6	−7·0	−7·7	−7·0	−6·9	−7·9	−5·6	−5·2	−3·9
15	−3·9	−4·9	−6·6	−6·2	−5·7	−6·8	−6·3	−5·4	−5·6	−4·5	−4·0	−4·0
16	−2·4	−3·9	−4·6	−4·6	−4·1	−5·2	−5·4	−2·5	−3·3	−3·4	−3·7	−3·6
17	−1·4	−2·7	−2·7	−2·6	−2·0	−3·0	−3·3	−0·9	−1·5	−2·4	−2·3	−1·8
18	−0·7	−1·6	−1·2	−1·5	−0·5	−1·3	−1·5	+0·3	−0·8	−0·8	−1·3	−1·3
19	+2·2	−0·2	−0·6	−0·6	+0·4	−0·3	−0·4	+2·5	−1·0	+0·3	−0·3	−0·6
20	+2·5	+0·3	+0·1	+0·2	+0·2	−0·4	+0·1	+0·1	−0·4	+0·5	+1·1	+1·3
21	+2·3	+1·4	+1·0	+0·7	+0·6	+0·3	−0·2	+0·1	+0·5	+0·9	+1·5	+1·4
22	+3·9	+2·3	+1·5	+2·4	+0·8	+0·7	+0·3	+1·1	+0·2	+1·9	+1·5	+3·2
23	+2·5	+2·2	+1·3	+3·0	+0·8	+0·6	+1·1	+0·4	+1·0	+2·1	+2·0	+1·3
24	+0·3	+1·9	+0·7	+2·8	+0·5	+0·6	+0·3	+0·4	+1·1	+0·7	+1·1	+0·7
Average Departure from mean	2·0	2·2	2·9	3·2	2·9	3·2	3·1	3·3	3·2	2·4	2·1	1·7

Table IV.

Diurnal Variation of Magnetic Declination at Meanook for each Month during the Year 1917.

105th Mean Time	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Hour	′	′	′	′	′	′	′	′	′	′	′	′
1	−0·6	+0·4	+0·2	+1·2	− 0·6	− 1·6	− 0·2	− 4·8	−2·9	−0·6	−0·5	−1·8
2	−0·7	+2·2	+1·4	0·0	− 3·7	− 1·8	− 3·1	− 3·3	+0·2	+1·8	−0·1	−0·5
3	−1·4	+1·7	+0·7	+1·5	+ 1·1	− 1·9	+ 0·3	− 3·1	+2·0	+2·6	+1·3	+0·5
4	+4·0	+2·3	+1·6	+4·7	+ 1·7	+ 1·7	+ 2·4	+ 1·8	+3·1	+9·2	+1·0	+3·7
5	+1·0	+1·5	+1·2	+6·5	+ 3·0	+ 3·2	+ 2·4	+ 4·5	+4·2	+3·5	+1·1	+2·7
6	+4·7	+2·9	+2·0	+5·6	+ 6·6	+ 7·2	+ 7·0	+12·3	+5·4	+5·1	+1·6	+2·0
7	+3·1	+1·9	+2·5	+7·4	+ 9·2	+10·6	+ 7·0	+ 8·7	+7·5	+3·2	+1·3	+0·8
8	+4·4	+2·9	+5·0	+7·2	+11·2	+12·2	+12·4	+12·0	+9·2	+4·6	+3·9	+1·6
9	+4·0	+3·4	+6·8	+7·7	+ 9·4	+10·4	+13·9	+13·2	+8·7	+5·0	+4·2	+1·5
10	+0·9	+3·3	+7·0	+6·4	+ 6·4	+ 8·4	+10·1	+12·6	+7·3	+4·3	+3·6	+2·7
11	−0·2	+2·0	+4·5	+3·0	+ 3·3	+ 4·3	+ 5·4	+ 4·7	+2·9	+0·7	+1·9	+2·4
12	−2·0	−1·8	+0·7	−0·5	− 0·9	+ 0·8	+ 0·9	− 0·6	−1·6	−2·6	−0·2	+0·3
13	−3·1	−2·4	−1·6	−3·2	− 4·7	− 2·9	− 3·1	− 5·0	−4·4	−3·8	−1·6	−0·7
14	−4·6	−2·8	−4·0	−5·2	− 6·4	− 5·6	− 6·9	− 6·5	−5·3	−4·3	−2·9	−2·0
15	−4·3	−4·3	−4·9	−6·9	− 7·7	− 7·7	− 7·6	− 5·6	−5·9	−4·6	−3·8	−3·6
16	−3·0	−4·2	−4·6	−8·0	− 7·3	− 7·4	− 7·2	− 3·7	−5·3	−4·9	−3·2	−2·8
17	−2·8	−4·5	−4·4	−7·6	− 6·7	− 6·9	− 6·7	− 5·4	−4·3	−4·3	−3·0	−2·8
18	−1·5	−3·1	−4·1	−7·0	− 5·4	− 6·8	− 5·4	− 3·7	−4·5	−3·6	−2·1	−1·9
19	−0·8	−1·3	−3·2	−5·3	− 3·8	− 4·5	− 4·4	− 3·0	−4·3	−2·6	−2·1	−1·6
20	+1·6	−1·2	−1·3	−3·7	− 2·0	− 2·9	− 5·4	− 6·6	−4·1	−2·8	−0·4	−0·9
21	+0·1	−1·0	−2·2	−0·7	− 1·3	− 2·6	− 5·7	− 2·2	−2·0	−1·2	−0·5	+0·5
22	+0·3	−1·0	−1·8	−2·1	− 0·4	− 2·0	− 1·6	− 5·6	−2·6	−1·1	+0·7	+0·5
23	+1·2	+0·9	−1·5	−0·5	− 1·2	− 2·5	− 2·3	− 5·6	−2·4	−2·6	−0·4	+0·4
24	−0·5	+2·2	−0·5	−0·7	+ 0·1	− 1·8	− 2·1	− 5·2	−1·0	−1·0	+0·2	−1·2
Average Departure from mean	2·1	2·3	3·0	4·3	4·3	4·9	5·1	5·8	4·2	3·3	1·7	1·6

Table V.

Value of constants in the Fourier Series $F = a_1 \sin(\alpha_1 + t) + a_2 \sin(\alpha_2 + 2t) + \ldots$ for Agincourt and Meanook Seasonal Diurnal Curves. Percentage Values of the Amplitudes and Local Mean Time of Occurrence of 1st Maximum.

Season	a_1		a_2		a_3		a_4	
	Ag	Me	Ag	Me	Ag	Me	Ag	Me
	′	′	′	′	′	′	′	′
Summer	4·0	7·1	4·0	4·3	1·5	1·0	0·2	0·3
Equinox	3·8	5·3	3·0	2·1	1·4	0·7	0·5	0·7
Winter	2·2	2·6	2·3	1·5	0·5	0·3	0·6	0·4

Percentage Value of Amplitudes a.

	%	%						
Summer	41·3	55·9	41·3	33·9	15·4	7·9	2·0	2·3
Equinox	43·7	60·2	34·5	24·0	16·1	8·0	5·7	8·0
Winter	39·3	4·2	41·1	31·2	8·9	6·3	10·7	8·3

	α_1		α_2		α_3		α_4	
	°	°	°	°	°	°	°	°
Summer	29·2	351·2	228·0	211·8	87·2	79·6	360·4	241·0
Equinox	38·9	4·6	217·9	207·9	65·6	17·2	251·4	266·9
Winter	48·9	17·2	197·0	203·7	40·8	331·6	227·1	236·4

Local Mean Time of Occurrence of First Maximum.

	h m	h m	h m	h m	h m	h m	h m	h m
Summer	4 03	6 36	7 24	7 56	0 04	0 13	1 30	3 29
Equinox	3 24	5 40	7 41	8 04	0 32	1 37	3 19	3 03
Winter	2 44	4 52	8 26	8 12	1 05	2 12	3 43	3 34

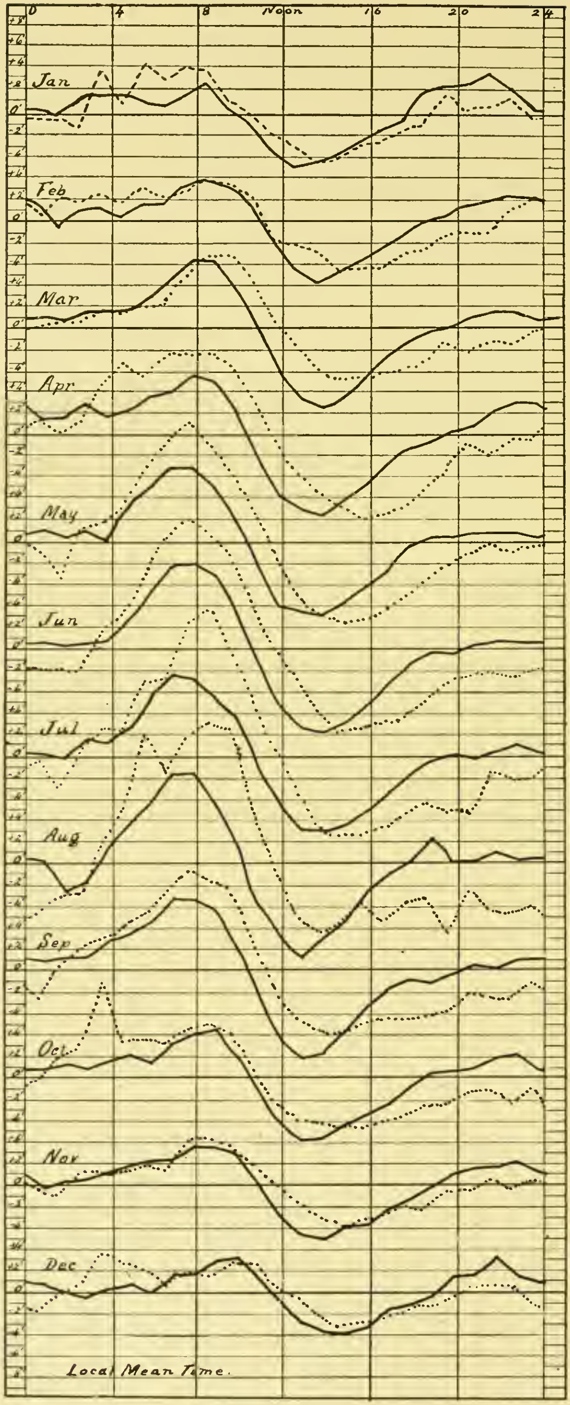
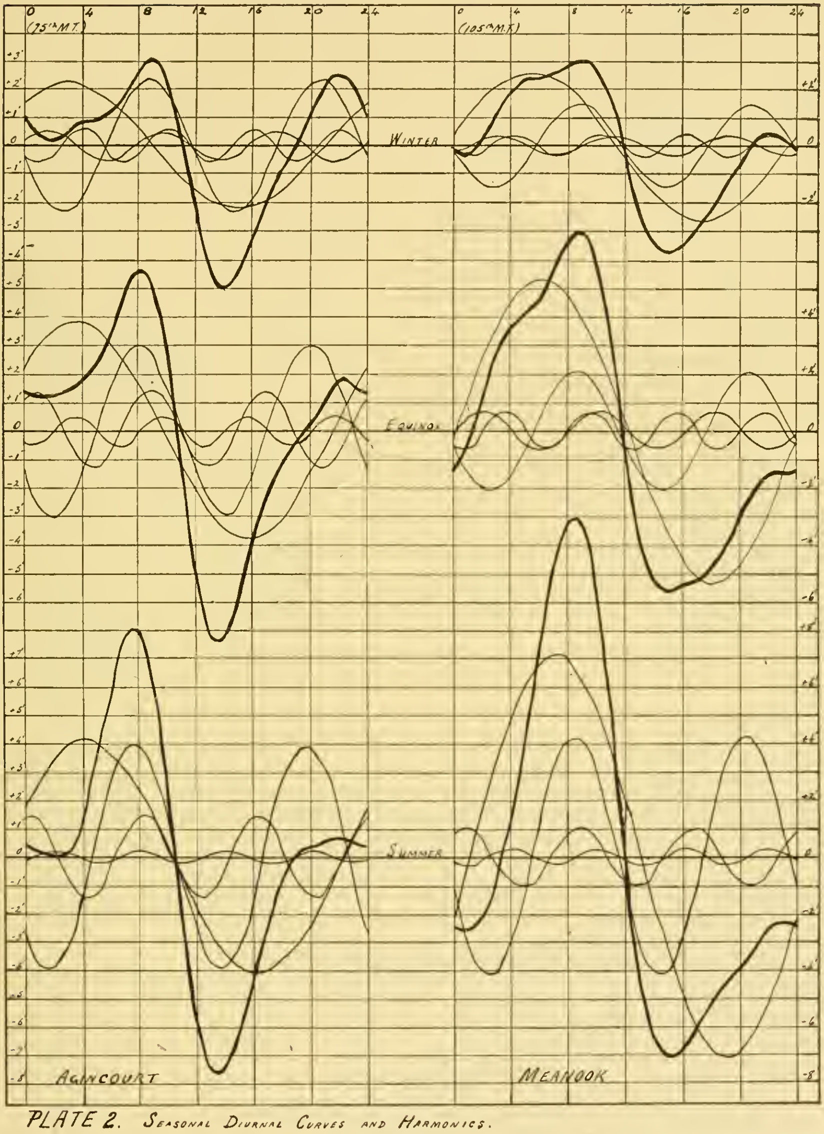


PLATE 1.

Dotted curve - Meanook Diurnal Variation
Full curve - Agincourt Diurnal Variation



(75° M.T.)
(105° M.T.)
Winter
Equinox
Summer
Agincourt
Meanook
PLATE 2. Seasonal Diurnal Curves and Harmonics.

PLATE 2.

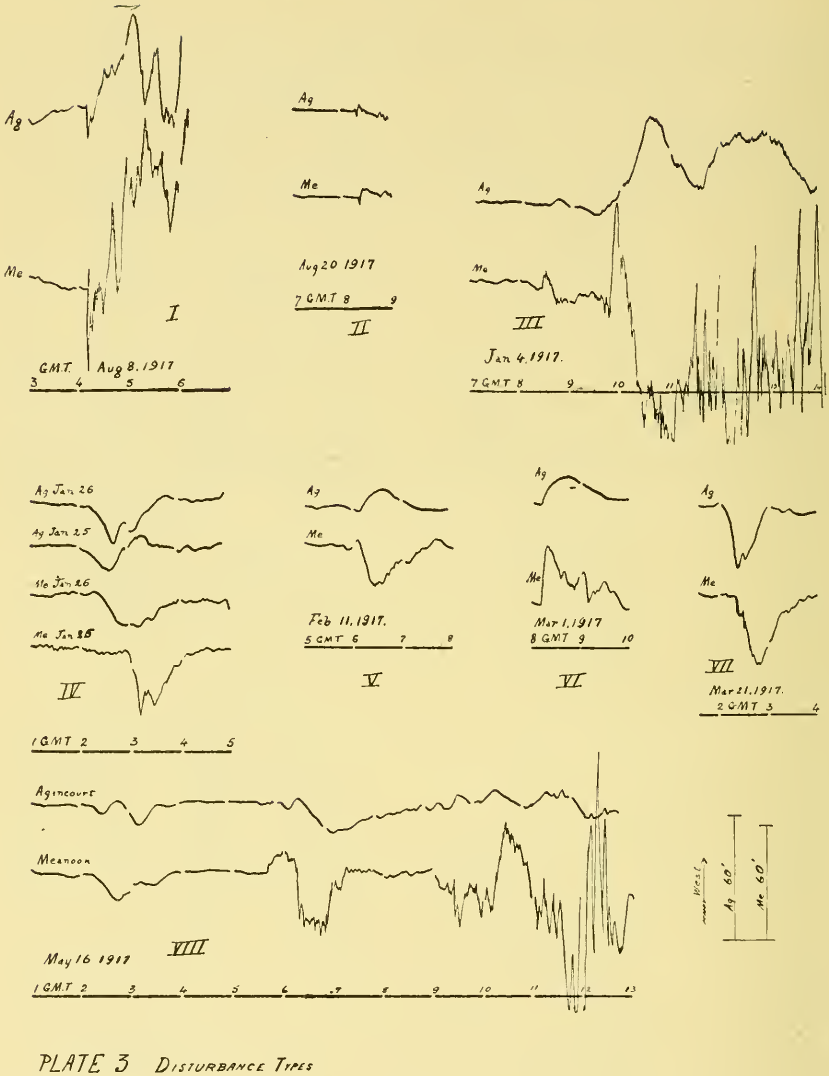

Ag
Me
I
GMT. Aug 8. 1917
3 4 5 6
Ag
Me
Aug 20 1917
7 GMT 8 9
II
Ag
Me
III
Jan 4. 1917.
7 GMT 8 9 10 11
Ag Jan 26
Ag Jan 25
Me Jan 26
Me Jan 25
IV
1 GMT 2 3 4 5
Ag
Me
Feb 11, 1917.
5 GMT 6 7 8
V
Ag
Me
Mar 1, 1917
8 GMT 9 10
VI
Ag
Me
VII
Mar 21, 1917.
2 GMT 3 4
Agincourt
Meanoon
May 16 1917
VIII
1 GMT 2 3 4 5 6 7 8 9 10 11 12 13
West
Ag 60'
Me 60'
PLATE 3 Disturbance Types

PLATE 3.

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SECTION III

SERIES III DECEMBER, 1918, and MARCH, 1919 VOL. XII

Summary of Fog-Signal Researches carried out at Father Point, Que., 1913 and 1917.

BY LOUIS VESSOT KING, M.A., D.Sc., ASSOCIATE PROFESSOR OF PHYSICS, McGILL UNIVERSITY, MONTREAL.

(Read May Meeting, 1918)

SECTION 1. SUMMARY OF 1913 FATHER POINT TESTS

It has long been known that steam and compressed-air sirens employed as fog-signals on land stations and on ships are extremely inefficient when the ratio of power input to acoustic energy emitted during a blast is considered. In the case of steam-whistles and sirens on board ships the inefficiency is further aggravated by the large waste of live steam involved.

In the autumn of 1913 the writer undertook a series of tests on the fog-signal situated at Father Point, Que. The particular type of siren tested is known as the "Northey diaphone" and was operated by compressed air. A special thermodynamic method was devised by the writer to obtain a rough measure of the proportion of energy (available as potential energy of compressed air) converted into aerial sound-waves. Measurements of the rate of falling off of the intensity of the sound were carried out to distances of 8 miles, making use for the purpose of a sound-measuring instrument known as the Webster phonometer, enabling the compression in the sound-waves to be measured in absolute units. The main results obtained from this series of tests may be enumerated as follows:

(i). The acoustic efficiency of the diaphone measured at the constricted portion of the conical trumpet is in the neighborhood of 5 per cent at normal operating pressure of about 25 pounds per square inch.

(ii). The compression in an aerial sound-wave corresponding to the transmission of the observed amount of energy as sound over the cross-section of the narrowest part of the conical trumpet of the diaphone is as high as $\pm$ 0·1 atmosphere. A theoretical investigation of aerial plane waves involving this large degree of compression indicates clearly that these sound-waves of large amplitude fall in the régime of abnormal propagation which has been studied by several writers. Considering the case of plane waves of large amplitude, it has been shown that the wave changes its form as it advances through the medium and ultimately tends to form a "bore" in which the region of high compression and rarefaction travel very close together: owing to adiabatic heating and cooling in the compressed and rarefied portions of the wave, temperature equalization by thermal conduction tends to take place across these two regions. As a result of this energy dissipation the amplitude of compression is reduced until conditions of normal propagation are reached and further energy losses are small.

(iii). Although in practice divergence in three dimensions would have a tendency to minimize the effect referred to, and to establish more promptly conditions of normal propagation, measurements of the falling off of sound intensity indicate that severe energy losses occur in the immediate neighbourhood of the siren throughout a distance varying between 1,000 and 2,000 feet. Beyond this distance the sound waves are capable of travelling very long distances on a calm day with very little energy loss.

(iv). Measurements of sound intensity carried out over distances of several miles on various occasions (15 days) gave no general law of falling off of amplitude with distance owing to the heterogeneity of the atmosphere as a medium for the transmission of sound. The theoretical "inverse square" law for the falling off of the intensity is utterly unreliable as a basis for calculation even on an apparently calm day. By far the most important factor responsible for very great variations in the intensity of sound is the effect of wind. Wind blowing against the direction of sound propagation results in refraction of the wave-front upwards and the formation of sound-shadows at the surface of the sea.

(v). The results of the acoustic surveys support the view (due to Major G. I. Taylor) that the high degree of attenuation of sound in a wind may be explained by the eddy-structure of the atmosphere which recent meteorological research has brought to light. There is reason to believe that extinction due to this cause is especially severe within a half-mile radius of the siren. It is probable, also, that eddy-motion in the immediate neighbourhood of the fog-signal apparatus due to the presence of buildings in the vicinity may have a detrimental effect in causing the intense sound-waves to dissipate their energy content by the formation of vortices.

Section 2. Summary of 1917 Father Point Tests.

A series of tests was carried out at Father Point in September and October, 1917, under a grant from the Advisory Council for Scientific and Industrial Research. The following results were obtained:

(*i*). Preliminary experiments were carried out on the development of a rotary valve by means of which the pressure-amplitude in the very intense sound-waves in and near the trumpet could be measured by means of an ordinary manometer.

(*ii*). A thorough investigation was made of the thermal method of measuring the acoustic output of a small two-inch diaphone capable of sounding a continuous blast. Temperature differences were measured by means of thermojunctions inserted one on the high pressure side of the piston, the other on the low pressure side. Almost continuous temperature readings were recorded as the air-pressure was allowed to fall gradually from 29 to 6 pounds per square inch. Although the acoustic output varied from the neighbourhood of 100 watts at the lower pressure to about 350 at the higher pressure, the *acoustic efficiency* decreased from about 24 per cent at low pressures to 8 per cent at the high pressures. Several series of observations with and without the trumpet confirmed these results which, taken with the 1913 tests on the large diaphone, indicate that higher efficiency in fog-signal apparatus may be looked for by the utilization of low pressures and the separation of sources into a number of small synchronized units.

(*iii*). An important problem solved during the 1917 tests was the determination of the *quality* of the sound given out by the diaphone, easily recognized by ear to be extremely complex at close quarters, although fairly pure at great distances. The accurate analysis of complex tones has only recently been achieved through the work of Professor Dayton C. Miller of the Case School of Applied Science. By means of an instrument of his invention called the "phonodeik," it is possible to actually "photograph" the sound-waves in the form of a sinuous line on a photographic film. The analysis of such a record gives exact data as to the relative proportions of acoustic energy contained in the fundamental and overtones. On receiving an invitation from the writer to undertake a study of the quality of sound generated by the diaphone, Professor Miller brought to Father Point his phonodeik by means of which a successful series of films was finally obtained at various distances to nearly three miles. These records brought out a number of interesting and important facts. It was found that the sound from a small two-inch diaphone unprovided with a trumpet was extremely complex. It was inferred that the effect of a trumpet of correct design is to concentrate the greater proportion of power in the master tone. From an inspection of the photographs it is clearly shown that the high overtones do not travel far but are filtered out by the action of the eddies. The master tone alone survives to an appreciable extent at distances greater than two miles. It is obvious that the overtones produced by a diaphone or siren represent waste of power and that the object of a designer of such apparatus is to concentrate the greatest possible amount of energy into the master tone.

(*iv*). Mention has already been made of the fact that of all atmospheric conditions, the velocity and eddy structure of the wind are by far the most important conditions affecting the propagation of sound. In the present series of tests provision for more comprehensive meteorological observations were made. While acoustic surveys were carried out at sea by means of the Webster phonometer (which measures the master tone of frequency about 180) with the assistance of Lieutenant E. S. Bieler, observations of wind velocity at altitudes of several thousand feet were carried out by sending up small pilot balloons and following their motion by specially designed theodolites. This part of the work was in charge of Mr. John Patterson and Dr. A. N. Shaw; as a result of their investigations, the technique of meteorological observing to be carried out in connection with fog-signal tests has been fully worked out. Anemometers of various types were tested and compared, while a simple form of pitot-tube for observing the gustiness of the atmosphere was designed and found to be extremely serviceable. It is hoped on future occasions to obtain a large number of acoustic surveys under a great variety of atmospheric conditions. A graphical representation of sound intensity combined with one of upper air wind structure may be expected to give information of value to fog-signal engineers.

Section 3. Note on Future Problems in Acoustic Engineering

The researches just described may be considered to have established the possibility of employing methods of physical measurement in the field of acoustic engineering. The Webster phonometer has been shown to be well adapted to the selective measurement of the master tone and to carrying out acoustic surveys by means of which the effect of atmospheric conditions on the propagations of sound may be graphically recorded. For a study of the quality of sound emitted the "phonodeik" devised by Professor Miller has been proved capable of use under open-air conditions. For the measurement of acoustic output and efficiency the thermal method devised by the writer seems to be the only satisfactory one in practice. From a thermal test combined with an analysis of a phondeik record complete information as to the performance of a fog-alarm may now be obtained. For instance, it is possible to state in horse-power or watts the total acoustic output of a siren as well as to compute the relative proportions of power contained in the master tone and in the overtones. That this may be done as a shop test is of great importance, as a designer will now be able to predetermine the behaviour of fog-signal apparatus without depending on tests carried out with the equipment installed at great cost at some station by the sea. It is to be expected that, with such methods of testing available, the development and improvement of fog-sirens will be much more rapid than in the past.

It is evident from these results that improvement in the design of aerial sound generators offers large field for scientific effort, not only with regard to economy of power, but also in the provision of less costly and more numerous fog-signal installations as additional aids to navigation in the neighbourhood of fog-infested shores.

Although submarine sound-signalling and automatic methods of radio-telegraphic signalling are rapidly being introduced as aids to navigation near rocky coasts, the need for powerful and efficient aerial fog-signals will be felt for many years to come in the interests of small ships unprovided with means of availing themselves of the first two methods. In the writer's opinion, scientific concentration on these problems with adequate facilities for experimental work at sea would in a few decades more than repay the expenditure incurred through a reduction of the yearly toll in lives and property resulting from accidents at sea.

On The Penetration of Frost in Concrete Structures

BY LOUIS V. KING, M.A.; D.SC., ASSOCIATE PROFESSOR OF PHYSICS,
McGILL UNIVERSITY

(Read May Meeting, 1918)

A problem of considerable interest and importance in marine construction was suggested to the writer in 1911 by Sir John Kennedy, Consulting Engineer to the Montreal Harbour Commission. It is found that concrete piers built in tidal waters and exposed to temperatures considerably below freezing suffer gradual disintegration between low and high tide level, due to alternate freezing and thawing as the surface is alternately exposed and covered by the rise and fall of the sea. Meteorological observations taken in the neighbourhood of Halifax show that early in the winter extreme cold may suddenly set in while the temperature of the sea is considerably above freezing. Alternate freezing and thawing takes place in the concrete face of the pier throughout a shallow layer between high and low tide, the rest of the structure remaining in an approximately constant state during the whole winter. The expansion of the wet structure on freezing and the change of volume on thawing gradually disintegrates the concrete which flakes off and exposes a fresh surface for the repetition of the process. The annual freezing and thawing out of the structure and other slow changes which take place owing to changes of weather are of very minor importance. In the interior of the solid at a considerable distance from the surface these fluctuations are very much reduced in amplitude and no actual disintegration takes place which exposes a new region of action as in the case of tidal effect.

A method of protection proposed by Sir John Kennedy is to face the concrete structure over the range of maximum tidal range with thick water-soaked wooden planks. Alternate freezing and thawing would then be confined to the wood while the concrete behind would remain in a more or less constant state throughout the winter. The question is then to determine what thickness is necessary to confine the maximum depth of penetration of the freezing and thawing region within the wooden facing.

SECTION 2.

Consider a thick water-soaked slab initially just at the freezing point 0°C exposed to air temperature $-\theta°$ at the instant $t=0$. The rate of growth of a frozen layer which at any time t has attained a depth x may be calculated as follows. We denote by K the heat conductivity of the frozen medium in C.G.S. units: E_f denotes the emissivity of the frozen medium with respect to air in calories per sq.cm. per second. We also denote by ρ_f the density of the frozen medium and by L the latent heat absorbed or released in the "freezing up" or "thawing out" of *unit mass* of the porous medium (including the water contained in the pores). If we write $h_f = K_f/E_f$ the loss of heat from an element of volume of thickness dx and unit area at a distance x from the surface is:

$$\frac{K_f\theta}{(x + h_f)}\,dt$$

This heat is derived from the "freezing up" of the element of volume which contributes an amount $\rho_f.L.dx$

We thus obtain the equation for x

$$(x + h_f)\,\frac{dx}{dt} = \frac{K_f\theta}{L\rho_f}$$

of which the solution which makes $x = 0$ when $t = 0$ is

$$x(h_f + \tfrac{1}{2}x) = \frac{K_f}{L\rho_f}\int_0^t \theta dt = \frac{K_f}{L\rho_f}\,\bar{\theta}t \ldots\ldots\ldots\ldots\ldots (1)$$

where $\bar{\theta}$ is the average temperature during the interval 0 to t.

Similarly, if the "thawing out" takes place when the medium or part of it is exposed to water at a temperature $+\theta'$ the depth x' thawed out in time t' is given by

$$x'\,(h'_w + \tfrac{1}{2}x) = \frac{K_w}{L\rho_w}\,\theta' t' \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where K_w and ρ_w refer to the water-soaked medium and h'_w refers to the surface conductivity of the interface with respect to water.

These equations with appropriate constants apply as they stand to the penetration of frost into wet concrete exposed to changes of air temperature. Equation (1) holds for the rate of growth of ice over water and has been found to give a good representation of existing observations with the following constants (distinguished by the suffix i) expressed in C.G.S. units: $L = 80$ calories, $\rho_i = 0{\cdot}9$, $K_i = {\cdot}0057$, $E_i = {\cdot}00024$ calories per sq. cm. per second $h_i = K_i/E_i = 24$ cm. The value given for h_i was obtained from observations by the writer on the rate of growth of ice under open air conditions with practically no wind.

In the application of equations (1) and (2) to a porous medium it must be kept in mind that surface conductivities vary very greatly with the *velocity* of the air or water in contact with the surface, while the remaining constants will depend on the amount of water contained in the medium.

Section 3. Determination of the Thermal Constants of Porous Media

For many practical purposes the required constants may be obtained with sufficient accuracy by an extremely simple test. Two identical slabs of the water-soaked medium are prepared about 30 cm. square and from 1 to 3 cm. thick. Each of the slabs is wetted over one face, the wet surface placed in contact and the two exposed to a temperature below freezing. In this way an "ice-sandwich" is made up. When the water contained in the medium has become entirely solidified, the "ice-sandwich" is brought to a uniform temperature slightly below freezing. It is then brought indoors and hung up vertically so that both faces are equally exposed to air at a temperature θ, several degrees above freezing (ordinary room temperature is suitable). Thawing begins at the outer surface, penetrates towards the interior and finally reaches the ice-layer cementing the two slabs which fall apart in a time t given by

$$x\ (h_w + \tfrac{1}{2}x) = (K_w/L\rho_w)\cdot\overline{\theta}t \quad \ldots\ldots\ldots\ldots\ldots (3)$$

where x is the thickness of the slabs.

If the ice-sandwich is immersed in a tank of water at room temperature $\overline{\theta}'$, kept constantly stirred so that h_w' is negligible compared to x, the time t' taken for the slabs to come apart is given by

$$\tfrac{1}{2}\ x^2 = (K_w/L\rho_w)\ \overline{\theta}t'' \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

the surface conductivity being so good that h_w' may be neglected compared to x. From (3) and (4) we are enabled to calculate separately $(L_w\rho_w/K_w)$ and h_w in terms of easily observed quantities.

The corresponding constants for a frozen slab may most easily be obtained by placing the thawed out slab (reduced to a temperature slightly above freezing) on the surface of a large sheet of freezing water out of doors, so that one face is exposed to the atmosphere. The slab freezes through and ice finally begins to accumulate on the outer surface: by rapidly weighing the slab at two known intervals from the commencement of the test we may calculate the thickness of ice formed and from the equations of the form (1) and (2) governing the process we may determine $(L\rho_f/K_f)$ and h_f.

Section 4. Results of Tests

Four samples of wood (soft pine) were tested by the above method with the following results. Specimens I. and II. were creosoted pine:

specimen III. was cut from a creosoted pile which had been immersed in the sea at Halifax for several years: Specimen IV. was a piece of untreated pine which had been under water during an entire summer. Tests were in all cases carried out on slabs ½″ × 12″ × 9″. Repeated observations by the ice-sandwich method gave fairly consistent results for each specimen. The results aré tabulated below:

Specimen	ρ_w	$L\rho_w/K_w$	$L\rho_f/K_f$	h_f	x
I.	·712	$3 \cdot 17 \times 10^4$	$\cdot 90 \times 10^4$	1·81 cm.	3·5 cm.
II.	·814	$1 \cdot 97 \times 10^4$	$\cdot 79 \times 10^4$	3·54	4·23
III.	1·120	$3 \cdot 52 \times 10^4$	$1 \cdot 10 \times 10^4$	13·3	2·34
IV.	·540	$3 \cdot 32 \times 10^4$	$1 \cdot 24 \times 10^4$	4·47	3·12

Section 5. Application to the Protection of Concrete Piles in Tidal Waters

From an inspection of the meteorological records for the neighbourhood of Halifax it is found that in the month of December the air-temperature may fall to −40°F., while the sea-water remains at 6° or 7°C. above freezing. Throughout January, February and March the sea temperatures remain steadily at -1°C., the freezing point of sea-water. Under these conditions no freezing and no thawing would take place on the surface of a concrete structure exposed to tidal rise and fall. We conclude that most of the disintegration due to this cause takes place in the early winter, chiefly towards the latter part of December. For purposes of calculation we will consider air-temperatures of -20°C. with sea-temperatures of +5°C.

Although the above numerical data can only be considered in the light of rough approximations, they serve a useful purpose in estimating the thickness of planking necessary to protect concrete from freezing and thawing as already described. If be x the maximum thickness of the region in which alternate freezing and thawing takes place, T the time between successive high waters (12·5 hours), $-\theta$°C. the temperature of the air *below* freezing, (−20°C.), θ°C. the temperature of the sea above freezing (+5°C.), it is not difficult to show that x is to be calculated from the formula

$$x \ (h_f + \tfrac{1}{2}x) \ \frac{L\rho_f}{L_f\theta} + x \ (h'_w + \tfrac{1}{2}x) \ \frac{L\rho_w}{K_w\theta'} \ = \ T \dots\dots\dots (5)$$

where the remaining symbols have meanings already assigned and are all known from tests of the kind already described except h'_w, the surface conductivity between wet wood and water which is negligible compared to $\tfrac{1}{2}x$. Values of x corresponding to each of the specimens are given in the last column of the above table. From this it will be seen that the best material for the purpose is the dense, water-saturated, creosoted pine represented by Specimen III. Allowing a liberal factor of safety 3, we conclude that a facing of 3-inch creosoted pine will serve as ample protection against repeated freezing and thawing in a concrete structure exposed to tidal action in the circumstances mentioned.

Since the data of the test just described, the writer is informed by Sir John Kennedy that this method of protection has been found to be entirely successful in its application to concrete wharf construction. The problem and its solution acquires an additional interest to-day in view of the large number of concrete ships which are being built. If intended for navigation in latitudes where the winter is severe, the question of protection against possible disintegration through the action of freezing and thawing as the ship is loaded and unloaded and subjected to the action of waves is one which should be carefully considered by designers and builders. The same remark applies to the possible deleterious effect of sea-water on concrete.[1] If trouble should arise from either of these causes, it may be found that a sheathing of water-soaked or creosote-impregnated wood may give the protection desired.

[1]In this connection see a paper by Professor H. T. Creighton, of Swarthmore College, "The Deterioriating Action of Salt and Brine on Reinforced Concrete," Journal of the Franklin Institute, Vol. 184, pp. 689-704, 1917.

The Carbonization of Lignites. Part II. Large Scale Laboratory Tests

BY EDGAR STANSFIELD, M.SC., AND ROSS E. GILMORE, M.SC.,

PRESENTED BY DR. ALFRED STANSFIELD, F.R.S.C.

(Read May Meeting, 1918)

This paper describes part of a systematic investigation of Canadian lignites with special reference to their behaviour with regard to carbonization and briquetting. In an earlier paper, Trans. R. S. C. Series III 1917 Vol. XI. p. 85, the general scope of the work was outlined and the results of a preliminary series of small scale tests were described. The present paper describes and gives the results of further laboratory tests carried out on a larger scale; but this series of tests is not yet completed.

In the preliminary tests the yield and calorific value were determined only of the residue left from the carbonization of lignite under specified conditions. In the present series the results determined include the yield and calorific value of the carbonized residue; the yield, composition and calorific value of the gas generated; the yield, calorific value and economic value of the tar oils produced; and the ammonium sulphate yield available. The conditions under which the lignite is carbonized have, in the present series of experiments, so far only been varied to show the influence on the results of the final temperature to which the charge is heated and the rate of heating. It is proposed to follow this up with tests to show the effect of the pressure in the retort and the atmosphere in the retort.

APPARATUS

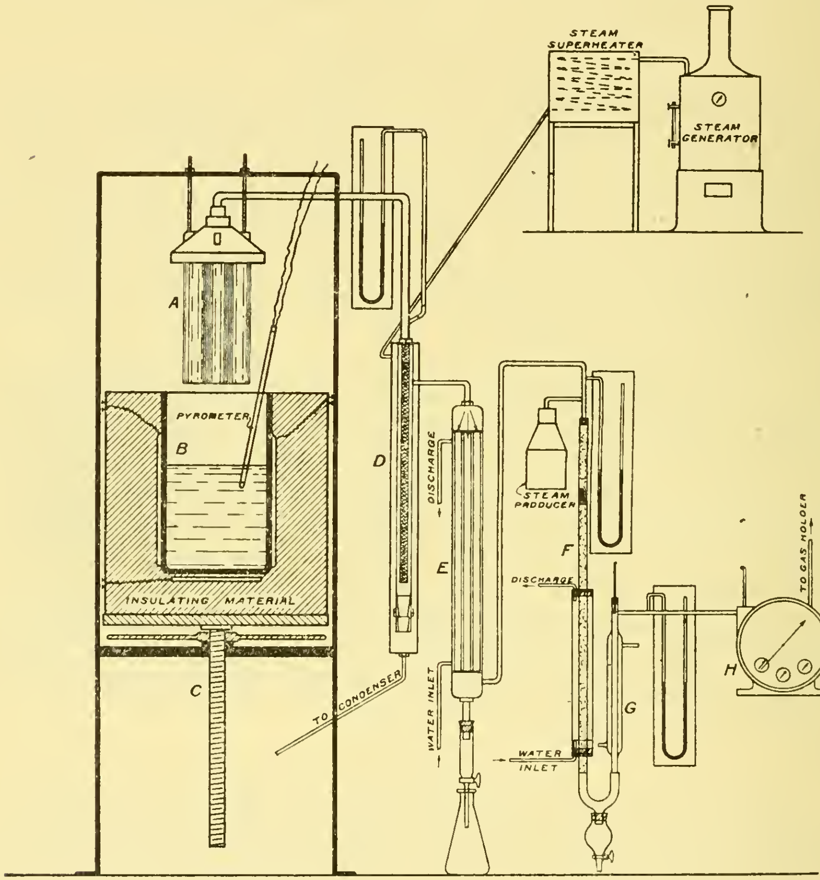
The apparatus designed for these tests embodies three important features:—an accurate temperature control; the reduction, as far as possible, of the temperature lag from the walls to the centre of the charge; and the complete removal and easy collection of the tar vapours. The general layout of the apparatus is shown diagramatically in Fig. 1.

The temperature control is effected by the use of an electrically heated lead-bath, B., with suitable thermal insulation. The bath

NOTE.—This investigation was carried out in the laboratories of the Fuel Testing Division of the Mines Branch of the Department of Mines at Ottawa, and is published with the permission of the Director, Dr. E. Haanel. All gas analyses were carried out by Mr. T. W. Hardy, B.Sc., B.E.

rests on a movable platform which can be raised by a screw C. The temperature is observed by means of a pyrometer and regulated by switches and a rheostat.

The reduction of lag is affected by the use of a tubular retort A. This consists of seven 12″ lengths of 2″ boiler tubing, mounted into a common cast iron head. No part of the charge is thus more than



APPARATUS FOR LIGNITE CARBONIZATION

Figure 1

1″ from the walls of the retort, which has a capacity, to the top of the tubes, of 2,300 grams of pea size lignite with about 35 per cent moisture content.

A satisfactory method for collecting the tar was only evolved after many weeks of work and many failures. Not only was it hard to remove the last traces of tar fog, but the condensate was usually in the form of a watery emulsion, very difficult to handle.

The method employed is as follows: the hot gases leaving the retort pass down through the centre tube of a small scrubber D, made of iron pipe and containing three interlacing coils of wire, passing up again through a surrounding annular space; the whole being jacketted with superheated steam. The heavy tar oils are here condensed in a practically water free condition, and drop into a weighed glass beaker. The lighter oils, steam, and gases pass on and down through a simple tubular condenser E where the two former condense and collect in a receiver, the oils floating on the water and showing only a slight tendency to emulsify. The cool gases leaving the condenser still contain some tar fog; they are therefore passed down through a tube scrubber F filled with glass beads (and a short layer of glass wool shown shaded) through which a jet of steam from a weighed boiler is also passed. The bottom half of this scrubber is water cooled. This scrubber completely removes the tar fog from the gas; the oil first condensed on the beads acts as an oil scrubber collecting more of the tar, the steam prevents the clogging of the scrubber by keeping the tar hot and fluid, and also, when condensing at the bottom, carries down with it any vapours still remaining. The gases are thus completely cleaned, and all the liquid products as well as the ammonia from the lignite are collected in the vessels and can be readily weighed and examined. The tar oils thus collected are reasonably free from water and can be redistilled without excessive bumping or frothing. The gases leaving the scrubber F pass through a final cooling tube G, through a gas meter H, and into a gas holder which is not shown.

Regular Series of Tests

In the experiments the retort was charged, usually with pea sized lignite containing about 34% moisture but in a few experiments with dried lignite, and connected to the purifying train which was then swept out with gas from a previous run. The lead bath, heated to temperature higher than that desired for the test in order to allow for the cooling effect of the retort, was then raised to surround the retort. The temperatures and pressures at the different parts of the system, and also the meter readings, were recorded at frequent intervals, and the experiment continued until the evolution of gas had practically ceased. The volumes of gas collected were corrected for temperature, pressure and moisture content, being reduced to moist gas at 60°F. and 30″ of mercury pressure. All other products were weighed, and all the products were carefully analysed. In a number of the experiments the gas was collected in two separate holders, and the two portions were then analysed separately, it will be noted that the gas from the second half of the run is much richer than that collected in the first holder.

The tables given below summarize the more important results obtained. As a general rule the results are the average of two or more experiments at each temperature.

Slow Series of Tests

In the slow series the general method was the same as the above, except that the lead bath was only heated beforehand to a temperature slightly above the melting point of lead. The bath was then raised slowly up and, after the retort was immersed, the temperature then slowly raised to the temperature of the test. The results are given in the following tables.

Table I

Typical Analysis of Shand Coal Employed in Tests

Proximate Analysis	Coal as Charged	Dry Coal
Proximate Analysis—		
Moisture..................%....	32·6	0·0
Ash.......................%....	8·6	12·8
Volatile Matter ....%....	27·1	40·2
Fixed Carbon ....%....	31·7	47·0
Calorific Value—		
Calories per gram.	3965	5880
B. Th. U. per lb.	7140	10580
Fuel Ratio........................	1·17	1·17

TABLE II

Weight Balance Sheet, Lignite Carbonization—Dry Coal Basis

Temperature	Water of Decomposition	Gas	Tar Oils[1]	Carbonized Residue	Unaccounted For
Regular Series					
	per cent	per cent	per cent	per cent	per cent
350°C.	6·9	4·1	1·0	87·5	−0·5
400	9·8	8·1	2·9	79·1	−0·1
475	11·9	12·3	4·2	71·4	−0·2
555	11·7	17·0	4·1	66·7	−0·5
605	13·4	18·0	4·2	64·3	−0·1
690	12·5	22·1	3·9	61·5	0·0
Regular Series, Dried Coal					
550	8·7	17·9	3·4	69·6	−0·4
Slow Series					
450	10·4	11·5	4·3	74·0	+0·2
550	12·6	15·5	4·5	67·4	0·0
655	12·4	20·2	4·0	63·8	+0·4

[1]Moist.

TABLE III

Commercial Products, Lignite Carbonization—Moist Coal as Charged

Temperature	Moisture as Charged	Gas	Yields per Short Ton		
			Ammonium Sulphate	Tar Oils	Carbonized Residue
Regular Series					
	per cent	c.f.	lbs.	gals.	lbs.
350°C.	32·3	590	0·5	0·1	1185
400	31·9	1190	1·4	4·1	1075
475	31·6	2020	4·4	5·4	980
555	31·8	3130	10·2	5·3	910
605	31·2	3810	11·8	5·6	885
690	33·0	4900	19·2	5·0	825
Regular Series, Dried Coal					
550	2·3	3010[1]	10·5[1]	4·6[1]	935[1]
Slow Series					
450	33·1	1710	3·3	5·3	990
550	34·0	2750	10·4	5·9	890
655	33·6	4200	14·5	5·1	845

[1]Calculated to the yield from a 33% moisture change for comparison.

TABLE IV

Thermal Balance Sheet, Lignite Carbonization—Heat Content of Products as Percentages of Heat in Original Charge

Temperature	Gas	Tar	Carbonized Residue	Loss
Regular Series				
	per cent	per cent	per cent	per cent
350°C.	0·7	1·6	92·2	5·5
400	1·7	4·7	88·3	5·3
475	5·0	6·7	81·7	6·6
555	8·3	6·0	78·1	7·6
605	10·6	6·5	74·8	8·1
690	14·4	5·9	70·4	9·3
Regular Series, Dried Coal				
550	7·5	5·5	81·1	5·9
Slow Series				
450	4·1	6·3	83·7	5·9
550	8·0	7·2	79·0	5·8
655	12·5	6·2	73·7	7·6

TABLE V

Carbonized Residue—Lignite Carbonization

Temperature	Yield on coal as charged	Water in coal as charged	Ash Content	Calorific Value	
				Calories per gram.	B.Th.U. per lb.
Regular Series					
	per cent	per cent	per cent		
350°C.	59·2	32·3	15·6	6195	11150
400	53·8	31·9	15·0	6564	11815
475	48·8	31·6	15·9	6727	12110
555	45·5	31·8	16·9	6882	12390
605	44·2	31·2	17·6	6845	12320
690	41·3	33·0	20·1	6729	12110
Regular Series, Dried Coal					
550	68·0	2·3	18·4	6848	12325
Slow Series					
450	49·5	33·1	16·9	6645	11960
550	44·4	34·0	18·5	6895	12410
655	42·3	33·6	19·1	6790	12220

TABLE VI

Tar Results—Lignite Carbonization

Crude Tar Oil			Dried Tar Oil				
Temperature	Water Content	Density	Yield per 2,000 lbs. dry coal	Calorific Value B.Th.U. per lb.	Distillation Results: Up to 310°C.	Distillation Results: Pitch Residue	Pitch as per cent of carbonized residue
Regular Series							
	per cent		gls.		per cent	per cent	per cent
450°C.	1·5	0·98	6·0	17,260	60·9	38·1	1·4
475	7·7	0·99	7·9	17,250	55·6	42·9	2·3
555	9·4	1·00	7·5	17,040	64·2[1]	34·7[1]	1·9
605	3·3	1·00	8·1	17,030	53·7	43·4	2·7
690	5·2	1·00	7·3	16,970	65·2	32·5	2·0
Regular Series, Dried Coal							
550	2·3	0·97	6·9	17,410	58·6	40·7	2·0
Slow Series							
450	9·6	0·99	7·8	17,110	62·7	36·2	1·9
550	1·8	0·99	8·9	17,020	60·5	38·3	2·5
655	6·6	0·99	7·6	17·560	60·0	38·5	2·3

[1]Cut at 325°C.

TABLE VII

Gas Results—Lignite Carbonization

Temperature	Yield per 2,000 lbs. dry coal	Calorific Value B. Th. U. per c.f.		Density	Combustible Gas		
		gross	net		Holder (1)	Holder (2)	Average
Regular Series							
					per cent	per cent	per cent
350°C.	870c.f.	180	170	1·22	28	....	28
400	1740	215	195	1·24	29	....	29
475	2950	355	320	0·96	46	....	46
555	4590	385	345	0·94	49	70	55
605	5530	405	365	0·86	52	75	61
690	7320	415	375	0·79	51	82	67
Regular Series, Dried Coal							
550	4490	355	320	1·02	36	67	49
Slow Series							
450	2560	340	310	1·17	39	....	39
550	4170	405	370	0·98	33	69	53
655	6320	420	380	0·83	46	80	64

Conclusions

As already stated, this series of tests is not yet completed. The results are self-explanatory; they show less difference than was expected between rapid and slow carbonization. The results emphatically disprove many published statements with regard to the carbonization of lignite. They show that the yields of gas are low, probably too low to provide the heat and power necessary to run a carbonizing and briquetting plant, unless the carbonizing is carried out at a temperature distinctly above that at which the residue of maximum calorific value is obtained. The tar yields are also low, and the pitch to be obtained therefrom only amounts to some 2% to 2½% of the corresponding carbonized residue. Probably 10% would be necessary for satisfactory briquettes.

The yields and calorific values of the carbonized residues, are, after allowing for variations in ash content, in satisfactory agreement with the results of the small scale tests given last year.

APPENDIX I.

Weathering of Carbonized Lignite

BY E. STANSFIELD, M.SC.; R. E. GILMORE, M.SC.;
J. H. H. NICOLLS, M.SC.

In an earlier report[1] it was stated that carbonized lignite changed notably on exposure to air, and this matter has since been further investigated.

Samples exposed to air over sulphuric acid in a desiccator, for periods of up to one year, showed gains in weight averaging 3.4%, although one isolated case of over 6% was observed. The calorific value, corrected to the original weight, showed an average decrease of 1·9%; the apparent drop in calorific value averaging 5·1%.

A sample exposed for three days to oxygen under a pressure of about 25 atmospheres, showed a gain in weight of 12·4%. Exposure in a repeatedly evacuated desiccator reduced this gain to 4·3%, but the drop in calorific value, corrected to the original weight, was almost negligible.

A sample of lignite, carbonized after its mineral impurities had been largely removed by treatment with hydrochloric and hydrofluoric acids, showed gains in weight which at first appeared to be normal, but later slowed off and fell below the average.

Dry air, enclosed over mercury in a tube containing a sample of lignite which had been carbonized in an evacuated retort, was rapidly absorbed at first, but more slowly later. After 4½ months the total absorption amounted to about 25% of the volume of the air, corresponding to 1·7% of the weight of the lignite residue. This residual gas contained no carbon dioxide, and only 0·07% of oxygen.

The following conclusions have been drawn. The carbonized lignite rapidly occludes oxygen and, possibly to a less extent, nitrogen; the occluded oxygen then gradually oxidises the material, with a corresponding slow reduction of the calorific value. The oxidation does not appear to be confined to the mineral impurities.

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[1]The Carbonization of Lignites, Trans. R.S.C. Series III (1917) Vol. XI p. 90.

Appendix II.

Extraction Tests

Preliminary Note By E. Stansfield, M.Sc., and R. C. Cantelo, B.Sc.

Some extraction tests have been made on lignite for the following reasons: to make a comparison between Canadian and German lignites, and to show how the various Canadian lignites differ amongst themselves. Similar tests were also made on peat. This work is still in progress.

The results are summarized in the following table.

Table VIII

Extraction Tests on Shand Lignite and Alfred Peat

Method of Extraction	Shand Lignite	Alfred Peat
	per cent	per cent
With benzine in Soxhlet Apparatus	0·6	4·5
With carbon disulphide in Soxhlet apparatus	0·5	3·3
With benzene in autoclave at 50 atmospheres and 300-310°C. for one hour	1·3	11·0

Note.—The yields are expressed as percentages by weight of the dry material.

The extracts from both lignite and peat in the Soxhlet apparatus consisted of dark reddish-brown, resinous material. The autoclave extracts consisted of black, tarry material. The lignite appeared unchanged after treatment in the autoclave. The peat had become much darker in colour and much smaller in volume, and showed an unaccounted-for loss of 21% by weight; presumably this was due to the formation of water and gas.

German lignites have been recorded as showing over 10% soluble in benzine in a Soxhlet extraction, whilst Fischer and Gludd[1] obtained 25% benzene-extraction in an autoclave. Comparison with the above results on Shand lignite show clearly why, although certain German lignites can be briquetted without the addition of a binder, Souris lignites cannot be so treated.

[1]Ber. 49 1460-8 (1916).

A Comparison of Anemometers under Open Air Conditions

BY A. NORMAN SHAW, D.SC.

PRESENTED BY PROFESSOR L. V. KING, D.SC., F.R.S.C.

(Read May Meeting, 1918)

The following is an *abstract* of the paper read before the Royal Society of Canada on May 23rd, 1918.

These experiments were performed with the same apparatus as that used for the meteorological observations in connection with Dr. L. V. King's Acoustic Surveys at Father Point in September and October, 1917. For an explanation of the methods and a description of the instruments employed, reference should be made to the articles by Mr. J. Patterson and the writer, which are included in Dr. King's Report to the Honorary Advisory Council of Scientific and Industrial Research, on "The Acoustic Efficiency of Fog-Signalling, Father Point Experiments, 1917."

The contents may be summarized as follows, the table at the end being compiled from the figures tabulated in the various sections:

SECTION I. *Introduction.*

SECTION II. *The Robinson Cup Anemometer Compared with Pilot Balloons Under Open Air Conditions.*

A comparison between the wind velocities determined with a Robinson Cup Anemometer at an elevation of 40 ft. and those calculated from observations on a pilot balloon drifting past it, showed a very satisfactory agreement between the two methods of observation, under open air conditions.

SECTION III. *The Robinson Cup Anemometer Compared with a Simple Pitot Tube Anemometer under Open Air Conditions.*

Two simple Pitot Tubes which could be constructed easily in any laboratory, were tested under open air conditions and found to give very satisfactory results.

SECTION IV. *Notes on the Use of this Pitot Tube with Reference to Gustiness.*

The use of such a Pitot Tube for the detection and measurement of gustiness was demonstrated. The relation between the mean gust velocity, the mean lull velocity, and the mean velocity, was investigated for velocities up to 20 mis/hr. Checks were made on the methods by (1) watching the behaviour of a tethered pilot balloon (2) by comparing with the record of a Dines Microbaragraph and (3) by counting the successive dark regions which were caused on the surface of the water on a day when the gustiness was marked.

SECTION V. *The Use of the Hot-Wire Anemometer Under Open Air Conditions.*

The linear Hot-Wire Anemometer as developed by Dr. L. V. King, was tested under open air conditions and appeared to be the most promising of anemometers, from the standpoint of precision. The claims of its designer seem fully to be justified.

SECTION VI. *The Kata-Thermometer Used as an Anemometer.*

The dry bulb Kata-Thermometer used as an anemometer, gave very good results for velocities less than 20 mis/hr. As it is an instrument with many valuable uses, its additional application as an anemometer was of special interest.

Summary of Comparisons under Open Air Conditions
Velocities in Miles per Hour

Instrument	Results of Observations									Remarks
Robinson Cups[1]	8	9	16	16	11	21	10	16	14	At elev. of 40 ft. Averages for 1 min. intervals.
Pilot Balloon[2]	8	10	16	14	18	21	10	16	14	Average up to elev. of 260 ft. Averages for 1 min. intervals.
Robinson Cups	3	21	22	19	20	20	21	21	17	Averages for ½ min. intervals.
Pitot Tubes[3]	3	21	22	20	20	20	20	20	17	“ “ “ “ “
Robinson Cups	5									“ “ 10 “ “
Hot-Wire[4]	5·2	(Successive fluctuations, 7·9, 6·8, 6·5, 6·2, 5·3, 3·7, 3·7, 4·0, 3·6, 3·1, 4·5)								“ “ “ “ “
Robinson Cups	6	6	3	10	10	(20)				“ “ 1 min. intervals.
Kata-Thermometer[5]	5·5	6·3	3·1	8·4	10·5	19·0	......	......	......	“ during cooling periods of bulb.
Hot-Wire	6·5	3·7	3·3	......	......	......	......	......	......	“ “ “ “ “ “
Kata-Thermometer	6·3	3·3	3·1	......	......	......	......	......	......	“ “ “ “ “ “

(1) A standard Robinson Cup outfit was used, similar to that described in "Instructions for the Installation and Maintenance of Wind Measuring and Recording Apparatus," *Circ. D, Instrument Div., Weather Bureau, U.S. Dept. of Agric.*
Marvin's correction formula was applied to the results.

(2). The pilot balloons consisted of thin rubber envelopes filled with pure hydrogen and had a dead weight of about 3 g. and a free lift of about 8 g. They rose when released with a velocity of about 80 metres per min. (See Hergessel, *Sixieme Reunion de la Commission Internationale pour l'Aërostation Scientifique*, 1909; also, Dines *Meteor. Off. Lon. Pub. M.O.* 212, p. 27). This was checked by comparisons with larger balloons.

(3). The Pitot Tubes each consisted of a U-Tube of about 5/16-inch internal diameter, with its ends bent both in the same direction at right angles to, and in the same plane as the U-part. One end was open and the other was tipped with a polished brass cylinder having a closed conical end. Round the side of the cylinder were six small holes each slightly less than a millimetre in diameter. The U was half filled with gasoline and was mounted on a stand which could be tilted to any desired angle in order to increase the sensitiveness. The formula, $v^2 = 2P/\rho$, was used. See Hunsaker, "The Pitot Tube and the Inclined Manometer," *Smithsonian Publication No. 2368*, p. 27, (1916); Bramwell and Fage, "On the Determination of the Pressure-Velocity Constant for a Pitot (Velocity-Head and Static-Pressure) Tube," *Tech. Rep. of the Adv. Com. for Aeronautics* (*Brit.*), 1912-13, p. 35; Rowse, "Pitot Tubes for Gas Measurements, *Pro. Am. Soc. Mech. Eng.*, April, 1913, p. 640.

(4). See L. V. King "The Linear Hot Wire Anemometer and its Applications in Technical Physics," *Jour. Frank. Inst.* Jan. 1916, pp. 1-25, where a complete list of references is given.

(5). See Hill, Griffith and Flack. "The Measurement of the Rate of Heat-loss at Body Temperature by Convection, Radiation and Evaporation." *Phil. Trans. Roy. Soc. Lon.* B. vol. 207, p. 201, (1915).

Very many thanks are due to Dr. L. V. King for his invitation to the writer to work at Father Point, and for making the arrangements which made these incidental tests possible, while the main work of the party was being performed. It is a pleasure, also, to record indebtedness to Mr. J. Patterson for the opportunity to acquire experience in the use of meteorological instruments, and to thank Lieut. E. Bièler for his kind assistance.

The writer regrets that owing to the limited amount of space available this year, it has been necessary to omit the main details and discussion of the observations, and to present the results in this abstracted form.

Macdonald College, McGill University. May 1918.

The Use of a Simple Form of Pitot-Tube Under Open Air Conditions

BY A. NORMAN SHAW, D.SC.

Presented by Prof. L. V. King, D.Sc.,F.R.S.C.

(Read May Meeting, 1918)

The following notes concerning the use of a simple form of Pitot Tube anemometer under open air conditions were made as a result of some meteorological observations in connection with Dr. L. V. King's Acoustic Surveys at Father Point in September and October 1917.[1] The experiments with Pitot Tubes, consisted merely of somewhat rough tests, but they are recorded because they provide suggestive information about the accuracy and possible use of a simple Tube which could be constructed with ease in any laboratory.

Two Pitot Tubes, designed primarily to test their suitability for the indication and measurement of gustiness, were employed. They were constructed according to specifications kindly given by Mr. J. Patterson, and each consisted of a U-tube of about 8 mm. internal diameter, with its ends bent both in the same direction at right angles to, and in the same plane as, the U part. One end was open and the other was tipped with a polished brass cylinder having a closed conical end. Round the side of the cylinder were six small holes each slightly less than a millimetre in diameter. The U was half filled with gasoline and was mounted on a stand which could be tilted to any desired angle in order to increase the sensitiveness for low velocities.

It is now generally accepted that the formula, $v^2 = 2\ P/\rho$, deduced for this type of Pitot Tube from Bernoulli's theorem for stream line motion in fluids,—where v is the velocity of the wind, P the pressure (in absolute units of force) on the open side, and ρ the density of the air—may be applied in the interpretation of the observations.[2] The

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[1]See A. N. Shaw, previous article in this number; also Dr. L. V. King's *Report to the Hon. Adv. Council of Scientific and Industrial Research* on "The Acoustic Efficiency of Fog-Signalling, Father Point Experiments, 1917," in which the meteorological observations are discussed by Mr. J. Patterson and the present writer.

[2]Hunsaker, "The Pitot Tube and the Inclined Manometer," *Smithsonian Publication No. 2368*, p. 27 (1916); Bramwell and Fage, "On the Determination of the Pressure-Velocity Constant for a Pitot (Velocity-Head and Static-Pressure) Tube," *Tech. Rep. of the Adv. Com. for Aeronautics* (*Brit.*), 1912-13, p. 35; Rowse, "Pitot Tubes for Gas Measurement," *Pro. Am. Soc. Mech. Eng.*, April 1913, p. 640.

alteration of this formula to suit our particular readings is a simple matter.

Let v = the velocity in miles per hour[1];

r = the reading in cms. of the gasolene on *one* side of the tube, *i.e.* the distance from the scale zero; (thus the "head" = 2 r).

d = the density of the gasolene in grams per cc.;

g = the gravitational acceleration constant in cms. per sec. per sec.;

A = the angle of slope of the stand in degrees;

ρ = the density of the air in grams per cc.;

then substituting in the above formula and multiplying by the required constants in order to express v in mis/hr., we get

$$v = 0\cdot00200 \frac{r\ d\ g\ \sin A}{\rho}$$

In our case d = 0·75 gms/cc, g = 980 cms/sec^2, sin A = 1·32, and ρ = 0·00129 gms/cc. hence the formula reduced to

$$v^2 = 151\ r$$

In the same way formulae could be deduced for any particular slopes and densities.

The two tubes were compared in a fluctuating wind, and the tops of the corresponding liquid columns in each tube were found to keep very closely in line. Occasionally the free period of vibration of the gasoline affected the readings momentarily by as much as 1 cm. but this was infrequent and was apparently quickly damped. It was thought that damping devices could readily be introduced, which would eliminate this entirely.

It was somewhat difficult to get the average Pitot reading during half a minute as there was a certain amount of gustiness and the movements of the gasoline were sometimes momentarily erratic and rapid. As the gusts were approximately periodic the following method was adopted. The maximum and minimum readings during the half minute were recorded and their mean taken, also the mean position of the liquid was estimated by another observer, and the mean of the two results was taken as representing approximately the average reading. It might be suggested that the square of the mean of the square roots should be taken in the first method since the velocity is proportional to the square roots of the readings, and that this would lower the means appreciably. It was, however, found that for the

[1]"Miles per hour" was considered more convenient than "metres per sec." because the accuracy of the results was of the order of 1 mi /hr, and these units were also more convenient in other parts of the investigation.

same reason the gauge was influenced more by the lulls than by the gusts, and there was thus a tendency to get readings that were too low. By taking the mean in the manner mentioned, it was thought that a fair approximation was obtained.

The tubes were compared with standardized Robinson Cups and other instruments, with very satisfactory results. It appeared certain that for velocities from 0 up to 25 mis/hr, there was a probable error of less than 1 mis/hr in the values obtained. Although it is somewhat an inversion to express an absolute method in terms of an empirical one, it was of interest to determine the constant of our Pitots in terms of standardized instruments. The constant, determined experimentally in this way, was found to be 152± 2·4 when the theoretical value was 151.[1]

It was found that the horizontal turning of the Pitots through angles of as much as 10° did not affect the readings of the gauge.

The following table gives an idea of the limitations of the readings when the gauge is at a slope of 2/15 (sin A=1·32), and sensitive enough to indicate the gust fluctuations.

Fluctuations of the Pitot Tube Readings During the Half Minute Intervals

Observations	Max. Reading	Min. Reading	Average of max. and min.	Estimated Mean Reading	Final Mean
1	5·0 cms.	1·2 cms.	3·1 cms.	2·5 cms.	2·8 cms.
2	5·0 "	1·5 "	3·2 "	3·0 "	3·1 "
3	4·0 "	1·4 "	2·7 "	2·7 "	2·7 "
4	4·2 "	0·8 "	2·5 "	2·7 "	2·6 "
5	4·5 "	1·0 "	2·8 "	2·4 "	2·6 "
6	3·5 "	1·1 "	2·3 "	2·8 "	2·6 "
7	4·0 "	0·9 "	2·4 "	2·8 "	2·6 "
8	3·5 "	0·9 "	2·2 "	2·8 "	2·5 "
9	4·0 "	1·2 "	2·6 "	2·6 "	2·6 "
10	3·0 "	1·0 "	2·0 "	2·2 "	2·1 "
11	3·0 "	0·6 "	1·8 "	2·5 "	2·2 "
12	4·0 "	1·0 "	2·5 "	2·3 "	2·4 "
13	3·2 "	1·0 "	2·1 "	2·0 "	2·0 "

It will be seen that in several cases the estimated mean readings are higher than the average of the max. and min., but it must be understood that the accuracy of estimation and the magnitude of the fluctuations due to free vibration, were sufficient to cause discrepancies of this kind, and the two determinations of the mean are

[1]Only 13 observations were made for this, but it was thought that the "probable error," ±2·4, could be mentioned reasonably, because the "probable error" for any *one* was less than 6% (± 8·6), and there were just as many experimental values above as below the mean. (Bessel's "probable error" formula was used.)

brought in for the purpose of obtaining a more reliable final mean than would be got from only one method, rather than to show any relationship between the two means.

Comparing the mean gust velocity calculated from the max. readings (viz. 24·2 mis/hr)and the mean lull velocity calculated from the min. readings (viz. 12·5 mis/hr) with the mean of the Rob. Cup readings (viz. 19·6 mis/hr) for the corresponding periods, we get for the duration of our test that the mean gust velocity was equal to 1·23 v, and that the mean lull velocity was equal to 0·65 v, where v is the mean velocity determined from the standardized cups. The extreme gust velocity was 1·4 v and the extreme lull velocity (with the exception of the exceptional observation No. 11) was 0·60 v.[1] These two latter values are probably too great because no correction has been made for the vibration of the gasoline, which would certainly augment the extreme readings.

Considering the fact that no recording or damping device was introduced, the general consistency of the figures in the table is perhaps more remarkable than is at first apparent. It should be noted that the probable error for a single mean by either method amounts to much less than 1 mile per hour in the calculated velocity. The extreme difference obtained in the unexplained variation of observation No. 11, amounts to 3 mis/hr. and there were only two other cases where the difference amounted to 2 mis/hr. In other tests the mean values for the wind were in complete agreement for several types of instrument.

These Tubes were used for recording the number of the gusts in a given period very successfully, as well as their range in velocity. A summary of some results obtained in this way, is given by Mr. J. Patterson and the present writer in a section of Dr. L. V. King's Report.[2] Checks were made on this method of indicating the frequency of gusts or double fluctuations of pressure (1) by watching the behaviour of a small tethered pilot balloon, (2) by comparing with the record of a Dines Microborograph, and (3) by counting the successive dark regions which were caused on the surface of the water on a day when the gustiness was very marked. A fair agreement was obtained.

The writer desires to express again his thanks to Dr. L. V. King for the opportunity to perform these tests during the main work of the party at Father Point, and to Mr. J. Patterson for his valuable directions.

Macdonald College, McGill University.

[1]Compare these four values with the results (1·2 v, 0·75 v, 1·3 v, and 0·65 v respectively) given by W. N. Shaw, in *Report of the Adv. Com. for Aeronautics (Brit.)*, 1909-10, p. 97; also G. C. Simpson in *M.D. Pub. 180*, p. 37.

[2]*Loc. cit.*

On the Embodiment in Actual Numbers of the Kummer Ideals in the Quadratic Realm

BY J. C. GLASHAN, LL.D., F.R.S.C.

(Read May Meeting, 1918).

The postulates defining the integral domain in the general quadratic realm are:—(1) The span of every quadratic integer is a rational integer, (2) The norm of every quadratic integer is a rational integer. The limitation imposed by the first postulate causes the failure in the integral quadratic domain of the unique-factorization law. The introduction of the Kummer ideals restores this law but necessitates the modification of the first postulate to: The spans of the bases of every ideal are rational integers. The adjunction of an auxiliary radical to the fundamental radical permits of the determination of actual numbers which restore the unique-factorization law and replace ideals in every other respect. The first postulate delimiting these biquadratic integers becomes: the product of the span of every biquadratic integer and its auxiliary radical is a rational integer.

The Utilization of Nitre Cake in the Manufacture of Superphosphate

BY FRANK T. SHUTT, D.SC., AND L. E. WRIGHT, B.SC.

(Read May Meeting, 1918)

Notwithstanding the advances that have been made of late years in the utilization of chemical by-products, nitre cake—essentially sodium bisulphate—the residue from the manufacture of nitric acid from Chili Saltpetre, must be regarded as a waste product and practically valueless. Many uses have been proposed for it, but only a few of these have proved profitable or of any commercial importance. The literature on the subject is voluminous and we find on record the results of a very large amount of investigatory work of the very highest order, but apparently the problem still awaits a successful issue. Even in peace times this by-product has accumulated and proved an expensive nuisance; in these days when it is being produced in millions of tons its disposal has become a very serious matter. Where location permits it to be discharged into tidal waters it is most cheaply and possibly least objectionably got rid of, but inland its disposal means, generally, the pollution of streams and lakes and the destruction of fish or the ruination of land. It is evident that a fortune awaits the one who can find a profitable use for it in large quantities.

Of the almost innumerable processes that have been brought out or suggested it would be quite impossible in this paper to give any account, but a few of the uses that nitre cake has been put to may be enumerated, for the purpose of showing the wide range of investigational activity in this matter: the production of hydrochloric acid and salt cake by furnacing with salt; the pickling of metals; the extraction of grease from wool; the bleaching of lace, etc; mineral water manufacture; the manufacture of crude ferric sulphate for sewage precipitation; the preparation of sodium sulphide; the separation into Glauber's salt and free acid and lastly, though by no means is the list exhausted, as a diluent for sulphuric acid in the manufacture of superphosphate. It is in connection with this latter use, though not employing sulphuric acid, that the work recorded in this paper was undertaken.

This preliminary investigation was taken in hand at the instance of the Metallurgical Division, Explosives Department, Imperial Munitions Board, which was anxious to find some useful purpose for the large amount (about 150 tons daily) of nitre cake produced at the munitions plant at Trenton, Ont. This nitre cake is stated "to contain 30 per cent free sulphuric acid, nitric acid not over ·2 per cent and small amounts of iron. Otherwise it is practically free from impurities." The supplies of nitre cake (Trenton), Florida Pebble Rock and Canadian Apatite used in this experimental work were furnished by the Director of Explosives.

In the preparation of the materials the nitre cake was reduced in an iron mortar until sufficiently fine to pass through a 60 mesh sieve. No particular difficulty was experienced in this operation. Reduction of the cake in a pebble or ball mill was tried, but this was found to be unsatisfactory, owing to the material adhering to the pebbles. Both the Florida Pebble Phosphate and the Canadian Apatite readily reduced in the pebble mill, screen tests showing that for the former 98 per cent passed the 80 mesh and 78 per cent a 100 mesh sieve and for the latter ground product 100 per cent passed the 100 mesh sieve.

After certain preliminary experiments it was decided to ascertain the action of the nitre cake on the phosphates when (1) the materials were mixed "dry" and (2) when the materials were made into a paste with the addition of a little water.

In the "dry mix" the powdered substances were weighed out in the several proportions stated in the tables of analysis, thoroughly mixed and placed in glass stoppered bottles. The product or "mix," after being allowed to remain at room temperatures, was analysed at the end of one week.[1] The product was a fine, flour-like material, with no evidence of caking.

In the "wet mix," to the materials mixed in the proportions noted, a small but known weight of water was added and the whole stirred to a damp mass. This was placed in stoppered bottles and allowed to stand 48 hours. The mass was then emptied out and allowed to air-dry. Although a slight caking or hardening took place, it was very readily broken down to a fine powder. The setting or hardening was more pronounced with the Canadian Apatite than with the Florida phosphate, but in both cases a first class product, as regards its mechanical condition, was obtained.

An outline of the analytical procedure may be given as follows: 2 grams of the mix were weighed into a beaker and 200 cc of water added. After occasional stirring for 2 hours the whole was filtered and the filtrate made up to 500 cc and an aliquot taken for the determination of water soluble phosphoric acid. The filter with its residue was then placed in a bottle with 500 cc of a 1 per cent solution of

[1]Analyses of "dry" mixes that had been allowed to stand two weeks gave results practically identical with those of one week's standing.

citric acid and shaken for 5 hours in a mechanical shaker and filtered. The phosphoric acid as determined in the filtrate is denoted in the tables of analyses as "1 per cent citric soluble." Determinations of the water soluble and ammonium citrate soluble phosphoric acid were also made according to the official methods of the Association of Agricultural Chemists, generally adopted on the American continent in the official analysis of fertilizers.

The composition of the Florida pebble phosphate and the Canadian Apatite used in the experiments, is as follows:

Analysis of Florida Pebble Phosphate and Canadian Apatite

	Florida Pebble Phosphate	Canadian Apatite
Total phosphoric acid	32·30	39·40
equivt. to tricalcic phosphate	72·54	86·05
One per cent Citric sol. phos. acid	11·50	6·06
equivt. to tricalcic phosphate	25·10	13·24
Citrate soluble phos. acid A.O.A.C.	1·91	nil
equivt. to tricalcic phosphate	4·17	"
Water-soluble phosphoric acid	nil	"

Discussion of Results

Tables I. and II. set forth clearly the results obtained in this investigation and will need but little explanatory text. The percentages of phosphoric acid as rendered available in the several mixes, as determined by treatment with water and 1 per cent citric acid solution and by the A.O.A.C. methods, are stated and the percentages of the total phosphoric acid in the mixes so converted are also given. Certain of the more important results may be briefly emphasized as follows:

Table I.—Florida Pebble Phosphate

Dry Mix: The highest percentage of available phosphoric acid, as obtained by using water and 1 per cent citric acid solution as solvent, resulted from the 1 to 1 mixture. This product contained 15·77 per cent, of which 6·83 per cent was soluble in water. This indicates that of the total phosphoric acid in the mix, 97·6 per cent had been converted into more or less available form. This is closely followed by the mix, 0·5 nitre cake to 1 F. P. Phosphate, which by the same analytical method is seen to contain 15·38 per cent of available phosphoric acid. Since the percentage of total phosphoric acid

TABLE I

Using Florida Pebble Phosphate

The Utilization of Nitre Cake in The Manufacture of Superphosphate

	Available Phosphoric Acid						Total P_2O_5 in Mix	Percentage of Total P_2O_5 rendered available	
(*a*) DRY MIX— Proportions	Water Soluble	1% Citric Soluble	Total H_2O & 1% Citric	Water Sol. A.O.A.C. method	Citrate Sol. A.O.A.C. method	Total A.O.A.C. method		H_2O & 1% Citric	A.O.A.C.
2½ N.C.: 1 F.P.P.	7·15	2·17	9·32	5·30	0·76	6·06	9·32	100·00	65·0
2 N.C.: 1 F.P.P.	7·28	3·70	10·89	5·04	0·94	5·98	10·80	100·00	55·4
1 N.C.: 1 F.P.P.	6·83	8·94	15·77	6·00	0·81	6·81	16·15	97·6	42·2
0·5 N.C.: 1 F.P.P.	5·04	10·34	15·38	5·30	1·92	7·22	21·54	71·4	33·5
(*b*) WET MIX— Proportions									
6 N.C.: 3 F.P.P.: 1 H_2O	7·57	2·94	10·51	6·83	0·64	7·47	10·47	100·00	71·3
3 N.C.: 3 F.P.P.: 1 H_2O	7·31	5·04	12·35	7·79	1·08	8·87	15·61	79·1	56·8
6 N.C.: 6 F.P.P.: 1 H_2O	7·66	8·43	16·09	7·85	1·41	9·26	16·00	100·00	57·9

TABLE II

The Utilization of Nitre Cake in The Manufacture of Superphosphate

Using Canadian Apatite

	Available Phosphoric Acid						Total P_2O_5 in Mix	Percentage of Total P_2O_5 rendered available	
	Water Soluble	1% Citric Soluble	Total H_2O & 1% Citric	Water Sol. A.O.A.C. method	Citrate Sol. A.O.A.C. method	Total A.O.A.C. method		H_2O & 1% Citric	A.O.A.C.
(*a*) DRY MIX— Proportions									
3 N.C.: 1 C.A.	3·64	3·00	6·64	3·00	0·00	3·00	9·85	67·42	30·5
2 N.C.: 1 C.A.	4·34	3·83	8·17	3·64	0·00	3·64	13·13	62·22	27·7
1 N.C.: 1 C.A.	3·96	4·47	8·43	4·21	0·16	4·37	19·70	42·79	22·18
0·5 N.C.: 1 C.A.	2·94	5·24	8·18	3·32	0·45	3·77	26·27	31·15	14·4
(*b*) WET MIX— Proportions									
N.C.: 3 C.A.: 1 H_2O	6·14	2·23	8·87	7·85	0·58	8·43	12·31	72·06	68·5
6 N.C.: 6 C.A.: 1 H_2O	6·26	3·64	9·90	6·45	0·57	7·02	18·88	52·43	37·17

in this latter mix is greater than in the 1 to 1 mix, the percentage rendered available is less, viz. 71·4 per cent.

Considering the results obtained by the A.O.A.C. methods, it will be observed that while the percentages of water soluble phosphoric acid do not differ greatly from the water soluble data just discussed, the percentages of "citrate soluble" are very much less than when 1 per cent citric acid solution is used. This markedly reduces the total percentages of available phosphoric acid, as compared with the results when employing the citric acid solution. In the mix 1 to 1, the total available phosphoric acid is 6·81 per cent, of which 6·00 per cent is soluble in water.

Wet Mix: Three series were experimented with, the proportion being

(*a*) 6 N.C. : 3 F.P.P. : 1 H_2O
(*b*) 3 N.C. : 3 F.P.P. : 1 H_2O
(*c*) 6 N.C. : 6 F.P.P. : 1 H_2O

The percentage of water soluble phosphoric acid in all three series was practically the same by both methods, but as the case of the dry mix the citric soluble percentages are much higher than those obtained by the A.O.A.C. citrate soluble method.

The best results were obtained with proportions of series (c) 6 N.C. : 6 F.P.P. : 1 H_2O which gave a product containing 16·09 per cent available phosphoric acid (of which 7·66 per cent was water soluble), as determined by 1 per cent citric acid solvent. Since the total phosphoric acid in the mix is 16·0 per cent, it is evident that the conversion is very satisfactory. Similarly in series (*a*) 100 per cent conversion was brought about, but the product contains a lower percentage of available phosphoric acid (10·51), corresponding to the lower percentage of total phosphoric acid in the original mix.

By the A.O.A.C. methods, series (*c*) similarly possessed the highest percentage of available phosphoric acid, viz. 9·26, which stated otherwise means that practically 60 per cent of the total phosphoric acid in the mix had been rendered available.

Table II.—Canadian Apatite

Dry Mix: It will be first evident that the degree of conversion is decidedly lower than in the similar series using Florida Pebble Phosphate, indicating the harder and more resistant nature of the Canadian Apatite.

The series in which the proportions were 1 N.C. to 1 C.A. proved, as in the case of the Florida Pebble Phosphate, the most successful. Its product contained 8·43 per cent available phosphoric acid (of which 3·96 per cent was water soluble), as determined by 1 per cent citric acid method. This is equivalent, practically, to a 43 per cent conversion. By the A.O.A.C. methods the available phosphoric acid was 4·37 per cent (practically entirely water soluble), or, expressed otherwise, a 23 per cent conversion.

Wet Mix: The results generally as regards the total available phosphoric acid in the several mixes, and hence in the degree of conversion, are considerably higher than in the corresponding dry mixes. In the series 6 N.C. : 6 C.A. : 1 H_2O the total available phosphoric acid is 9·90 per cent by the 1 per cent citric acid method and 7·02 per cent by the A.O.A.C. methods. This, respectively, is equivalent to 52 per cent and 37 per cent conversion of the total phosphoric acid in the mix.

Unfortunately more pressing work necessitated at this stage the postponement of further prosecution of this investigation. As opportunity permits the work will be proceeded with, laboratory experiments being supplemented by trials on a larger scale, to simulate more closely the results that would be obtained in the factory. Though of a preliminary and incomplete nature, the results here presented appear to justify the conclusion that the waste product nitre cake could be used advantageously in the manufacture of a superphosphate containing 7 per cent to 9 per cent available phosphoric acid (A.O.A.C.) employing either Florida Pebble Phosphate or Canadian Apatite, the only apparatus required being the grinding machinery for reducing the materials.

Summary

1. Employing finely ground Florida Pebble Phosphate (total P_2O_5, 32·3%) a dry mix of 1 N.C. to 1 F.P.P. yielded a superphosphate containing 15·77 per cent available phosphoric acid as determined by 1 per cent citric acid method or 6·81 per cent by the A. O. A. C. Methods. The wet mix, 6 N.C. : 6 F.P.P. : 1 H_2O gave 16·09 per cent, and 9·26 per cent available phosphoric acid, respectively, by the two methods of analysis.

2. Canadian Apatite (total P_2O_5, 39·40%) is less readily acted upon by the nitre cake than Florida Pebble Phosphate, the products of the several mixes showing lower percentages of available phosphoric acid than the corresponding mixes with the latter phosphate.

The dry mix 1 N.C. to 1 C.A. gave a product containing 8·43 per cent and 4·37 per cent available phosphoric acid, respectively, by the 1 per cent citric acid method and the A.O.A.C. methods. The wet mix product from 6 N.C. : 6 C.A. : 1 H_2O contained 9·90

per cent and 7·02 per cent available phosphoric acid respectively by the two methods of analysis employed. While in the case of the Florida Pebble Phosphate no very marked increase in the percentage of available phosphoric acid resulted from mixing the materials wet and allowing them to stand, the wet mixes, using Canadian Apatite, were decidedly richer than the corresponding dry mixes in this constituent.

An Agricultural Source of Benzoic Acid

BY P. J. MOLONEY, M.A., AND FRANK T. SHUTT, D.SC., F.R.S.C.

SUMMARY

(Read May Meeting, 1918)

The two chief sources of the benzoic acid of commerce are (1) toluene and (2) gum benzoin: from the first is manufactured, by oxidation, practically all the benzoic acid used in the coal-tar industry and from the second is obtained, by sublimation, that employed in pharmacy and as a food preservative.

The price of benzoic acid is five or six times higher than it was previous to the war and the thought occurred to one of the writers that it might be possible to find a cheaper source in the urine of the herbivoræ, provided one or other of the methods that have been proposed, and to some extent used, could be so simplified that the first stages could be conducted on the farm, without any special apparatus.

Scheele obtained benzoic acid from cow's urine in 1785, Liebig, in 1829, demonstrating that it was not present as such in the urine, but was formed by the decomposition of hippuric acid. The fact therefore that benzoic acid could be obtained from the urine of the herbivoræ has been known for more than a century, but the fact has been one of scientific interest rather than commercial importance.[1]

Benzoic acid has been prepared from urine by three methods:

(1) The urine is allowed to putrefy in order to induce the hydrolytic decomposition of the hippuric acid into benzoic acid and glycocoll according to the equation:

$$CH_2\begin{matrix}\diagup NHC_7H_5O \\ \diagdown COOH\end{matrix} + H_2O = CH_2\begin{matrix}\diagup NH_2 \\ \diagdown COOH\end{matrix} + C_6H_5COOH$$

Milk of Lime in then added, the solution filtered and the benzoic acid, after concentration of the filtrate by evaporation, precipitated with strong hydrochloric acid.

(2). The putrefied urine after addition of milk of lime is treated with CO_2. This removes the excess of lime. Ferric chloride is now

[1]Benzoic acid from this source has been characterized by a slight odour of urine, "removed or concealed by mixing the acid with a small quantity of gum benzoin and subliming it."

added and the insoluble ferric benzoate after filtration is decomposed by hydrochloric acid.

(3). The fresh urine is evaporated to about one third its original volume, filtered, acidified with hydrochloric acid and allowed to cool. Hippuric acid crystallizes out and may be hydrolyzed to benzoic acid and glycocoll by boiling with concentrated hydrochloric acid or sodium hydrate.

All three methods present certain difficulties, especially when considered as processes for use on the farm. Methods (1) and (2) involve expensive and disagreeable evaporation and (3) requires the necessary apparatus for the preparation of carbonic acid gas and includes the troublesome filtration of a fine, voluminous precipitate.

From a consideration of the change of solubility of benzoic acid with the temperature, the possibility suggested itself of separating benzoic acid from putrefied urine and also hippuric acid from fresh urine by precipitation, at low temperatures.

Solubility of Benzoic Acid in Water

Temperature C.	Grams Benzoic acid per 100 grams solution
0	0·170
10	0·209
20	0·289
25	0·343

From these data it may be shown that by cooling a solution of benzoic acid to 0°C an amount of acid will separate out equivalent to an amount obtained by concentration of the solution to one half its volume and cooling to 25°C.[2] Thus, from a solution of benzoic acid containing ·5 grams per 100 cc ·330 grams will separate out on cooling to 0°C, leaving in solution ·170 grams. The same solution (·5 grams per 100 cc.) concentrated to one half its volume, *i.e.* 50 cc., precipitates ·329 grams on cooling to 25°C, leaving in solution ·171 grams.

No table of solubilities for hippuric acid could be found, but conjecturing that its curve of solubility would approximately parallel that of benzoic acid, the work about to be described in this paper was undertaken, the method used for determining the benzoic acid content *i.e.* the total amount of benzoic acid after hydrolization of the hip-

[2]To avoid loss of benzoic acid by volatilization during evaporation it would be necessary to first convert into the sodium salt by addition of caustic soda.

puric acid, of the urine in the several experiments being that of Steenbock.[1] (J. Biol. Chem. XI. 204. 1912).

Benzoic Acid from Cow's Urine

1.	100 cc. fresh urine, total	0·64 gram
2.	100 cc. fresh urine evaporated to one half original volume, acidified with HCl and cooled to room temperature and the benzoic acid content determined in the precipitated hippuric acid	0·35 "
3.	100 cc. fresh urine, acidified with HCl, cooled to 0°C and the benzoic acid determined in the precipitated hippuric acid	0·35 "

From these results it will be seen that a method for obtaining benzoic acid from urine by cooling the fresh, acidified urine to 0°C is as efficient as evaporating the fresh urine to one half its original volume and precipitating the hippuric acid at room temperature.

Using the above data as a basis of calculation and assuming 20 pounds of urine daily per 1,000 pounds weight of cow, the total daily benzoic acid output would be approximately 1 pound per 8 cows. By acidifying and cooling to 0°C, as described above, and assuming that all the urine is collected, the amount of benzoic acid available daily would be approximately 1 pound per 15 cows.

In the case of putrefied urine, *i.e.* urine in which the hippuric acid had been hydrolyzed by bacterial action to benzoic acid and glycocoll, it was found that very little benzoic acid separated out after acidification and cooling to 0°C. However, if the putrified urine is first clarified with milk of lime, allowed to stand until clear and the supernatant liquid poured or siphoned off, the benzoic acid readily separates out on acidification and cooling, the percentage of efficiency being practically that obtained in working on fresh urine.

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[1]100 cc. fresh urine is boiled with 10 grams NaOH for 2 hours under a reflux condenser in order to hydrolyze the hippuric acid to benzoic and then acidified with 50 per cent H_2SO_4. Bromine water is then added to precipitate phenols—and the solution cooled and made up to 250 cc. A 50 cc aliquot is extracted with 4 portions — 50 cc — 40 cc — 20 cc — 20 cc of sulphuric ether. The combined ether solution is slowly dropped into a U tube through which a current of air is drawn, the U tube being kept in a water-bath which is kept at a temperature of 40°C.

The benzoic acid is then sublimed from the U tube into a tared condensing tube —the condensing tube consisting of a glass tube 25 cm. long, 9 mm. bore, 25 grams in weight, with 3 glass bulbs blown on it, the bulbs being filled with glass wool.

The sublimation was carried out at a temperature below 130°C.

On account of the possibly greater value of the products—hippuric acid, benzoic acid and glycocoll—it would seem desirable to use fresh urine, but so far it has not been determined if this would be generally possible under ordinary stable conditions.

In this simple method of acidification and cooling to 0°C it would appear that we have the basis of an economic process for the production of benzoic acid from urine, which might be employed over a large part of the Dominion during the winter months. The modern cow barn with its concrete gutter would much facilitate the collection of the urine and where twenty-five or more head of stock are housed in the same building, as is now frequently the case on dairy farms, there would seem to be the possibility of making the preparation of this by-product a profitable adjunct to the dairy business.

The Radioactivity of the Natural Gases of Canada

BY JOHN SATTERLY, D.SC.,F.R.S.C., AND J. C. MCLENNAN, PH.D.,F.R.S.C.

(Read May Meeting, 1918)

Introductory. The earliest account of any measurement of the radioactivity of a Canadian natural gas appears in a paper by Professor J. C. McLennan in 1904.[1] He examined several natural gases in the Province of Ontario and estimated their relative radioactivities. At that time there was no means of estimating the absolute radium content but the fertile suggestion was made that since the gas helium is one of the products of radioactive disintegration it was likely that helium would be found to be one of the constituents of natural gas.

Since 1904 many investigators have published reports on the radioactivity and helium content of natural gases in Europe and the United States[2] but up to the present only one "natural" gas in Canada has been examined for radioactivity. In the same interval much work has been done on natural mineral waters and the gases issuing from such natural springs.[3]

In the spring of 1916 it was decided from reasons of both practical and theoretical natures to make a systematic survey of the natural gases of the whole of the Dominion, examining all the gases for their radioactive and helium contents in the hopes of establishing relations between these two factors and also possibly between these and the nitrogen content. We may anticipate the result of the work by saying here that no direct relation has been established between the radioactivity and either the helium and nitrogen contents but that helium and nitrogen usually vary together *i.e.*, when one is high the other is high.

Collection and Testing of the Gases. With one exception all the gases were collected in the field by Professor McLennan and great

[1]Proc. International Electrical Congress, St. Louis, 1904.

[2]Moureau and Lepape. Comptes Rendus, p. 598, 1914. Cady and McFarland. Journ. Amer. Chem. Soc. Vol. XXIV, p. 1523, 1907.

[3]Satterly and Elworthy Mineral Springs of Canada. Bulletin No. 16 of the Bureau of Mines. Parts I and II. (Bibliography on p. 54 of Part I). Also Satterly and Elworthy "The Radioactivity of Some Canadian Mineral Springs" Roy. Soc. Canada, 1917. Vol. XI and Elworthy—Examination of the Hot Springs at Banff, Alberta. Trans. Roy. Soc., Canada 1917, Vol. XI.

pains were taken to see that the collecting bottles were clean. In collection two methods were adopted. In most cases five gallon water bottles were used and the gas collected by water displacement. When full the bottle was securely sealed by an indiarubber stopper and efficient metal clasp. In some cases where the gas pressure was considerable and where a large quantity of gas was wanted large steel cylinders were employed. These were filled up to rock pressure and blown off several times in succession depending on the value of the pressure. The remaining air would not be more than one in ten thousand of the whole gas. The date and time of collection of the gas were noted as in some cases days elapsed between collection in the field and testing in the laboratory.

All the radioactive measurements and calculations were made by Dr. Satterly in the Physics Building of the University of Toronto. The methods used were very similar to those used by him in his earlier work* on the radioactivity of gases and in his Canadian work with Mr. R. T. Elworthy* on the radioactivity of the mineral waters of this country

At the same time the gases were subjected to a brief further examination. Fractional condensation was carried out with liquid air to see how much of the gas was uncondensed at about −185°C. This residue is chiefly nitrogen. It was, however, further treated to find the percentage of helium in the original gas. The details of this work will be found in a larger paper.

Principles of the Methods Used for the Measurement of the Radioactivity of a Gas. The gas issuing from the ground will usually contain both radium and thorium emanations, but the latter has such a short average life (about a minute and a half) that it quickly decays into insignificance. The average life of radium emanation is much longer. In four days it has dropped to half its initial value and after twenty-five days there is still one per cent left. Unless, therefore, the gas is tested as it issues the radioactivity measured is due solely to radium emanation and it is the amount of this emanation per litre of the gas that is the subject of discussion in this paper.

The amount of emanation is usually deduced from the increased conductivity of the gas containing it over the conductivity of normal air. This conductivity is measured in a ionisation vessel fitted with a gold leaf electroscope. The details of almost the identical apparatus will be found in the paper by Satterly and Elworthy mentioned above. The gold leaf is charged and its rate of fall over a definite part of a microscope scale observed. This rate of fall or

*See references at end of paper.

"leak" is first observed when the vessel is filled with pure dry air. If now the vessel is filled with dry air containing radium emanation the increase of leak is taken as a measure of the radium emanation present. If the emanation is in some gas other than air the procedure is much the same. A measured quantity of gas is introduced by an aspirator system into the vessel—it may be enough to fill the vessel or the balance may be made up with air—and the leak found as before. A correction may be necessary on account of the effect of the gas on the current produced by the emanation. This will be taken up later. A more important effect is caused by the changes which radium emanation undergoes and produces. On account of the decay of the emanation and the production of the successive products of disintegration on the sides of the vessel the leak varies with time. It increases for three hours and then diminishes. For purposes of comparison the leaks should always be taken at the same interval after filling the vessel with the gas. The leak taken about ten minutes after filling is usually the best to observe.[1] In some cases the leak was also taken after the three hour interval. The ratio of these two leaks serves as a sure identification of the active substance and as a test of the accuracy of the work. In all cases of course the "air" leak must be deducted from the measured leak to get the leak due to the emanation.

The Radium Solutions. In order to express the emanation content in terms of radium a standard solution must be employed. The one used came from the Bureau of Standards at Washington and contained $1 \cdot 22 \times 10^{-9}$ gm. radium. To extract the emanation from the solution the latter is boiled in a closed flask. Air is then rapidly drawn through the solution into an aspirator. This sweeps out all the emanation. The emanation-charged air is then sent into the ionisation vessel and the leak read.

By comparison the quantity of radium emanation in the gas sample can then be expressed in terms of the quantity of radium with which it would be in equilibrium.

Effect of the Nature of the Gas on the Leak Produced by a Given Quantity of Radium Emanation. In order to find the relative ionisations produced by a given quantity of radium emanation in dry air and in natural gas of known composition, experiments were performed in which the emanation was swept out of the solution with the gas in question instead of air. In one particular case the gas from the Calgary Pipe Line was used. This contains $91 \cdot 3\%$ of methane and other hydrocarbons, $8 \cdot 5\%$ of nitrogen and $\cdot 2\%$ of oxygen

[1]Satterly. Phil. Mag., Oct., 1908.

and carbondioxide. The leak was 1·12 times that observed with air. This figure is therefore used to reduce the leak observed in this gas to give the leak that would have been produced in air by the same amount of emanation.[1] For other gases of known compositions the reducing factor can now be calculated, or, of course it can be redetermined with each sample.

Results. The following table gives the results. The radium emanation content is expressed in terms of radium, the quantity of radium quoted being that which would be in equilibrium with the radium emanation in a litre of gas.

For convenience the gases are listed geographically.

In a larger paper which will be published in due course the full particulars of these fields, including a description of the country, the geological formations, the logs of the wells, the yields of gas, the pipe lines in operation, etc., will be given.

[1]See also Metcalfe. Phil. Mag., 1909.

Ontario fields	Date of Collection 1916	Amount of Radium Emanation per litre of Gas. The unit $=10^{-12}$ curie	Percentage of Helium	Percentage of Gas, uncondensed at the temperature of liquid air; chiefly nitrogen
				Approximately
1 Oil Springs and Petrolia:				
A Bredger's Well.	May 5	22	·14	5
B Park's Well.	"	4	·14	5
2 Tilbury—				
A Glenwood, Northern Pipeline	" 3	18	·14	4
B Brown's Well.	"	14	·13	4
3 Selkirk—Rainham—Dunnville ...				
A Dunnville, Mumby's Well.	" 11	50	·24	8
B " Robin's Well.	"	34	·27	8
4 Brant—Onondaga				
A Onondaga Main at Brantford.	April 24	220	·25	7
B Van Sickle Farm Well.	"	550	·29	6
C Bow Park Well.	"	800	·33	8
D Onondaga-Middleport Main	"	131	·32	8
5 Blackheath—Seneca—				
A Blackheath Main (Nat'l Gas Co.).	April 21	220	·32	5
B A Well Supplying A.	"	212	·32	4
C "	"	247	·32	8
D "	"	346	·32	5
6 Welland—				
A Stevensville (No. 382).	April 27	150	·28	4
B Sherkston (No. 318).	" 28	172	·28	5
C Willoughby (No. 616).	" 27	28	·11	2
D Pt. Abino.	" 28	51	·26	7
E Bertie Township (No. 436).	May 29	34	·22	7
F Humberstone Township (No. 437).	" 29	67	·26	5
7 Toronto—				
A St. Augustine, Scarborough Hts	" 29	174	·009	13

Alberta Fields	Date of Collection, 1916	Amount of Radium Emanation per litre of gas The Unit $=10^{-12}$ curie	Percentage of Helium	Percentage of gas uncondensed at the temperature of liquid air; chiefly nitrogen
				Approximately
1 Medicine Hat—				
A Cousins and Sissons Well.....	Mar. 31	57	·13	3
B Electric Park................	May 2	69	·12	5
C Central Park................	"	67	·11	5
2 Bow Island—				
A Well No. 4..................	April 1	16	·29	7
B Pipe from Wells 3, 11, 14.....	" 1	93	·29	9
C Well No. 6..................	" 1	10	·34	9
D Pipe Line at Calgary.........	" 4	46	·33	8
3 Suffield-Brooks-Bassano-Calgary				
A Suffield Town well...........	April 3	54	·10	11
B Suffield, C.P.R well..........	May 6	63	·12	5
C Bassano.....................	April 3	113	·06	16
D Brooks, West Well...........	" 3	71	·09	....
E Brooks, East Well...........	" 3	67	·08	5
F Calgary, Walker Well........	" 4	16	·15	4
4 Okotoks—				
A Dingman Well	April 5	26	·01	1
6 Wetaskiwin-Viking—				
A Wetaskiwin..................	" 7	205	·05	3
B Viking......................	" 6	16	·05	3
British Columbia Wells at—				
A Pender Island...............	April 10	390	·028	99
B Port Haney..................	" 11	490	·013	..
C Pitt Meadows................	" 11	540	·003	99

Results of other work on the Radioactivity of Natural Gas. Natural gas radioactivity was first tested in Canada by McLennan in 1904. He estimated roughly the radioactivity of the gas from several gas wells in Ontario and found that the gas at Bow Park was very active. This is confirmed by the figures quoted in this paper. At that time it was impossible to estimate the amount in absolute measure. Boyle and Tory[1] mention that the gas from the well at Viking was not radioactive. A distinct radioactivity was found in two of our samples. One sample was collected at high pressure in a steel tank and its radioactivity was tested twice, on April 10 and April 20 respectively, and the law of decay was found to be that of radium emanation so that the activity could not be ascribed to contamination from the tank. Eve[2] has measured the activity of some of the natural gas escaping from mineral springs at Caledonia Springs, Ontario; Boyle and McIntosh[3] have measured some of the gases escaping from the springs at Banff in the Canadian Rockies.

Satterly in 1914, and Elworthy in 1916, made many measurements on these springs and tested many other springs in Eastern Ontario and Southern Quebec. They found values of emanation content ranging from 140 to 800×10^{-12} curie per litre in Ontario and Quebec and from 1910 to 3340×10^{-12} curie at Banff. The following table gives a few of the results obtained by these and other workers on the radioactivity of atmospheric air, air drawn from the soil, marsh gas bubbling from stagnant water, and gas bubbling from saline springs in Canada. Records of other saline springs are given in the paper by Satterly and Elworthy, referred to above.

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[1]Boyle and Tory, Trans. Roy. Soc., Canada. Dec., 1915.

[2]Eve. Trans. Roy. Soc., Canada, 1910.

[3]Boyle and McIntosh. Trans. Roy. Soc., Canada, 1913.

The Amount of Emanation in Various Natural Gases. The unit is the 10^{-12} curie. The figures indicate the number of units per litre of gas.

Atmospheric air—	
At Cambridge, England: Satterly[1]	·035-·350
" Montreal, Canada: Eve[2]	·060
" Manila, Philippines: Wright & Smith[3]	·071
Air drawn from the Soil—	
" Cambridge, England: Satterly[4]	70–230
" Dublin, Ireland: Joly & Smyth[5]	200
" Newhaven, Connecticut: Sanderson[6]	240
" Manila, Philippines: Wright & Smith[3]	305
" Toronto, Canada: Satterly[7]	760–1210
Marsh Gas—	
At Cambridge, England: Satterly[8]	150–360
" Caledonia Springs, Ontario: Satterly[10]	300
Natural Gas bubbling up with Saline Waters—	
At Caledonia Springs, Ontario: Satterly[10]	200–300
" Caledonia Springs, Ontario: Eve[9]	200–600
" Varennes Springs, Quebec: Satterly[10]	800
" Bath, Hot Springs, England: Ramsay[10]	33600
" Saratoga Springs, New York: Moore & Whittemoore[10]	50–800
" Yellowstone Park: Schlundt & Moore[10]	7300
" Banff, Alberta: Elworthy[10]	1910-3340

[1]Phil. Mag., 1908 and 1910.
[2]Phil. Mag., 1908.
[3]Phys. Rev., 1915.
[4]Proc. Camb. Phil. Soc., Vol. XVI. Parts IV and VI.
[5]Sci. Proc. Roy. Dub. Soc., Vol. XIII, 1911.
[6]Amer. Journ. Sci. 1911.
[7]This is the first publication of these results.
[8]Proc. Camb. Phil. Soc. Vol. XVI, Part IV.
[9]Trans. Roy. Soc. Can. 1910.
[10]For full list of springs and references see Bulletin No. 16, Mines Branch of Canada, "The Mineral Springs of Canada," Vol. I. The Radioactivity of some Canadian Mineral Springs.

The Analysis of Photographs of Fog Signals Obtained with the Phonodeik

BY DAYTON C. MILLER, D.SC., PROFESSOR OF PHYSICS, CASE SCHOOL OF APPLIED SCIENCE, CLEVELAND

Presented by Professor Louis V. King, D.Sc.,F.R.S.C.

(Read May Meeting, 1918)

In September, 1913, the acoustic efficiency of fog-signal machinery was investigated by Professor Louis V. King of McGill University, at Father Point, Quebec. In September, 1917, these investigations were continued under a grant from the Advisory Council for Scientific and Industrial Research, with the co-operation of the Department of Marine and Fisheries of the Canadian Government.[1] On the latter occasion, upon invitation of Professor King, the writer joined the temporary staff of five members at the Father Point Station for the purpose of making photographs of fog-signals with the "Phonodeik." This instrument is an apparatus devised by the writer in 1908 in which the wave form corresponding to a sound may be photographically recorded in a form suitable for quantitative analysis; it has been fully described in "The Science of Musical Sounds,"[2] and consists essentially of a sensitive diaphragm, with a collecting horn. The vibrations of the diaphragm are mechanically transmitted to a small mirror and recorded by a spot of light on a moving photographic film. The apparatus can be made very sensitive by tuning the resonance of the horn, but in these observations there was no such tuning, and only a moderate sensitiveness was used.

Twenty-three photographs of sound waves were obtained, which form the basis of this report; fourteen of these are of the sound from the regular fog-signal, a 4-inch Diaphone, taken at points over the water at various distances directly in front of the horn, that is, on

[1]On the Acoustic Efficiency of Fog Signal Machinery: Louis V. King, *Journal of the Franklin Institute*, March, 1917, pp. 259-286.

[2]The photographic study of sound waves: Dayton C. Miller, "The Science of Musical Sounds," New York (1916); the Phonodeik, pp. 78-88; practical analysis and synthesis, pp. 92-141, bibliography on analysis and synthesis, pp. 272-277; correcting records of sound waves, pp. 142-166; graphic presentation of analyses, pp. 166-174. Brief accounts of the phonodeik are given in *Proceedings of the British Association for the Advancement of Science*, Winnipeg (1909) p. 414, and Dundee (1912) p. 419, and of the methods of correcting analyses for resonance in *Proceedings of the Fifth International Congress of Mathematicians*, Cambridge (1912), II, pp. 245-249.

the "acoustic axis" of the horn, and three were taken out of the axis, at the wharf. Six photographs were obtained of the sounds from a 2-inch diaphone operating under various pressures of air and with and without its resonating trumpet.

Through the courtesy of Lieutenant Colonel W. P. Anderson, Chief Engineer of the Department of Marine and Fisheries, the regular diaphone fog-signal of the Father Point Station was operated as desired for experimental purposes in clear weather, and the pilot boat "*Eureka*" was made available to carry the phonodeik to the various stations at sea. The Captain and other officers of the "*Eureka*" and the engineer in charge of the fog-signal station gave all possible assistance which was most highly appreciated.

At the time of each phonodeik record at sea, Professor King made observations with the phonometer, and Lieutenant E. S. Bieler made sextant observations for distance. During the observations at sea, Mr. J. Patterson and Dr. A. Norman Shaw made complete meteorological observations at the Experimental Station. The operation of the phonodeik, the provision of special facilities, and the photographic operations required much labor in which all of the gentlemen named rendered most enthusiastic and efficient assistance, which is gratefully acknowledged. A general account of the work is given in reports by Professor King and other members of the staff,[1] the following report being confined to the analytical study of the photographic records of the fog-signals.

All of the wave forms obtained with the phonodeik have been completely analyzed and synthesized by the harmonic method, to twenty components, and for the more complex waves, to thirty components. The resonance characteristics of the recording apparatus as used in the experiments have been determined for the range of frequencies considered, from 87 to 2610, and each separate component has been corrected for these effects. The results of the analysis are: (1) the actual amplitudes, in millimeters on the photographic film, of each of the twenty (or thirty) harmonic components of the twenty-three curves: (2) the corrected values of these amplitudes, that is, the relative amplitudes of the actual sound waves in air unaffected by the resonance of the phonodeik: (3) the relative phases of these components: and (4) the relative intensities (loudness) of the components, the intensity being assumed as proportional to the square of the product of the amplitude and frequency. (5) Each analysis

[1]On the Propagation of Sound in the Free Atmosphere and the Acoustic Efficiency of Fog Signal Machinery: an account of Experiments carried out at Father Point, Quebec, September, 1913. Read before the *Roy. Soc., London*, June 14th, 1917. Publication delayed owing to war conditions.

has been verified by the synthesis of the curve from the numerical results of the analysis. The complete processes of, and apparatus for, the analysis, synthesis, and correction of such curves have been fully described and illustrated by the writer in the reference already given[2] and in the Journal of the Franklin Institute.[1 2]

The type of fog-alarm in use at the Father Point Station is that known as the Northey diaphone. As described by Professor King, the essential feature of this apparatus is a hollow plug-like piston in which are cut a number of equidistant circumferential slits lying in planes perpendicular to the axis of the piston. The piston fits closely in a stationary cylinder in which are cut corresponding slits. Under the influence of compressed air, by means of a special driving-head and a valve system somewhat resembling that of a compressed air riveter, the piston receives a rapid and regular oscillatory movement which alternately opens and closes the slits in the cylinder. This forms the "throat" of the fog-horn. Air at the pressure of about 25 pounds per square inch is supplied from compressors and storage tanks to a chamber surrounding the exterior of the cylinder. As the hollow piston oscillates the compressed air passes through the slits into the hollow throat in intermittent puffs, giving rise to intense sound waves which are propagated to the external atmosphere through a conical trumpet tuned to resonance with the pitch of the signal tone.

In the diaphone under observation the piston makes 87 to-and-fro movements, or complete cycles, per second. The character of the puffs of air emitted in the forward movement of the piston is nearly the same as that produced by the backward movement, so that practically, the period of the sound wave is that of the half cycle, and its frequency is 174. The harmonic analyses of sounds described in this paper are all based upon a fundamental frequency of 87, but nearly all of the energy of the sound is confined to the even-numbered terms of the harmonic components, so that the effective frequency of the fog-alarm is 174, and this frequency is used in interpreting the results.

Table I gives the results of the analyses of all the photographs taken on the acoustic axis of the horn, at distances ranging from 760 feet to 13,500 feet. The photographs represented by *b*, *c*, *e*, and *f* were taken at about six o'clock, p.m., on September 24, 1917, while all the others were taken between 10 o'clock a.m., and 12.30 o'clock,

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[1]The Henrici Harmonic Analyzer and Devices for Extending and Facilitating Its Use, Dayton C. Miller, *Journal of the Franklin Institute*, September, 1916, pp. 285-322.

[2]A 32-Element Harmonic Synthesizer, Dayton C. Miller, *Journal of the Franklin Institute*, January, 1916, pp. 51-81.

TABLE I

Harmonic Analyses of Phonodeik Records of Fog Signals

Corrected amplitudes, in millimeters, for harmonic components 1 to 20, $n = 87$, $\lambda = 133 \cdot 3$ m.m.

Station and Distance		Component and Frequency																			
No.	ft.	1 87	2 174	3 261	4 348	5 435	6 522	7 609	8 696	9 783	10 870	11 957	12 1044	13 1131	14 1218	15 1305	16 1392	17 1479	18 1566	19 1653	20 1740
a.......	760	6·2	14·1	7·0	17·1	2·1	27·1	1·6	17·1	6·5	20·1	3·5	6·0	1·5	2·5	0·8	1·3	0·9	1·0	0·3	0·9
b.......	860	15·2	41·8	2·1	16·1	0·8	23·2	3·4	16·8	3·6	9·9	7·1	15·2	6·3	9·5	3·1	5·2	2·6	2·7	1·4	1·6
c.......	940	4·8	108·0	2·1	7·1	0·9	6·2	1·0	3·1	3·4	3·1	1·9	2·2	0·3	0·2	0·4	0·5	0·1	0·4	0·2	0·2
d.......	1540	1·4	27·6	6·8	7·5	0·4	2·8	0·2	2·4	0·9	1·9	0·4	0·3	0·3	0·8	0·4	0·8	0·3	0·2	0·0	0·1
e.......	1560	2·9	15·8	2·9	136·9	0·6	11·7	0·2	8·4	1·6	3·5	2·5	2·2	0·5	2·2	0·5	0·9	0·1	0·5	0·1	0·4
f.......	2900	4·8	26·2	9·8	17·6	0·5	3·6	0·5	1·3	0·8	2·5	0·4	2·4	0·2	0·7	0·2	1·5	0·0	0·2	0·2	0·6
g.......	3590	1·8	11·4	2·1	8·6	0·8	7·1	1·0	2·4	1·6	4·9	1·8	5·3	0·4	0·8	0·6	1·5	0·3	0·5	0·3	0·8
h.......	4890	10·9	9·0	4·2	4·8	0·4	1·6	0·3	1·6	1·1	2·9	1·0	0·7	0·5	0·1	0·4	0·3	0·2	0·2	0·1	0·2
i.......	5640	0·4	16·8	2·0	4·8	0·4	1·7	0·2	1·6	0·9	2·3	0·9	1·2	0·6	0·5	0·1	0·3	0·0	0·3	0·1	0·1
j.......	5900	7·9	6·3	2·2	6·7	0·0	3·2	0·2	1·7	0·5	0·8	0·6	0·6	0·2	0·2	0·1	0·0	0·0	0·0	0·0	0·1
k.......	8300	2·4	10·0	0·8	9·5	0·2	1·5	0·1	0·8	0·1	0·8	0·5	1·3	0·2	0·7	0·1	0·0	0·0	0·0	0·0	0·0
l.......	9400	2·5	3·9	1·4	3·2	0·1	0·7	0·8	0·5	0·1	0·3	0·3	0·2	0·0	0·1	0·0	0·0	0·0	0·0	0·0	0·0
m......	10500	0·7	4·8	0·5	0·6	0·0	0·3	0·1	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
n......	13500	0·1	0·4	0·2	0·1	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0

p.m., on September 27, 1917. The body of the table gives the corrected actual amplitudes, in millimeters on the photographic film, of the first twenty harmonic components of the curves representing the several sounds, based on a fundamental frequency of 87. These are the observed amplitudes corrected for the resonance and free-period distortions of the recording apparatus. The values of the components from 21 to 30 have been omitted as they are so small as to have little influence on the conclusions.

The analyses as given in Table I. show that the sound of the diaphone as heard at any station is very variable, due, probably, to the incidental conditions of the generating apparatus and to the momentary atmospheric conditions. The ear fully confirms this conclusion. A comparison of the amplitudes, or even of the wave forms of sounds conveys a very inadequate idea of their effects, since the intensities, or loudnesses, vary as the squares of the amplitudes and also as the squares of the frequencies of the components. Usually it is most instructive to interpret analyses of sounds in terms of intensities. There is no available method for expressing the loudness in absolute measure, but the analyses do give the data for relative measures, and the intensities of all the components of all the records have been computed. For the present purpose an arbitrarily assumed standard is the average value of the loudness of the first three fog-horn sounds shown in the table, reduced to the distance of the middle station, 860 feet from the fog-horn, and this loudness is represented by the number 10,000. The values of the loudness of the components of this average sound are shown in line *abc* of Table II. Similar reduction and averaging has been made for curves *d* and *e*, for *f* and *g*, and for *i* and *j*; the loudnesses for the single curves *h*, *k*, *l*, *m*, and *n* have been computed. Table II. gives the final data in terms of the loudness of ten components, based on a fundamental of 174, of all observations taken on the axis of the horn at distances at sea from 860 feet to 13,500 feet. The table also gives the total loudness of each sound, the sum of all its partials, and the loudness of a sound intensity 10,000 at the distance 860 which varies simply according to the inverse-square law.

The diaphone is designed with the purpose of producing a sound having the energy concentrated in a "master-tone" of a frequency of 174, which pitch has been adopted by the British light-house authorities as having the most satisfactory carrying qualities. The variability of the sound of the diaphone is shown more strikingly by Table II. than by Table I, but it appears that the master-tone carries better than the others, as shown by the observations at distances of 10,500 feet and 13,500 feet. However, the second partial of frequency 348 seems to carry better as far as 9,400 feet, and the sixth partial of frequency 1,044 carries well as far as 8,300 feet; while these observations favor the master-tone, they are not sufficient to show that any other tone having a frequency of less than 1,000 may not be equally efficient. The energy is distributed over many partial tones in very capricious proportions, and there is yet much to be desired in the control of the output of energy of the diaphone.

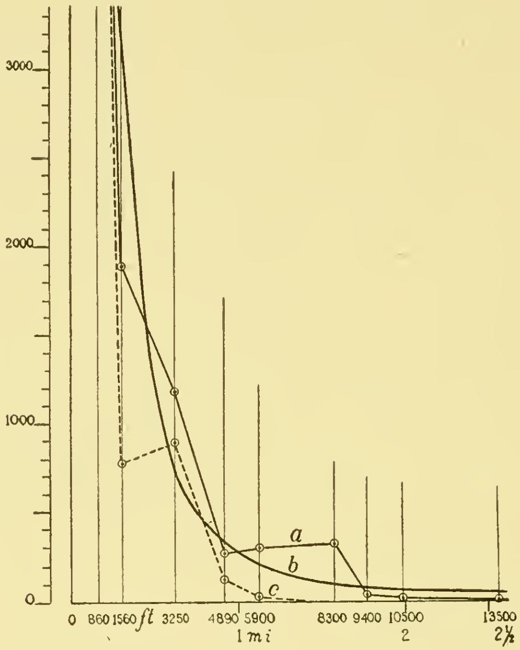

FIG. 1.—Variation of Loudness of Fog Signals with Distance

The information contained in Table II. may be represented by the diagram, Fig. 1. If a sound passing outward has the loudness 10,000 at the station distant 860 feet from the horn, and if the sound is transmitted according to the simple inverse-square law without absorption or dissipation, its curve of loudness would be the smooth, heavy line *b*. This curve crosses the ordinate for the distance of 860 feet at a point above the base line equal to three times the height of the portion of the diagram here shown. It would be interesting to compare with this curve the transmission curves for each partial tone, but since so few observations are available, the averages of the energies of the four lower partial tones, numbers 1, 2, 3 and 4, and of the four higher partials, numbers 7, 8, 9, 10, for each sound at each

TABLE 11

Relative Loudness of Harmonic Components of Fog Signals at Various Distances

Station and Distance		Component and Frequency										Totals	Inverse Square Law
No.	Ft.	1 174	2 348	3 522	4 696	5 870	6 1044	7 1218	8 1392	9 1566	10 1740		
a b c	860	2469	341	1606	1284	1640	1486	712	287	108	66	10000	10000
d e	1560	234	244	302	279	90	46	61	21	5	5	1286	3039
f g	3250	163	315	149	31	202	328	12	61	6	25	1292	700
h	4890	58	43	34	20	79	13	1	2	3	1	254	337
i j	5900	64	63	26	20	31	14	3	1	0	0	222	212
k	8300	47	127	9	5	8	27	0	0	0	0	223	107
l	9400	7	19	2	2	1	1	0	0	0	0	32	83
m	10500	10	1	0	0	0	0	0	0	0	0	11	67
n	13500	0·06	0·01	0·03	0·01	0·01	0	0	0	0	0	0·12	40

station, have been plotted in curves *a* and *c*, respectively. The ordinates of these curves have been increased proportionally so that both curves pass through the point 10,000 on the ordinate for 860 feet.

These curves indicate that the energy of the partials of low frequency from 174 to 696 is absorbed so that it has lost more than half of its value at a distance of two miles. The energy of the partials of frequency from 1218 to 1740 is absorbed at a much greater rate, and even if these partials contained as much initial energy as the lower ones, yet the sound would be completely absorbed at a distance of less than two miles. It will be worth while to compute the absorption coefficient when observations of greater weight are available.

Three photographs of the sound from the diaphone were taken from the deck of the boat while it was tied to the wharf, at a distance of 960 feet from the horn, and on an azimuth about 30° to the west of the acoustic axis of the trumpet. This station is on a line at right angles to the axis through the average station *a b c* of Table II. The average energy received at the wharf is represented by 1,378, which is less than 14 per cent of that received on the axis directly opposite where the energy is represented by 10,000. If the energy on the axis at a distance of 860 feet is reduced to the distance 960 feet, it is represented by 8,025. The energy at the wharf at the same distance from the horn but on an azimuth 30° to the west is 17 per cent of this. Or, in other words, moving 30° in the arc of a circle from the axis of the horn, reduces the energy received to one sixth of that received on the axis.

On the axis of the horn, the first five partial tones contain 74 per cent of the energy and the partials from six to ten contain 26 per cent. At the wharf, the partials from six to ten contain only 3 per cent of the total energy. This shows, what would be expected, that the trumpet is more effective in directing the shorter wave-lengths, or that the shorter wave-lengths do not deviate as far into the "acoustic shadow" as do the longer waves; it is an illustration of acoustic diffraction.

A series of photographs were taken of the sound from the 2-inch experimental diaphone, when sounding under air pressures of 18·7 lbs., 23·5 lbs., and 28·8 lbs., per square inch, and with and without the resonating trumpet. The phonodeik was placed at a distance of about 100 feet from the diaphone, on a line at right angles to the axis, through the end of the trumpet. This location of the observing station was an unfavorable one, and though the curves have been fully analyzed, the details need not be given. Two interesting facts are indicated.

When the trumpet is attached the sound received at the lateral station is reduced to 51 per cent of that received when the trumpet is removed, notwithstanding that the energy output of the diaphone is probably increased by the trumpet. This conclusion is in general agreement with that obtained from the observations at the wharf.

The acoustic energy emitted by the diaphone increases with the operating pressure of the air. As measured at this station, the trumpet being in place, if the total energy of all frequencies is represented by 100 when the air pressure operating the diaphone is 18·7 lbs. per square inch, then when the pressure is 23·5 lbs. per square inch the energy is 230, and for a pressure of 28·8 lbs. per square inch it is 320. If account is taken of the energy contained in the first five partial tones only, of frequencies from 174 to 870, the partials which carry the farthest, then the energy increases with the pressures mentioned in the ratios of 100:300:500. The increasing air pressure increases the energy of the lower partials more rapidly than of the higher ones.

Concerning the Integrals of Lelieuvre.

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(Read May Meeting, 1918).

INTRODUCTION.

It is proposed in this paper to discuss the form assumed by the Integrals of Lelieuvre when they fulfil the condition that one family of the parametric curves consists of straight lines. In their final form the expressions obtained are not wholly free from quadratures, but they are entirely general and sufficiently simple to be readily applicable and serviceable in the study of scrolls. The procedure employed in this discussion is suggested by a comparison of the equations of Lelieuvre with those of Gauss for the representation of the coordinates of a point on a surface in terms of two independent parameters p and q. The notations and formulae of the general theory of surfaces which we require in this work are drawn largely from Forsyth's Differential Geometry; and this treatise will be cited hereafter, for brevity, as (G). In the concluding section of this paper, we shall apply the formulae developed in the earlier sections to a study of Scrolls whose asymptotic tangents are contained in linear complexes.

The Gauss Equations.

It will be convenient to have before us a number of expressions from the general theory of surfaces, and these we shall now write down.

The fundamental magnitudes of the first and second orders are (E, F, G) and (L, M, N) respectively. The symbols $(X, Y, Z; \Gamma, \Gamma', \Gamma''; \Delta, \Delta', \Delta''; V; T; K)$ have the following definitions:

Let m, m', m'', n, n', n'' be defined by the equations

$$m=\Sigma x_1 x_{11},\quad m'=\Sigma x_1 x_{12},\quad m''=\Sigma x_1 x_{22},$$
$$n=\Sigma x_2 x_{11},\quad n'=\Sigma x_2 x_{12},\quad n''=\Sigma x_2 x_{22},$$

where the summation extends over the three axes and the subscripts denote differentiation; thus

$$x_1=\frac{\partial x}{\partial p},\quad x_2=\frac{\partial x}{\partial q},\quad x_{12}=\frac{\partial^2 x}{\partial p\partial q},\ \text{etc.}$$

The quantities given above are then defined by the equations

$$V^2 = EG - F^2; \quad X,\ Y,\ Z = \frac{1}{V} \left\| \begin{matrix} x_1 & y_1 & z_1 \\ x_2 & y_2 & z_2 \end{matrix} \right\|,$$

$$T^2 = LN - M^2, \quad K = \left(\frac{T}{V}\right)^2,$$

$$\begin{aligned} V^2\Gamma &= m\,G - n\,F, & V^2\Delta &= n\,E - m\,F, \\ V^2\Gamma' &= m'G - n'F, & V^2\Delta' &= n'E - m'F, \\ V^2\Gamma'' &= m''G - n''F, & V^2\Delta'' &= n''E - m''F. \end{aligned}$$

The Gauss differential equations of a surface are

(1)
$$\begin{aligned} x_{11} &= LX + x_1\Gamma + x_2\Delta, \\ y_{12} &= MY + y_1\Gamma' + y_2\Delta', \\ z_{22} &= NZ + z_1\Gamma'' + z_2\Delta'', \end{aligned}$$

with similar equations arising from these by permuting x, y, z.

The integrability conditions of (1) are:

The Gauss equation

$$T^2 = -\tfrac{1}{2}(E_{22} - 2F_{12} + G_{11}) + (E,F,G)(\Gamma',\Delta')^2 - (E,F,G)(\Gamma,\Delta)(\Gamma'',\Delta''),$$

(2) and the Mainardi-Codazzi equations

$$\frac{\partial}{\partial q}\left(\frac{L}{V}\right) - \frac{\partial}{\partial p}\left(\frac{M}{V}\right) = \frac{1}{V}(-L\Delta'' + 2M\Delta' - N\Delta),$$

$$\frac{\partial}{\partial p}\left(\frac{N}{V}\right) - \frac{\partial}{\partial q}\left(\frac{M}{V}\right) = \frac{1}{V}(-L\Gamma'' + 2M\Gamma' - N\Gamma).$$

If the surface defined by the above equations be non-developable, then a curve $C(p, q)$ traced upon the surface will be a straight line, provided that this curve is both an asymptotic line and a geodesic line on the surface (G. p. 202). These conditions are expressed by the equations:

(3)
$$\begin{aligned} &\text{(i)} & A &\equiv Lp'^2 + 2M\Gamma'p'q' + Nq'^2 = 0, \\ &\text{(ii)} & D_1 &\equiv \Gamma p'^2 + 2\Gamma'p'q' + \Gamma''q'^2 + p'' = 0, \\ &\text{(iii)} & D_2 &\equiv \Delta p'^2 + 2\Delta'p'q' + \Delta''q'^2 + p'' = 0, \end{aligned}$$

where
$$p' = \frac{dp}{ds}, \quad q' = \frac{dq}{ds}, \text{ etc.}$$

If now the asymptotic curves be chosen as parametric curves, and if also the curves $p = \text{const.}$ be straight lines, we have the relations

$$L = \Sigma x_{11}X = 0, \quad N = \Sigma x_{22}X = 0,$$

and from $(3-(\text{ii}))$.

(4)
$$\Gamma'' = G\frac{\partial F}{\partial q} - \tfrac{1}{2}F\frac{\partial G}{\partial q} - \tfrac{1}{2}G\frac{\partial G}{\partial p} = 0.$$

These conditions lead to great simplification in the equations with which we have to deal (G. p. 73). The quantities $(\Gamma, \Gamma', \Gamma''; \ \Delta, \Delta', \Delta'')$ are now expressible in the following convenient forms:

$$(5)\qquad 2\Gamma=\frac{M_1}{M}+\frac{V_1}{V}\quad,\quad 2\Delta''=\frac{M_2}{M}+\frac{V_2}{V},$$

$$2\Gamma'=-\frac{M_2}{M}+\frac{V_2}{V}\quad,\quad 2\Delta'=-\frac{M_1}{M}+\frac{V_1}{V},$$

$$\Gamma''=\frac{G(F_2-\frac{1}{2}G_1)-\frac{1}{2}FG_2}{V^2}\ ,\quad \Delta=\frac{E(F_1-\frac{1}{2}E_2)-\frac{1}{2}FE_1}{V^2}.$$

In the case of a real surface, V does not vanish for real and independent parameters p, q. Also for a non-developable surface having its asymptotic curves parametric, M is different from zero. The expression

$$MV=\left(x_1\,y_2\,z_{12}\right)$$

is therefore different from zero and may be used as a divisor without further discussion.

The Integrals of Lelieuvre.

It is known that a non-developable surface referred to its asymptotic curves as parametric curves can be represented by the Integrals of Lelieuvre (Eisenhardt—Differential Geometry, p. 194)

$$(6)\qquad x=\int\left(\theta_2\frac{\partial\theta_3}{\partial p}-\theta_3\frac{\partial\theta_2}{\partial p}\right)dp-\left(\theta_2\frac{\partial\theta_3}{\partial q}-\theta_3\frac{\partial\theta_2}{\partial q}\right)dq,$$

$$y=\int\left(\theta_3\frac{\partial\theta_1}{\partial p}-\theta_1\frac{\partial\theta_3}{\partial p}\right)dp-\left(\theta_3\frac{\partial\theta_1}{\partial q}-\theta_1\frac{\partial\theta_3}{\partial q}\right)dq,$$

$$z=\int\left(\theta_1\frac{\partial\theta_2}{\partial p}-\theta_2\frac{\partial\theta_1}{\partial p}\right)dp-\left(\theta_1\frac{\partial\theta_2}{\partial q}-\theta_2\frac{\partial\theta_1}{\partial q}\right)dq,$$

where θ_1, θ_2, θ_3 are three independent particular solutions of the Laplace equation with equal invariants:

$$(\text{A})\qquad \frac{\partial^2\theta}{\partial p\partial q}=\lambda\,(p,q)\,\theta.$$

Throughout the subsequent discussion, in writing down determinants whose elements are built up from θ_1, θ_2, θ_3 and their derivatives, we shall use the familiar notation employed to express MV in terms of x, y, z above. Thus from (6) we find at once

$$(7)\qquad x_1=\left(\theta_2\frac{\partial\theta_3}{\partial p}\right),\quad x_2=-\left(\theta_2\frac{\partial\theta_3}{\partial q}\right),$$

$$x_{11}=\left(\theta_2\frac{\partial^2\theta_3}{\partial p^2}\right),\quad x_{22}=-\left(\theta_2\frac{\partial^2\theta_3}{\partial q^2}\right),$$

$$x_{12}=\left(\frac{\partial\theta_2}{\partial q}\,\frac{\partial\theta_3}{\partial p}\right)+\left(\theta_2\frac{\partial^2\theta_3}{\partial p\partial q}\right)=\left(\frac{\partial\theta_2}{\partial q}\,\frac{\partial\theta_3}{\partial p}\right),$$

by virtue of (A), and similar expressions for y, z.

The fundamental magnitudes of the first and second orders have, therefore, the following values:

$$(8)\qquad E=\Sigma\left(\theta_1\frac{\partial\theta_2}{\partial p}\right)^2,\quad F=-\Sigma\left(\theta_1\frac{\partial\theta_2}{\partial p}\right)\left(\theta_1\frac{\partial\theta_2}{\partial q}\right),\quad G=\Sigma\left(\theta_1\frac{\partial\theta_2}{\partial q}\right)^2,$$

$$L=0\qquad,\quad MV=\left(\theta_1\frac{\partial\theta_2}{\partial p}\frac{\partial\theta_3}{\partial q}\right)^2,\quad N=0.$$

From what has been said above and the form of MV, it is clear that $\left(\theta_1\frac{\partial\theta_2}{\partial p}\frac{\partial\theta_3}{\partial q}\right)$ can not vanish, except for certain critical values of p and q.

By making use of a known theorem in the theory of determinants, viz.,

$$\begin{vmatrix} A^2+B^2+C^2 & AA'+BB'+CC' \\ AA'+BB'+CC' & A'^2+B'^2+C'^2 \end{vmatrix}=\Sigma\begin{vmatrix} A & B \\ A' & B' \end{vmatrix}^2,$$

we find

$$V^2=EG-F^2=\begin{vmatrix} \Sigma\left(\theta_1\frac{\partial\theta_2}{\partial p}\right)^2 & -\Sigma\left(\theta_1\frac{\partial\theta_2}{\partial p}\right)\left(\theta_1\frac{\partial\theta_2}{\partial q}\right) \\ -\Sigma\left(\theta_1\frac{\partial\theta_2}{\partial p}\right)\left(\theta_1\frac{\partial\theta_2}{\partial q}\right) & \Sigma\left(\theta_1\frac{\partial\theta_2}{\partial q}\right)^2 \end{vmatrix}$$

$$=\Sigma\begin{vmatrix} \left(\theta_1\frac{\partial\theta_2}{\partial p}\right) & \left(\theta_2\frac{\partial\theta_3}{\partial p}\right) \\ \left(\theta_1\frac{\partial\theta_2}{\partial q}\right) & \left(\theta_2\frac{\partial\theta_3}{\partial q}\right) \end{vmatrix}^2.$$

To reduce this expression we make use of a theorem on minors, viz.:

$$\text{If } D=\begin{vmatrix} a & b & c \\ a' & b' & c' \\ a'' & b'' & c'' \end{vmatrix},\ \text{then } \Sigma\begin{vmatrix} B' & C' \\ B'' & C'' \end{vmatrix}=(a+b+c)D,$$

where B', B'', etc., are the minors of b', b'', etc., in D. If we make use of this result, the above expression for V^2 becomes

$$(\theta_1^2+\theta_2^2+\theta_3^2)\left(\theta_1\frac{\partial\theta_2}{\partial p}\frac{\partial\theta_3}{\partial q}\right)^2.$$

Gauss's measure of curvature K is given by the formula

$$K=\left(\frac{T}{V}\right)^2=\frac{LN-M^2}{V^2}=-\frac{1}{(\theta_1^2+\theta_2^2+\theta_3^2)^2}.$$

The expressions for Γ, Γ', Γ'', Δ, Δ', Δ'' can now be found from (5); they can also be calculated quite readily from their definitions by making use of the above theorems in determinants. The values of these symbols are found to be:

(9)
$$\Gamma = \frac{\left(\theta_1 \dfrac{\partial^2\theta_2}{\partial q^2} \dfrac{\partial\theta_3}{\partial q}\right)}{\sqrt{MV}}, \qquad \Delta = \frac{\left(\theta_1 \dfrac{\partial^2\theta_2}{\partial p^2} \dfrac{\partial\theta_3}{\partial p}\right)}{\sqrt{MV}},$$
$$\Gamma' = \frac{\partial}{\partial q} \log \sqrt{\theta_1^2+\theta_2^2+\theta_3^2}, \quad \Delta' = \frac{\partial}{\partial p} \log \sqrt{\theta_1^2+\theta_2^2+\theta_3^2},$$
$$\Gamma'' = \frac{\left(\theta_1 \dfrac{\partial\theta_2}{\partial q} \dfrac{\partial^2\theta_3}{\partial q_2}\right)}{\sqrt{MV}}, \qquad \Delta'' = \frac{\left(\theta_1 \dfrac{\partial\theta_2}{\partial p} \dfrac{\partial^2\theta_3}{\partial p^2}\right)}{\sqrt{MV}}.$$

We have seen that the vanishing of Γ'' is the condition that the family $p=\text{const.}$ be straight lines. It therefore follows that $\left(\theta_1 \dfrac{\partial\theta_2}{\partial q} \dfrac{\partial^2\theta_3}{\partial q^2}\right)$ must vanish identically.

We shall first investigate equation (A) of range 1. In this case the invariant $\lambda(p,q)$ vanishes; the integrals of (A) are then of the form

(10) $$\theta_r = \mu_r(p) + \nu_r(q) \ldots\ldots, \quad r = 1, 2, 3.$$

The vanishing of Γ'' implies that μ_r and ν_r satisfy the condition

(11) $$\left(\mu_1 + \nu_1, \frac{d\nu_2}{dq} \frac{d^2\nu_3}{dq^2}\right) = 0.$$

From (11) we conclude that

(12)
$$\left(\frac{d\nu_2}{dq} \frac{d^2\nu_3}{dq^2}\right)\mu_1 + \left(\frac{d\nu_3}{dq} \frac{d^2\nu_1}{dq^2}\right)\mu_2 + \left(\frac{d\nu_1}{dq} \frac{d^2\nu_2}{dq^2}\right)\mu_3 + \left(\nu_1 \frac{d\nu_2}{dq} \frac{d^2\nu_3}{dq^2}\right) = 0.$$

The point (μ_1, μ_2, μ_3) must therefore either describe a plane curve whose position in space is determined by the functions (V_1, V_2, V_3), and is naturally independent of the value of q, or else the coefficients of (12) must vanish separately. In the latter case it is evident that the locus of (ν_1, ν_2, ν_3) is a straight line. In the former case let us assume the plane to be

$$lx + my + nz + p = 0,$$

where l, m, n, p are constants.

Then
$$(\nu_2'\nu_3'') = l\phi,$$
$$(\nu_3'\nu_1'') = m\phi,$$
$$(\nu_1'\nu_2'') = n\phi,$$
$$(\nu_1\nu_2'\nu_3'') = p\phi,$$

and, therefore,

$$l\nu_1 + m\nu_2 + n\nu_3 = p.$$

Combining this result with

$$l\mu_1 + m\mu_2 + n\mu_3 + p = 0,$$

we have

$$l\theta_1 + m\theta_2 + n\theta_3 = 0.$$

But it was assumed at the outset that θ_1, θ_2, θ_3 were independent solutions of (A). The only tenable assumption is then that the locus of (ν_1, ν_2, ν_3) is a straight line. This assumption is also sufficient to insure the vanishing of Γ''.

We may assume ν_1, ν_2, ν_3 to have the following values:

$$\nu_1 = a_1\rho(q)+b_1,\ \ \nu_2 = a_2\rho(q)+b_2,\ \ \nu_3 = a_3\rho(q)+b_3,$$

where a_i, b_i are constants and $\rho(q)$ is an arbitrary function. The equations of the surface can now be written

(13)
$$x = \Big[(a_2\mu_3)+(b_2a_3)\Big]\rho+(b_2\mu_3)+\int(\mu_2 d\mu_3),$$
$$y = \Big[(a_3\mu_1)+(b_3a_1)\Big]\rho+(b_3\mu_1)+\int(\mu_3 d\mu_1),$$
$$z = \Big[(a_1\mu_2)+(b_1a_2)\Big]\rho+(b_1\mu_2)+\int(\mu_1 d\mu_2).$$

Let us now proceed to the general case when no assumption is made as to the range of the solutions of (A). As before the condition to be satisfied is the vanishing of Γ'', and this condition implies the equation

$$\left(\theta_1\frac{\partial\theta_2}{\partial q}\frac{\partial^2\theta_3}{\partial q^2}\right)=0.$$

It therefore follows that relations of the form

(14)
$$a\theta_1 + b\theta_2 + \theta_3 = 0,$$
$$a\frac{\partial\theta_1}{\partial q}+b\frac{\partial\theta_2}{\partial q}+\frac{\partial\theta_3}{\partial q}=0,$$
$$a\frac{\partial^2\theta_1}{\partial q^2}+b\frac{\partial^2\theta_2}{\partial q^2}+\frac{\partial^2\theta_3}{\partial q^2}=0$$

must exist, where, as yet, a and b are not known to be other than functions of p and q.

From (A) we find

(15)
$$\frac{\partial^3\theta}{\partial p\partial q^2}=\frac{\partial\lambda}{\partial q}\theta+\lambda\frac{\partial\theta}{\partial q}.$$

From (14), by differentiating with respect to p and taking cognizance of (14) and (A), we find

(16)
$$\frac{\partial a}{\partial p}\cdot\frac{\partial\theta_1}{\partial q}+\frac{\partial b}{\partial p}\cdot\frac{\partial\theta_2}{\partial q}=0.$$

Again from the same equations and (15), we infer

(17)
$$a\left(\frac{\partial\lambda}{\partial q}\theta_1+\lambda\frac{\partial\theta_1}{\partial q}\right)+b\left(\frac{\partial\lambda}{\partial q}\theta_2+\lambda\frac{\partial\theta_2}{\partial q}\right)+\left(\frac{\partial\lambda}{\partial q}\theta_3+\lambda\frac{\partial\theta_3}{\partial q}\right)$$
$$+\left(\frac{\partial a}{\partial p}\frac{\partial^2\theta_1}{\partial q^2}+\frac{\partial b}{\partial p}\frac{\partial^2\theta_2}{\partial q^2}\right)=0.$$

It therefore follows that

(18) $$\frac{\partial a}{\partial p} \cdot \frac{\partial^2 \theta_1}{\partial q^2} + \frac{\partial b}{\partial p} \cdot \frac{\partial^2 \theta_2}{\partial q^2} = 0.$$

Now a and b can not be constants, since θ_1, θ_2, θ_3 are independent; they can not be functions of q alone, since Δ does not vanish. If Δ and Γ'' both vanished identically, the surface would be a ruled quadric.

On eliminating $\frac{\partial a}{\partial p}$ and $\frac{\partial b}{\partial p}$ between (16) and (18), we find

(19) $$\frac{\partial}{\partial q}\left(\log \frac{\left(\frac{\partial \theta_1}{dq}\right)}{\left(\frac{\partial \theta_2}{\partial q}\right)}\right) = 0.$$

The integration of this equation leads to the relation

(20) $$\alpha(p)\theta_1 + \beta(p)\theta_2 = 1,$$

and this is the restriction imposed on (A) by the conditions of the problem.

If we now differentiate (20) with respect to q and the resulting equation with respect to p, cognizance being taken of (A), we find the relation

$$\frac{1}{\lambda} \cdot \frac{d\sigma(p)}{dp} \cdot \frac{\partial \theta_2}{\partial q} = \theta_1 + \sigma(p)\, \theta_2;$$

and therefore

(21) $$\frac{d\sigma}{dp} \cdot \frac{\partial}{\partial q}\left(\frac{1}{\lambda} \frac{\partial \theta_2}{\partial q}\right) = 0,$$

since

$$\frac{\partial \theta_1}{\partial q} = -\sigma(p)\, \frac{\partial \theta_2}{\partial q}.$$

Thus

(22) $$\frac{1}{\lambda}\, \frac{\partial^2 \theta_2}{\partial q^2} + \frac{\partial \theta_2}{\partial q}\, \frac{d}{\partial q}\left(\frac{1}{\lambda}\right) = 0,$$

since $\sigma(p)$ can not be a constant.

Now derive (22) with respect to p, then (on taking account of (15))

$$\frac{\partial^2 \theta_2}{\partial q^2} \cdot \frac{\partial}{\partial p}\left(\frac{1}{\lambda}\right) + \frac{1}{\lambda}\, \frac{\partial}{\partial q}\, (\lambda\theta_2) + \lambda\theta_2\, \frac{\partial}{\partial q}\left(\frac{1}{\lambda}\right) + \frac{\partial \theta_2}{\partial q} \cdot \frac{\partial^2}{\partial p \partial q}\left(\frac{1}{\lambda}\right) = 0,$$

or what is the same thing

(23) $$\frac{\partial^2 \theta_2}{\partial q^2}\, \frac{\partial}{\partial p}\left(\frac{1}{\lambda}\right) + \frac{\partial \theta_2}{\partial q}\left(1 + \frac{\partial^2 \left(\frac{1}{\lambda}\right)}{\partial p \partial q}\right) = 0.$$

If we eliminate θ_2 between (22) and (23), there results the equation

$$\frac{\frac{\partial}{\partial p}\left(\frac{1}{\lambda}\right)}{\left(\frac{1}{\lambda}\right)}=\frac{1+\frac{\partial^2}{\partial p\partial q}\left(\frac{1}{\lambda}\right)}{\frac{\partial}{\partial q}\left(\frac{1}{\lambda}\right)};$$

which, on simplification, reduces to

(24) $$\frac{\partial^2 \log\lambda}{\partial p\partial q}-\lambda=0.$$

This equation however expresses the fact that one application of the Laplace σ—transformation to (A) leads to an equation with vanishing invariant. (Forsyth, Theory of Differential Equations, Part IV, Vol. VI, p. 133). The integration of (A) can therefore be effected by the method of Laplace; and thence the equations sought can be found from (6).

Equation (24) is known as Liouville's equation, and its general integral is (Forsyth, Differential Equations, Vol. VI, p. 143).

$$\lambda=2\frac{\alpha'(p)\beta'(q)}{[\alpha(p)+\beta(q)]^2}.$$

Equation (A) now becomes

(A′) $$\frac{\partial^2\theta}{\partial p\partial q}=2\frac{\alpha'\beta'}{(\alpha+\beta)^2}\theta.$$

If we effect the transformation

$$\bar{p}=\alpha(p),\ \bar{q}=\beta(q)$$

on this equation and drop the bars in the resulting equation, we obtain

(B) $$\frac{\partial^2\theta}{\partial p\partial q}=\frac{2}{(p+q)^2}\theta.$$

To (B) apply the Laplace σ—transformation

$$\bar{\theta}=\frac{\partial\theta}{\partial p};$$

then we have

$$\frac{\partial\bar{\theta}}{\partial q}=\frac{2}{(p+q)^2}\theta,$$

and therefore

$$\frac{\partial}{\partial p}\left(\frac{(p+q)^2}{2}\frac{\partial\bar{\theta}}{\partial q}\right)=\bar{\theta}.$$

On integrating this equation with respect to q, we obtain

$$\frac{\partial\bar{\theta}}{\partial p}+\frac{2}{p+q}\bar{\theta}=\eta(p).$$

This is a linear equation of the first order; its integral is

$$\bar{\theta}=\frac{1}{(p+q)^2}\left[\int(p+q)^2\eta(p)dp+2\zeta_3(q)\right]$$
$$=\frac{2(\eta_3+\zeta_3)}{(p+q)^2}-\frac{2}{(p+q)}\eta_2+\eta_1,$$

where

$$\eta(p)=\eta_1'(p),\ \eta_1(p)=\eta_2'(p),\ \eta_2(p)=\eta_3'(p).$$

But

$$\frac{\partial\bar{\theta}}{\partial q}=\frac{2}{(p+q)^2}\theta,$$

and therefore

$$\theta=\eta_3'+\zeta_3'-\frac{2}{(p+q)}(\eta_3+\zeta_3),$$

or (on changing the notation slightly)

(25) $$\theta=\eta'+\zeta'-\frac{2}{p+q}(\eta+\zeta).$$

The function $\zeta(q)$ is not however entirely arbitrary. We have seen by (21) that θ must satisfy the equation

$$\frac{\partial}{\partial q}\left(\frac{1}{\lambda}\frac{\partial\theta}{\partial q}\right)=0,$$

which implies the following condition on $\zeta(q)$:

$$\frac{\partial}{\partial q}\left\{\frac{(p+q)^2}{2}\left(\zeta''-\frac{2}{p+q}\zeta'+\frac{2}{(p+q)^2}\overline{\eta+\zeta}\right)\right\}=0.$$

From this we conclude that

$$\zeta'''=0,$$

and therefore

$$\zeta=aq^2+bq+c.$$

The function θ now takes the form

$$\theta=\eta'+2(ap-b)-\frac{2}{p+q}\left\{\eta+(ap^2-2bp)+c\right\}$$
$$=\frac{d\sigma(p)}{dp}-\frac{2}{p+q}\sigma(p),$$

where

$$\sigma(p)=\eta(p)+p(ap-2b)+c.$$

We can verify at once that

(26) $$\theta=\sigma'-\frac{2}{p+q}\sigma$$

satisfies the condition

$$\Gamma''=0.$$

Finally, if we insert the value of θ as given by (26) in the equations (6), we obtain the following formulae which (with (13)) are those we had in view:

(27)
$$x = -\frac{2}{p+q}(\sigma_2\sigma_3') + \int(\sigma_2'\sigma_3'')\,dp,$$
$$y = -\frac{2}{p+q}(\sigma_3\sigma_1') + \int(\sigma_3'\sigma_1'')\,dp,$$
$$z = -\frac{2}{p+q}(\sigma_1\sigma_2') + \int(\sigma_1'\sigma_2'')\,dp.$$

Applications.

In this section of the paper it is proposed to discuss the restrictions to be imposed upon the otherwise arbitrary functions appearing in the equations of (S) in order that the twisted asymptotic curves on (S) may belong to linear complexes.

We shall first consider surfaces of range 1, *i.e.*, those corresponding to

$$\lambda = 0.$$

Let the one parameter family of linear complexes which contain the curves q be defined by the equation

(28)
$$\Sigma l(y\delta z - z\delta y) + \Sigma \alpha\delta x = 0,$$

where Σ denotes the cyclic sum over the three axes, and α, β, γ, l, m, n are functions of q alone. Then on identifying the tangent plane to (S) at the point (x, y, z) with the polar plane of this point in the complex (28), we are led to the following relations:

(29)
$$\frac{\alpha + mz - ny}{\theta_1} = \frac{\beta + \eta x - lz}{\theta_2} = \frac{\gamma + ly - mx}{\theta_3} = \tau.$$

If we differentiate these relations with respect to p and take account of (10), we find

(30)
$$mz_1 - ny_1 = \tau'\theta_1 + \tau\mu_1',$$
$$nx_1 - lz_1 = \tau'\theta_2 + \tau\mu_2',$$
$$ly_1 - mx_1 = \tau'\theta_3 + \tau\mu_3'.$$

The functions x_1, y_1, z_1 can be obtained at once from (13); on inserting them in (30), we obtain

(31)
$$\tau'\theta_1 + \tau\mu_1' = \theta_1(m\mu_2' + n\mu_3') - (m\theta_2 + n\theta_3)\mu_1',$$
$$\tau'\theta_2 + \tau\mu_2' = \theta_2(n\mu_3' + l\mu_1') - (n\theta_3 + l\theta_1)\mu_2',$$
$$\tau'\theta_3 + \tau\mu_3' = \theta_3(l\mu_1' + m\mu_2') - (l\theta_1 + m\theta_2)\mu_3'.$$

These equations are not all independent; any one is a consequence of the remaining two. If we eliminate τ between the first two, we find

(32)
$$(\tau' - l\mu_1' - m\mu_2' - n\mu_3')\,(\theta_1\mu_2') = 0.$$

If the factor $(\theta_1\mu_2')$ were to vanish, we should find

$$\frac{(\mu_1'\mu_2)+(\mu_1'b_2)}{(a_1\mu_2')}=\rho(q),$$

which is impossible. We must therefore have

(33) $$\tau'-l\mu_1'-m\mu_2'-n\mu_3'=0.$$

From this and (31) it is necessary that

(34) $$\mu_1'(\tau+l\theta_1+m\theta_2+n\theta_3)=0.$$

If μ_1' vanishes, the curve (μ_1, μ_2, μ_3) is situated in the plane $\mu=$const. If the expression in brackets vanishes, it follows from (33) and (34) that

(35) $$l\mu_1+m\mu_2+n\mu_3=H(q);$$

and therefore (μ_1, μ_2, μ_3) describes a curve in the plane (35) which must be independent of the particular value assigned to q. Let us consider, as a particular example, the case in which the (ν) line is parallel to the (μ) plane, and let these be defined as follows:

(36) $$\mu_1=p,\quad \mu_2=\mu',\quad \mu_3=c,$$
$$\nu_1=0,\quad \nu_2=q,\quad \nu_3=0.$$

The equations of (S) become

(37) $$x=c(q-\mu'),$$
$$y=cp,$$
$$z=p\mu'-2\mu-pq.$$

The equation of the complex (28) becomes

(38) $$(x\delta y-y\delta x)+2c(p\delta x+\mu'\delta y)+c^2\delta z=0.$$

Hence

$$\frac{\partial z}{\partial x}=\frac{y-2cp}{c^2},\quad \frac{\partial z}{\partial y}=-\frac{(x+2c\mu')}{c^2},$$

and therefore

$$\left(y-c^2\frac{\partial z}{\partial x}\right)=f\left(x+c^2\frac{\partial z}{\partial y}\right),$$

where f is an arbitrary function.

The surface (S) defined by (37) is therefore an integral surface of the familiar equation

(39) $$\left(\frac{\partial^2 z}{\partial x\partial y}\right)^2-\left(\frac{\partial^2 z}{\partial x^2}\right)\left(\frac{\partial^2 z}{\partial y^2}\right)=\frac{1}{c^4}.$$

Among the integrals of this equation are the Cayley Cubic Scrolls (See paper by the Author, Trans. Royal Society of Canada, Series III, Vol. X, p. 130). If we compare the results just referred to with equation (38) of this paper, we shall see that the axes of the complexes (38) are parallel and in the xz plane; they are therefore perpendicular to the (ν) line and the plane of the (μ) curve.

Let us now consider surfaces (S) of range 2 defined by equations (27). The procedure to be followed is the same as that used above. The conditions to be satisfied in order that the curves q may belong to the complexes (28) are:

$$\begin{aligned} \alpha+mz-ny&=\tau\theta_1, \\ \beta+nx-lz&=\tau\theta_2, \\ \gamma+ly-mx&=\tau\theta_3. \end{aligned} \tag{40}$$

From these, on deriving with respect to p and inserting the values of x_1, y_1, z_1 as found from (6), we obtain

$$\begin{aligned} \theta_1(m\theta_2'+n\theta_3')-\theta_1'(m\theta_2+n\theta_3)&=\tau\theta_1'+\tau'\theta_1, \\ \theta_2(n\theta_3'+l\theta_1')-\theta_2'(n\theta_3+l\theta_1)&=\tau\theta_2'+\tau'\theta_2, \\ \theta_3(l\theta_1'+m\theta_2')-\theta_3'(l\theta_1+m\theta_2)&=\tau\theta_3'+\tau'\theta_3. \end{aligned} \tag{41}$$

These equations, as before, are not independent; they impose only two conditions on the functions involved. If we eliminate τ between the first two, we find

$$(\theta_1\theta_2')\ (l\theta_1'+m\theta_2'+n\theta_3'-\tau')=0. \tag{42}$$

The factor $(\theta_1\theta_2')$ can not vanish, since $\lambda(p, q)$ is unequal to zero. It therefore follows that

$$l\theta_1'+m\theta_2'+n\theta_3'-\tau'=0. \tag{43}$$

Employing this value of τ' in (41), we infer that

$$l\theta_1+m\theta_2+n\theta_3+\tau=0. \tag{44}$$

Hence, from (43) and (44)

$$\tau=\tau(q),$$

and

$$a_1\theta_1+a_2\theta_2+a_3\theta_3=1, \tag{45}$$

where a_1, a_2, a_3 are functions of q alone.

If we insert the value θ given by (26) in (45), there results the equation

$$\frac{d}{dp}(a_1\sigma_1+a_2\sigma_2+a_3\sigma_3)-\frac{2}{p+q}(a_1\sigma_1+a_2\sigma_2+a_3\sigma_3)=1. \tag{46}$$

We may regard this as a linear differential equation in p; its integral is

$$a_1\sigma_1+a_2\sigma_2+a_3\sigma_3=(p+q)^2\left(f(q)-\frac{1}{(p+q)}\right). \tag{47}$$

Thus $(a_1\sigma_1+a_2\sigma_2+a_3\sigma_3)$ is a quadratic function of p.

From (46) and (47) we find, by successive differentiation with respect to p,

$$\begin{aligned} a_1\sigma_1+a_2\sigma_2+a_3\sigma_3&=(p+q)^2f(q)-(p+q), \\ a_1\sigma_1'+a_2\sigma_2'+a_3\sigma_3'&=2(p+q)f(q)-1, \\ a_1\sigma_1''+a_2\sigma_2''+a_3\sigma_3''&=2f(q), \\ a_1\sigma_1'''+a_2\sigma_2'''+a_3\sigma_3'''&=0. \end{aligned} \tag{48}$$

On eliminating a_1, a_2, a_3 between these equations, there results the relation

$$(49)\qquad (p+q)^2\,(\sigma_1'\sigma_2''\sigma_3''')-2\,(p+q)\,(\sigma_1\sigma_2''\sigma_3''')+2\,(\sigma_1\sigma_2'\sigma_3''')$$
$$=\frac{(p+q)\,(\sigma_1'\sigma_2''\sigma_3''')-(\sigma_1\sigma_2''\sigma_3''')}{f(q)}\equiv g\,(p,q).$$

From equations (9) and (26), it can be readily shown that

(50)

$$-(p+q)^2\sqrt{MV}\Delta=(p+q)^2(\sigma_1'\sigma_2''\sigma_3''')-2(p+q)\,(\sigma_1\sigma_2''\sigma_3''')+2(\sigma_1\sigma_2'\sigma_3''').$$

Hence

$$(51)\qquad g\,(p,q)+(p+q)^2\sqrt{MV}\Delta=0.$$

From these equations we derive at once the result

$$(52)\qquad \frac{d^3g}{dq^3}=0,$$

and therefore

$$g\,(p,q)=k\,(p)\,q^2-2l\,(p)\,q+m\,(p),$$

a quadratic function in q.

We have now before us the equations necessary for the discussion of the various configurations that may occur.

First.

If q_1, q_2, q_3 be three arbitrary values of q, then from (47), we have

$$(53)\qquad \begin{aligned} a_1(q_1)\sigma_1+a_2(q_1)\sigma_2+a_3(q_1)\sigma_3&=\pi_1(p),\\ a_1(q_2)\sigma_1+a_2(q_2)\sigma_2+a_3(q_2)\sigma_3&=\pi_2(p),\\ a_1(q_3)\sigma_1+a_2(q_3)\sigma_2+a_3(q_3)\sigma_3&=\pi_3(p),\end{aligned}$$

where $\pi_1(p)$ is a quadratic function. If then $\big(a_1(q_1)\;a_2(q_2)\;a_3(q_3)\big)$ is unequal to zero, $\sigma_1(p)$, $\sigma_2(p)$, $\sigma_3(p)$ are functions of the second degree, and Δ vanishes identically as well as Γ''. The integral surface (S) is therefore a ruled quadric.

Second.

If the determinant $\big(a_1(q_1)\;a_2(q_2)\;a_3(q_3)\big)$ vanishes, we have yet an exceptional case to consider, namely, when $g(p,\,q)$ vanishes identically. In this case each of the determinants $(\sigma_1'\sigma_2''\sigma_3''')$, $(\sigma_1\sigma_2'\sigma_3''')$, $(\sigma_1\sigma_2''\sigma_3''')$ must be equal to zero. The functions σ_1, σ_2, σ_3 must therefore be connected by a relation of the form

$$a\sigma_1+b\sigma_2+c\sigma_3=0.$$

But this relation implies a linear relation between θ_1, θ_2, θ_3 which was excluded at the outset.

Third.

The function $g(p,\,q)$ does not vanish identically; but it vanishes for

$$(54)\qquad q=l(p)\pm\sqrt{l^2(p)-k(p)\,m(p)}.$$

Now p and q are independent, and therefore each member of (54) must be equal to a constant, say q_1, q_2. If the functions $k(p)$, $l(p)$, $m(p)$ are such that

$$l^2(p) \neq k(p)\, m(p),$$

there are two values of q, namely q_1 and q_2 for which Δ vanishes for all values of p. In this case (S) has two distinct straight line directrices.

If

$$l^2(p) = k(p)\, m(p),$$

q_1 and q_2 are respectively equal to q_0. In this case the two directrices of (S) become coincident.

In conclusion we may note certain properties of the complex (28) corresponding to the cases we have just discussed.

When $(\alpha_1\alpha_2\alpha_3)$ is unequal to zero each regulus of the quadric is contained in a net of complexes.

When $(\alpha_1\alpha_2\alpha_3)$ is equal to zero, let q_1 and q_2 be two values of q for which the minors $(\alpha_1\alpha_2)$, $(\alpha_2\alpha_3)$, $(\alpha_3\alpha_1)$ are unequal to zero. Then the vanishing of $(\alpha_1\alpha_2\alpha_3)$ implies that

$$A\,\alpha_1(q) + B\alpha_2(q) + C\alpha_3(q) = 0. \tag{55}$$

From (45) we see that the axis of the complex (28) is determined in direction by α_1, α_2, α_3. It therefore follows from (55) that axis of (28) describes a surface having a plane directrix. If α_1, α_2, α_3 be such that A, B, C all vanish, then the axis of (28) must be parallel to a fixed direction. Equation (45) now leads to the relation

$$a\theta_1 + b\theta_2 + c\theta_3 = H(q), \tag{56}$$

where a, b, c are constants. Since θ_1, θ_2, θ_3 are solutions of (A), the function $H(q)$ must also be a solution; and therefore $\lambda(p, q)$ vanishes. The corresponding surfaces have been discussed previously.

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Rational Plane Anharmonic Cubics.

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(Read May Meeting, 1918).

In this paper we propose to study the rational plane cubic curves whose parametric equations are

(1) $$y_i = a_i t^3 + 3b_i t^2 + 3c_i t + d_i, \qquad (i = 1, 2, 3)$$

where a_i, b_i, c_i, d_i are constants. We shall first find the condition that the cubic be an anharmonic cubic. We shall then determine the coordinates of the vertices of the *invariant triangle*, the singular points, and other points connected with an anharmonic cubic.

It will be convenient to adopt the following notation:

(2) $$\alpha = |bcd|, \quad 3\beta = |cda|, \quad 3\gamma = |dab|, \quad \delta = |abc|,$$

(3) $$l = \beta^2 - \alpha\gamma, \quad 2m = \alpha\delta - \beta\gamma, \quad n = \gamma^2 - \beta\delta.$$

It is easy to show that the identities

(4) $$a_i\alpha - 3b_i\beta + 3c_i\gamma - d_i\delta = 0, \qquad (i = 1, 2, 3)$$

(5) $$\alpha n + 2\beta m + \gamma l = 0, \quad \beta n + 2\gamma m + \delta l = 0,$$

exist among the determinants in (2) and (3).

For certain values of the constants a, b, c, d, equations (1) may represent a straight line or a conic. In particular, if $\alpha = \beta = \gamma = \delta = 0$, the coordinates y_1, y_2, y_3 are linearly dependent and the locus is a straight line. We shall assume at the outset that α, β, γ, δ are not all zero.

1. THE DIFFERENTIAL EQUATION. Following Wilczynski we shall study the anharmonic cubic by means of a linear homogeneous differential equation of the third order, of which y_1, y_2, y_3 are solutions. This differential equation may be written

(6) $$y''' + 3p_1 y'' + 3p_2 y' + p_3 y = 0,$$

where p_1, p_2, p_3 are functions of t. It is easily shown that, if y_1, y_2, y_3 are solutions of (6), we must have

(7) $$\begin{aligned} -\Delta p_1 &= \beta + 2\gamma t + \delta t^2, \\ \Delta p_2 &= 2(\gamma + \delta t), \\ -\Delta p_3 &= 6\delta, \end{aligned}$$

where

$$(8)\qquad \Delta=\alpha+3\beta t+3\gamma t^2+\delta t^3=\begin{vmatrix} 1, & -3t, & 3t^2, & -t^3 \\ a_1, & b_1, & c_1, & d_1 \\ a_2, & b_2, & c_2, & d_2 \\ a_3, & b_3, & c_3, & d_3 \end{vmatrix}.$$

2. THE INVARIANT θ_3. The seminvariants P_2, P_3 are defined by

$$P_2=p_2-p_1{}^2-p_1{}',$$
$$P_3=p_3-3p_1p_2+2p_1{}^3-p_1{}''.$$

Substituting the values of p_1, p_2, p_3 we find

$$(9)\quad -\frac{1}{4}\Delta^2P_2=1-2mt+nt^2,$$

$$(10)\quad \frac{1}{4}\Delta^3P_3=4\beta l-2\alpha m+(15\gamma l+9\alpha n)t+(21\beta n+15\delta l)t^2+(14\gamma n-10\delta m)t^3+6\delta nt^4.$$

In order to study the projective properties of the cubic defined by (1) it is necessary first to calculate the *invariants*, which are not changed by any transformation of the type

$$\bar{y}=\lambda y,\ \bar{t}=\xi(t),\ \lambda=\text{some function of } t.$$

The simplest of these invariants is defined by

$$\theta_3=P_3-\frac{3}{2}P_2{}'.$$

Substituting the values of P_2, P_3, we obtain, after reduction,

$$(11)\qquad \frac{1}{20}\Delta^3\theta_3=A+3Bt+3Ct^2+Dt^3,$$

where

$$(12)\qquad \begin{array}{ll} A=-(\alpha m+\beta l), & C=-(\gamma m+\delta l), \\ B=-(\beta m+\gamma l), & D=\quad \delta m+\gamma n. \end{array}$$

3. THE CONDITION THAT EQUATIONS (1) SHALL REPRESENT A CONIC. A necessary and sufficient condition* that equations (1) shall represent a conic is $\theta_3\equiv 0$. That is, $A=B=C=D=0$. Hence

$$(13)\qquad \begin{aligned} \alpha m+\beta l &=0,\\ \beta m+\gamma l &=0,\\ \gamma m+\delta l &=0,\\ \delta m+\gamma n &=0. \end{aligned}$$

Consider the first three equations. It is evident that either $l=m=n=0$ or

$$\begin{vmatrix}\alpha & \beta\\ \beta & \gamma\end{vmatrix}=-l=0,\quad \begin{vmatrix}\alpha & \beta\\ \gamma & \delta\end{vmatrix}=-2m=0,\ \text{and}\ \begin{vmatrix}\beta & \gamma\\ \gamma & \delta\end{vmatrix}=-n=0.$$

*Wilczynski, Projective Differential Geometry, p. 61.

But if $l=m=0$, if follows from (5) that either $\alpha=\beta=0$ or $n=0$. If $\alpha=\beta=0$ it follows from (3) and the last equation of (13) that $n=0$.

Hence *a necessary and sufficient condition that equations* (1) *represent a conic is* $l=m=n=0$. It is interesting to note that in this case P_2 also vanishes. We shall assume throughout this paper that one of the determinants l, m, n, is different from zero. For convenience we shall first assume that neither l, m, nor n is equal to zero. The special cases (1) $l=m=0$, $n \neq 0$, and (2) $l \neq 0$, $m=n=0$ will be considered later.

4. THE CONDITION THAT EQUATIONS (1) SHALL REPRESENT AN ANHARMONIC CUBIC. The invariant θ_8 is defined by the equation

(14) $$\theta_8=6\theta_3\theta_3''-7(\theta_3')^2-27P_2\theta_3^2.$$

It is easily seen that, after the substitution of P_2 and θ_3 in this equation, one would obtain $\Delta^8\theta_8=R^8$, where R^8 is a rational function of t of at most the eighth degree.

Equations (1) will represent an anharmonic cubic if, and only if,

$$\frac{\theta^3{}_8}{\theta^8{}_3}=\frac{3^9\cdot 7^3}{2^4\cdot 5^2}.$$

In this case

$$(R^8)^3=\text{constant}\times(A+3Bt+3Ct^2+Dt^3)^8.$$

Hence, a *necessary* condition that the cubic (1) be anharmonic is that the expression $A+3Bt+3Ct^2+Dt^3$ be of the form $\lambda(\mu+vt)^3$, where λ, μ, v are constants.

The cubic

(15) $$A+3Bt+3Ct^2+Dt^3=0$$

will have three equal roots if, and only if,

$$B^2-AC=AD-BC=C^2-BD=0.$$

From (12), (3), (5), we find

(16) $$\begin{aligned} B^2-AC&=l(ln-m^2),\\ AD-BC&=2m(ln-m^2),\\ C^2-BD&=n(ln-m^2). \end{aligned}$$

Hence the cubic (15) will have three equal roots if

(17) $$m^2-ln=0.$$

From (16) it follows that

$$(AD-BC)^2-4(B^2-AC)\,(C^2-BD)=4(ln-m^2)^3.$$

Since the left member of this equation is the discriminant of the cubic (15), the cubic cannot have two equal roots without being a perfect cube.

Making use of (5), (17), we obtain certain identities which will be of use in the sequel.

(18) $$\alpha m^2+2\beta lm+\gamma l^2=0, \quad (\alpha m+\beta l)^2=l^3,$$
$$\beta m^2+2\gamma lm+\delta l^2=0, \quad (\beta m+\gamma l)^2=l^2 n.$$

It can now be easily shown that

$$A+3Bt+3Ct^2+Dt^3=-(\alpha m+\beta l)\,\frac{(l-mt)^3}{l}$$

and

(19) $$lm^2\Delta=(l-mt)^2(\alpha n+\delta lt)=(l-mt)m^2K,$$

where

(20) $$m^2K=(l-mt)\ (\alpha n+\delta lt).$$

Substituting in (9) and (11) we obtain

(21) $$K^2P_2=-4l,$$

(22) $$K^3\theta_3\ =-20(\alpha m+\beta l).$$

Differentiating the last equation we obtain, after reduction,

$$mK^4\theta_3{}'=60(\alpha m+\beta l)\ (\beta m-\gamma l-2\delta lt),$$
$$m^2K^5\theta_3{}''=-120(\alpha m+\beta l)\ \left[2(\beta m-\gamma l-2\delta lt)^2+\delta lmK\right].$$

The invariant θ_8 may now be calculated from (14). We find

(23) $$K^8\theta_8=2^4\cdot 3^3\cdot 5^2\cdot 7\ l(\alpha m+\beta l)^2.$$

Hence

(24) $$\frac{\theta^3{}_8}{\theta^8{}_3}=\frac{3^9\cdot 7^3}{2^4\cdot 5^2}\times\frac{l^3}{(\alpha m+\beta l)^2}=\frac{3^9\cdot 7^3}{2^4\cdot 5^2}.$$

We are thus led to the theorem: Equations (1) will represent an anharmonic cubic if, and only if,

(25) $$(\alpha\delta-\beta\gamma)^2-4(\beta^2-\alpha\gamma)\ (\gamma^2-\beta\delta)=0.$$

5. Singular Points. Every rational cubic has one and only one double point. We propose now to investigate the character of this double point when the cubic is anharmonic. The flex parameters are the three roots of the cubic*

(26) $$\Delta=\alpha+3\beta t+3\gamma t^2+\delta t^3=0,$$

and the two nodal parameters are the roots of the quadratic*

(27) $$\begin{vmatrix} 3\delta, & 3\gamma, & 3\beta \\ 3\gamma, & 3\beta, & 3\alpha \\ l, & -t, & t^2 \end{vmatrix}=0.$$

Equation (27) reduces, by means of (17), to

(28) $$(mt-l)^2=0.$$

*Salmon's Higher Plane Curves, third edition, pages 187-188.

Since the roots of (28) are equal, it follows that a rational anharmonic cubic cannot have an *ordinary* double point. Hence every such cubic has one and only one cusp. The cusp parameter is $t=\frac{l}{m}$.
Substituting this value of t in (1) we obtain

$$(29)\quad \begin{matrix} mn\delta x_i = -3(\beta m+\gamma l)\ (la_i+2mb_i+nc_i) \\ \text{or} \\ n^2\alpha x_i\ = -3(\beta m+\gamma l)\ (lb_i+2mc_i+nd_i), \end{matrix}\qquad (i=1,\ 2,\ 3)$$

according as δ is, or is not, different from zero. Now $(\beta m+\gamma l)^2=l^2n \neq 0$. Hence the coordinates of the cusp of an anharmonic cubic are

$$(29)\qquad \begin{matrix} x_i=la_i+2mb_i+nc_i, \\ \text{or} \\ x_i=lb_i+2mc_i+nd_i, \end{matrix}\qquad (i=1,\ 2,\ 3)$$

according as δ is, or is not, different from zero.

The number of points of inflection of a curve of the nth degree is equal to $3n(n-2)-6d-8r$, where d denotes the number of double points and r the number of cusps. Hence every rational anharmonic cubic has one and only one inflection point. A glance at (19) shows that the flex parameter is $t=-\frac{\alpha n}{\delta l}$.

After substituting this value of t in (1) it can be easily shown that the coordinates of the point of inflection are

$$(30)\qquad x_i=(3\gamma n+\delta m)\alpha a_i+(5\beta m+\gamma l)\,\delta b_i+2\delta^2 lc_i. \qquad (i=1,\ 2,\ 3)$$

6. THE TANGENTS FROM A GIVEN POINT TO THE CUBIC. The parameters of the points of contact of the four tangents which may be drawn from any point x_i to a rational cubic are the roots of the equation*

$$(31)\quad |abx|t^4+2|acx|t^3+(|adx|+3|bcx|)t^2+2|bdx|t+|cdx|=0.$$

Since an anharmonic cubic is of class three, this quartic must reduce to a cubic. It can be easily shown that the left member is divisible by $(mt-l)$. Dividing by this factor we obtain

(32)

$$lm|bax|t^3+l(l|bax|+2m|cax|)t^2+m(2m|bdx|+n|cdx|)t+m^2|cdx|=0.$$

The roots of this equation are the parameters of the points of contact of the three tangents which can be drawn from any point to the anharmonic cubic.

If the point x_i happens to be on the cubic the tangent at this point counts as two and only one other tangent is possible. We propose now to find the value of the parameter which corresponds to its point of contact. Let $x=at^3+3bt^2+3ct+d$, then

*J. E. Rowe, Bulletin American Mathematical Society, Vol. 22, No. 2.

$$|bax| = |b,\ a,\ 3ct+d| = 3|bac|t + |bad| = -3\delta t - 3\gamma,$$
$$|cax| = |c,\ a,\ 3bt^2+d| = 3|cab|t^2 + |cad| = 3\delta t^2 - 3\beta,$$
$$|bdx| = |b,\ d,\ at^3+3ct| = |bda|t^3 + 3|bdc|t = 3\gamma t^3 - 3\alpha t,$$
$$|cdx| = |c,\ d,\ at^3+3bt^2| = |cda|t^3 + 3|cdb|t^2 = 3\beta t^3 + 3\alpha t^2.$$

Substituting in (32) we obtain, after reduction,

$$[-l(\delta t+\gamma)T + m(\beta t+\alpha)]\ (T-t)^2 = 0,$$

where we have replaced t in (32) by T. Hence the tangent to the cubic, drawn from any point on the curve, touches the cubic at the point defined by the parameter value

$$T = \frac{m}{l} \times \frac{\beta t+\alpha}{\delta t+\gamma}. \tag{33}$$

7. The Halphen Point. Solving (33) for t, we obtain

$$t = -\frac{\gamma l T - \alpha m}{\delta l T - \beta m},$$

or, after interchanging T and t,

$$T = -\frac{\gamma l t - \alpha m}{\delta l t - \beta m}. \tag{34}$$

That is, the tangent to the curve at any point t cuts the curve again at the point T, where T is defined by (34). This second point has been called the *tangential* of the first point.

The system of cubics which have eight consecutive points in common with the given cubic at the point P, all pass through a ninth point which is on the given cubic. Wilczynski has called this point the *Halphen point* of P.

Let us regard (34) as a transformation which transforms the parameter of the point P into the parameter of its tangential. If this transformation be twice repeated we obtain

$$T = \frac{(5\gamma l + 2\beta m)t - 3\alpha m}{5\beta m + 2\gamma l - 3\delta l t}. \tag{35}$$

This is the parameter value which corresponds to the Halphen point.*

8. The fundamental covariants. All points of the plane, which are intrinsically connected with the given cubic, must be independent of the choice of the parameter in (1). That is they must be defined by *covariants*. The three simplest covariants are

$$(36)\qquad \begin{aligned} C_0 &= y, \\ C_4 &= \theta_3' y + 3\theta_3 z, \\ C_8 &= [(\theta_3')^2 + 9P_2\theta_3^2]y + 6\theta_3\theta_3' z + 18\theta^2{}_3\rho, \end{aligned}$$

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*Wilczynski, Projective Differential Geometry, p. 69.

where

$$(37) \qquad \begin{aligned} z &= y' + p_1 y, \\ \rho &= y'' + 2p_1 y' + p_2 y. \end{aligned}$$

The geometric significance of the points defined by the fundamental covariants (36) has been explained by the author in a former paper.* Any other covariant may be expressed in terms of these three covariants and of invariants.

From (1), (7), (19), we find, after reduction

(38)

$$mKz = 3amc - \beta md + (6amb - 3\gamma lc + \delta ld)t + (3ama + 3\beta mb - 6\gamma lb)t^2 + (2\beta ma - 3\gamma la - 3\delta lb)t^3 - 2\delta lat^4,$$

$$\frac{(l-mt)K\rho}{l} = 6ab - 6\beta c + 2\gamma d + 8aat + 12\beta at^2 + 8\gamma at^3 + 2\delta at^4.$$

Whence

(39)

$$\frac{m^2K^4}{60(\beta m + \gamma l)l} \times C_4 = 3amc + \gamma ld - 2\beta md + 3(2amb - \beta mc + \delta ld)t + 3(ama - \gamma lb + 2\delta lc)t^2 + (\beta ma - 2\gamma la + 3\delta lb)t^3,$$

$$\begin{aligned} \frac{m^2K^8}{3600l^4} \times C_8 = {} & 12a^2nb - 18a\beta nc + 6a\gamma mc + 3\beta^2nd + 3a\gamma nd - 2a\delta md - 4\beta\gamma md \\ & + (16a^2na + 36a\gamma mb + 24a\delta lb - 15\beta\delta lc + 6a\delta mc - 3\gamma^2 lc - 10\beta\delta md + 10\gamma\delta ld)t \\ & + (13a\delta la + 15a\beta na + 18a\delta mb - 3\beta^2nb + 18\beta\gamma mb - 9\gamma^2 lb - 12\beta\delta mc + 8\delta^2 ld)t^2 \\ & + (27\beta\delta la + 21a\gamma na + 10a\delta ma + 26\beta\gamma ma + 6\beta\delta mb - 18\gamma\delta lb + 12\delta^2 lc)t^3. \end{aligned}$$

The fact that the right members of these two equations are cubics agrees with a theorem proved by the author in a former paper, namely, that every covariant point either remains fixed, describes a straight line, or describes a curve which is projective with a given curve.

9. THE INVARIANT TRIANGLE. Associated with every anharmonic curve of the first class is a triangle, called the *invariant triangle*, which has the following property. Suppose any tangent is drawn to the curve. The anharmonic ratio of the point of contact and the three points of intersection of this tangent with the three sides of the triangle is constant for all points on the curve. The vertices of this triangle are the only covariant points whose coordinates reduce to constants. They are defined by the covariant†

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*Harding, Giornale di Matematiche, Vol. 54, No. 3.

†Harding, Giornale, Vol. 54, No. 4.

(40) $$H_8 = C_8 + \phi_4 C_4 + \phi_8 C_0,$$

where the invariants ϕ_4, ϕ_8, are defined by the equations

(41) $$\begin{aligned} &\phi^3_4 - 4\theta_8\phi_4 + 216\theta^4_3 = 0,\\ &\phi^2_4 - 2(\phi_8 + \theta_8) = 0. \end{aligned}$$

Let $\phi_4 = 6\theta^{\frac{4}{3}}_3 v$. The first equation of (41) then reduces to

(42) $$v^3 - \frac{1}{9}\frac{\theta_8}{\theta^{\frac{8}{3}}_3}v + 1 = 0,$$

or, after reducing by means of (24),

$$v^3 - \frac{21}{20}\sqrt[3]{20}\, v + 1 = 0.$$

The roots of this equation are $v = \frac{-5}{\sqrt[3]{20}}, \frac{4}{\sqrt[3]{20}}, \frac{1}{\sqrt[3]{20}}$. From (22) and (18) we find

$$K^4\theta^{\frac{4}{3}}_3 = 20\sqrt[3]{20}\, l^2.$$

Hence

(43) $$\begin{aligned} K^4\phi_4^{(1)} &= -600\, l^2,\\ K^4\phi_4^{(2)} &= 480\, l^2,\\ K^4\phi_4^{(3)} &= 120\, l^2. \end{aligned}$$

Also, from (23), (43), (18),

(44) $$\begin{aligned} K^8\phi_8^{(1)} &= 29\cdot 3600\, l^4,\\ K^8\phi_8^{(2)} &= 11\cdot 3600\, l^4,\\ K^8\phi_8^{(3)} &= 19\cdot 3600\, l^4. \end{aligned}$$

Substituting (39), (43), (44), in (40), we obtain, after a rather tedious reduction

$$m^2K^8H_8^{(1)} = 36\cdot 1200\, l^4(A + 3Bt + 3Ct^2 + Dt^3)$$

where

$$\begin{aligned} A &= \frac{\alpha^3 n^2}{\delta l^2}(la + 2mb + nc) = \frac{\alpha^2 n}{l}(lb + 2mc + nd),\\ B &= \frac{\alpha^2 n}{l}(la + 2mb + nc) = \alpha\delta(lb + 2mc + nd),\\ C &= \alpha\delta\,(la + 2mb + nc),\\ D &= \frac{\delta^2 l}{n}(la + 2mb + nc) = \delta\left[(3\beta l + 2\alpha m)a + (\alpha n - 3\gamma l)b + \delta lc\right]. \end{aligned}$$

That is,

(45) $$m^2K^8H_8^{(1)} = 36\cdot 1200\, l^4\left[\frac{\alpha^3n^2}{\delta l^2} + \frac{3\alpha^2 nt}{l} + 3\alpha\delta t^2 + \frac{\delta^2 l t^3}{n}\right](la + 2mb + nc)$$

or $$m^2K^8H_8^{(1)} = 36\cdot 1200\, \alpha^2 l^3 n\,(lb + 2mc + nd),$$

according as δ is, or is not, different from zero.

In a similar manner we obtain

(46) $m^5K^8H_8^{(2)} = 36\cdot 1200(mt-l)^3[(3\gamma n+\delta m)\alpha a+(5\beta m+\gamma l)\delta b+2\delta^2 lc]$,

(47) $m^5K^8H_8^{(3)} = 36\cdot 1200\, l^4\Delta(\alpha ma-\beta mb+\gamma lb-\delta lc)$.

Hence the coordinates of P_1, P_2, P_3, the vertices of the invariant triangle, are

$$
(48)\quad \begin{aligned} x_i^{(1)} &= la_i+2mb_i+nc_i \text{ or } lb_i+2mc_i+nd_i, \\ x_i^{(2)} &= (3\gamma n+\delta m)\alpha a_i+(5\beta m+\gamma l)\delta b_i+2d^2lc_i, \qquad (i=1,2,3) \\ x_i^{(3)} &= \alpha ma_i-(\beta m-\gamma l)b_i-\delta lc_i, \end{aligned}
$$

where the second value of $x_i^{(1)}$ must be used if $\delta=0$.

A glance at (29) and (30) shows that P_1 and P_2 are, respectively, the cusp and the inflection point of the cubic. Writing $x_i^{(3)}$ for x we obtain

$$
\begin{aligned} &|bax| = -\delta l|bac| = \delta^2 l,\ |cax| = -(\beta m-\gamma l)|cab| = -(\beta m-\gamma l)\delta, \\ &|bdx| = \alpha m|bda| - \delta l|bdc| = 3\alpha\gamma m+\alpha\delta l, \\ &|cdx| = \alpha m|cda| - (\beta m-\gamma l)|cdb| = 3\alpha\beta m-(\beta m-\gamma l)\alpha = -\alpha^2 n. \end{aligned}
$$

Equation (32) then reduces to

$$(\delta lt+\alpha n)^2(mt-l)=0.$$

That is, P_3 is the point of intersection of the cuspidal tangent and the inflectional tangent. Hence the invariant triangle of an anharmonic cubic is the triangle formed by the cuspidal tangent, the inflectional tangent, and the line joining the cusp to the point of inflection.

10. Special Cases. Up to this point we have assumed that each of the determinants l, m, n is different from zero. We are thus left with two special cases to consider, namely: $l=m=0$, $n\neq 0$, and $m=n=0$, $l\neq 0$. It is easily shown that all our previous results hold in each of these special cases. We shall need the following identities:

$$
(49)\quad \begin{aligned} &\frac{\alpha n}{l} = 3\gamma+\frac{2\delta l}{m} = 3\gamma+\frac{2\delta m}{n}, \quad \frac{\delta l}{n} = 3\beta+\frac{2\alpha m}{l}, \\ &\frac{\beta n}{m} = -2\gamma-\frac{\delta l}{m}, \qquad \frac{\gamma l}{m} = -2\beta-\frac{\alpha n}{m}, \\ &\frac{\delta l}{m} = -2\gamma-\frac{\beta m}{l}, \qquad \frac{\alpha n}{m} = -2\beta-\frac{\gamma l}{m}. \end{aligned}
$$

We shall state only the final results, which are easily obtained by means of these identities.

Case 1. $l=m=0$, $n\neq 0$. In this case $\dfrac{l}{m}=\dfrac{m}{n}=0$. Equations (5) show that $\alpha=\beta=0$, $n=\gamma^2$. Hence

(4′) $3\gamma c_i = \delta d_i$. (i = 1, 2, 3)

(8′) $\Delta \doteq 3\gamma t^2+\delta t^3$.

(19′) $K=0.$

(22′) $\Delta^3\theta_3=20\gamma^3t^3.$

(23′) $\Delta^8\theta_8=2^4\cdot 3^3\cdot 5^2\cdot 7\gamma^8t^8.$

Cusp parameter is $t=0$ and flex parameter is $t=\dfrac{-3\gamma}{\delta}$.

(29′) $x_i=d_i$, since $c_1 : c_2 : c_3=d_1 : d_2 : d_3$,

(30′) $x_i=9\gamma^2a_i-9\gamma\delta b_i+2\delta^2c_i.$

(32′) $3\gamma|abx|t^3+2\delta|adx|t^2+3(\gamma|adx|+\delta|bdx|)t+6\gamma|bdx|=0.$

(33′) $$T=-\frac{2\gamma t}{\gamma+\delta t}.$$

(34′) $$T=-\frac{\gamma t}{2\gamma+\delta t}.$$

(35′) $$T=-\frac{\gamma t}{8\gamma+3\delta t}.$$

(38)′ $$\Delta z=-2\gamma dt+12\gamma bt^3+(7\gamma a+3\delta b)t^4+2\delta at^5,$$
$$\Delta\rho=2\gamma d+8\gamma at^3+2\delta at^4.$$

(39′) $$\frac{\Delta^4}{60\gamma^3t^4}\times C_4=-5\gamma d-15\gamma ct+(3\gamma b-6\delta c)t^2+(4\gamma a-3\delta b)t^3,$$
$$\frac{\Delta^8}{3600\gamma^6t^8}\times C_8=29\gamma^2d+87\gamma^2ct+3(16\delta c-19\gamma b)\gamma t^2+(11\gamma^2a-30\gamma\delta b+12\delta^2c)t^3.$$

(43′) $$\Delta^4\phi_4^{(1)}=-600\gamma^4t^4,$$
$$\Delta^4\phi_4^{(2)}=480\gamma^4t^4,$$
$$\Delta^4\phi_4^{(3)}=120\gamma^4t^4.$$

(44′) $$\Delta^8\phi_8^{(1)}=29\cdot 3600\gamma^8t^8,$$
$$\Delta^8\phi_8^{(2)}=11\cdot 3600\gamma^8t^8,$$
$$\Delta^8\phi_8^{(3)}=-19.3600\gamma^8t^8.$$

(48′) $$x_i^{(1)}=d_i,$$
$$x_i^{(2)}=9\gamma^2a_i-9\gamma\delta b_i+2\delta^2c_i,$$
$$x_i^{(3)}=3\gamma b_i-\delta c_i.$$

Case 2. $m=n=0$, $l\neq 0$. In this case $\dfrac{l}{m}=\dfrac{m}{n}=\infty$. Equations (5) show that $\gamma=\delta=0$, $n=\beta^2$. Hence

(4″) $3\beta b_i=\alpha a_i.$

(8″) $\Delta=\alpha+3\beta t.$

(19″) $K=\Delta.$

$$(22'') \qquad \Delta^3\theta_3 = -20\beta^3.$$

$$(23'') \qquad \Delta^8\theta_8 = 2^4\cdot 3^3\cdot 5^2\cdot 7\,\beta^8.$$

Cusp parameter is $t=\infty$, Flex parameter is $t=-\dfrac{\alpha}{3\beta}$.

$$(29'') \qquad x_i = a_i,$$

$$(30'') \qquad x_i = 2\alpha^2 b_i - 9\alpha\beta c_i + 9\beta^2 d_i.$$

$$(32'') \qquad 6\beta|acx|t^3 + 3(\beta|adx| + \alpha|acx|)t^2 + 2\alpha|adx|t + 3\beta|cdx| = 0.$$

$$(33'') \qquad T = -\frac{\beta t + \alpha}{2\beta}.$$

$$(34'') \qquad T = -\frac{\alpha + 2\beta t}{\beta}.$$

$$(35'') \qquad T = -\frac{8\beta t + 3\alpha}{B}.$$

$$(38'') \qquad \begin{aligned} \Delta z &= 3\alpha c - \beta d + (6\alpha b + 6\beta c)t + 8\alpha a t^2 + 8\beta a t^3,\\ \Delta\rho &= 6\alpha b - 6\beta c + 8\alpha a t + 12\beta a t^2. \end{aligned}$$

$$(39'') \qquad \begin{aligned} \frac{\Delta^4}{60\beta^3} \times C_4 &= 4\beta d - 3\alpha c - 3(2\alpha b - \beta c)t - 5\alpha a t^2 - 5\beta a t^3,\\ \frac{\Delta^8}{3600\beta^6} \times C_8 &= 12\alpha^2 b - 30\alpha\beta c + 11\beta^2 d + (16\alpha^2 a - 57\beta^2 c)t\\ &\qquad + 29\alpha\beta a t^2 + 29\beta^2 a t^3. \end{aligned}$$

$$(43'') \qquad \begin{aligned} \Delta^4\phi_4^{(1)} &= -600\beta^4,\\ \Delta^4\phi_4^{(2)} &= \quad 480\beta^4,\\ \Delta^4\phi_4^{(3)} &= \quad 120\beta^4. \end{aligned}$$

$$(44'') \qquad \begin{aligned} \Delta^8\phi_8^{(1)} &= \quad 29\cdot 3600\beta^8,\\ \Delta^8\phi_8^{(2)} &= \quad 11\cdot 3600\beta^8,\\ \Delta^8\phi_8^{(3)} &= -19\cdot 3600\beta^8. \end{aligned}$$

$$(48'') \qquad \begin{aligned} x_i^{(1)} &= a_i,\\ x_i^{(2)} &= 2\alpha^2 b_i - 9\alpha\beta c_i + 9\beta^2 d_i,\\ x_i^{(3)} &= \alpha b_i - 3\beta c_i. \end{aligned}$$

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SECTION IV

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Bacteria of Frozen Soils in Quebec. II.

By J. VANDERLECK, Ch.E.

Presented by F. C. HARRISON, D.Sc., F.R.S.C.

(Read May Meeting, 1918.)

INTRODUCTION.

At the last meeting of the Society (May, 1917), a paper[1] was read dealing with the presence of bacteria in Quebec soils during the winter of 1916–17. The final conclusions and summary arrived at were as follows:—

1. Bacteria increased rapidly in January in all soils where raw material was available for bacterial decomposition. This increase took place in frozen and unfrozen soils.
2. When raw material was absent this increase did not materialise.
3. During March in frozen soils a moderate increase in the numbers of bacteria was observed. This increase reached only from twice to four times the original numbers.
4. Severe frost would check any bacterial development in frozen soil.
5. A high water content of the soil would counteract the frost action; a low water content would assist in depressing bacterial development.
6. A sudden severe frost killed most of the bacteria in the exposed soil.
7. As soon as the soil thawed a decrease in numbers of bacteria was observed.
8. An increase in soil moisture was usually followed by an increase in bacteria.

[1] Transactions Royal Society of Canada, Ser. III, Vol. XI, Section IV, page 15. June and September, 1917.

These conclusions were based practically on the results obtained in the winter of 1916–17, for although experiments had been carried on for five years, in no single year had it been possible to obtain sufficient data. For the winter of 1917–18 a very complete series of tests was planned to cover all doubtful points and in order to keep a close check on the bacterial content of the different soils fortnightly analyses were taken.

In this part of Quebec the soil seldom freezes until January, and as the bacterial content of the soil is very low in November all soil testing was started in this month. Unluckily the winter of 1917–18 was most unusual. Severe frost set in before the end of November, whilst there was practically no snow covering. In the first week of December the ground was frozen to much greater depth than during any winter since soil analyses were undertaken in 1912. This early severe frost was followed by very unsettled weather during February and March, interfering with the taking of the soil samples. The soil conditions do not represent the ones usually found in Eastern Canada, but give a good indication of what happens in soils in winter in the prairie provinces, where there is severe frost and only a light snow covering.

The soils investigated were the same as those used the previous year:—

1. Quantitative and qualitative determination of bacteria in the soil from a cultivated field. The soil consisted of a light rich loam to a depth of eighteen inches and was free from stones. Onions were grown on this field, which was subsequently manured and ploughed.

2. Quantitative and qualitative determination of bacteria in the soil of a plot which had been fallowed for four years. The soil consisted of a clay loam nineteen inches deep, resting on bed rock but well drained.

3. Quantitative and qualitative determination of bacteria in the same soil as described in Experiment 2, but this plot was sown to grass for three years.

4. Quantitative and qualitative determination of bacteria from soil beneath a lawn. The sod was eight years old and the soil was very poor and gravelly. This plot was kept free from snow until February, when a continued heavy snowfall prevented any snow removal. On Febraury 20th a heavy rainfall flooded this field and further sampling was impossible until April. This was the field mentioned in Experiment 2 the year before.

5. Quantitative and qualitative determination of bacteria in cultivated black muck soil. This field was flooded in the end of

February, and sampling had to be postponed until the second half of April.

In each experiment samples were taken on the five, ten and fifteen inch levels and the depth of the frost line determined. The levels were slightly changed from the year before, when all samples were on four, eight, twelve and sixteen inch levels. In frozen soil the differences are not sufficiently important to make a change of one or two inches. Thus the sample of the five inch level practically represents the surface conditions; the ten inch level the area of greatest bacterial activity, and the fifteen inch level subsoil.

All bacteria found in the samples were again classified in three groups suggested by Conn, but this interesting phase of the investigations will be taken up in detail next winter.

As was done in the previous winter, the plots were again selected to afford a large range of conditions. In Experiemnt I a rich arable soil, well manured, can be compared with the rich arable soil of Experiment II which was not manured and not cropped, but fallowed for four years. In Experiment III the arable soil of Experiment II is cropped but not manured. Finally the plot on the permanent lawn was subjected to the full severity of a Canadian winter from the very first. In the 1916–17 experiment this exposure to the frost did not commence until the middle of February. One sample was also taken on the outdoor rink as a comparison with a similar sample taken the previous year.

Methods.

The methods employed were those of the previous year, but the soil was frozen to such hardness that sampling wich pick and crowbar was no sinecure. With the exception of the first and last samples the soil was frozen solidly throughout the winter, and the samples were collected in large chips or flakes. These were broken up and the stones picked out. In a few cases samples partly thawed in transportation to the laboratory and were allowed to thaw completely. For water determination three samples of 50 gr. each were taken; for bacteriological determination 2 grams of the frozen powder were put in 100 c.c. sterile water and shaken for at least five minutes. Further dilutions were made so that in each case 1 c.c. of the proper dilution were made so that in each case 1 c.c. of the proper dilution was added to the plates. All samples were plated in duplicate on beef peptone ager containing 1% glucose sugar and ½% blue litmus, beef peptone gelatine and soil extract gelatine. Only one dilution was used for each set of six plates.

The beef peptone agar and beef peptone gelatine were prepared according to the formulae given by the American Public Health

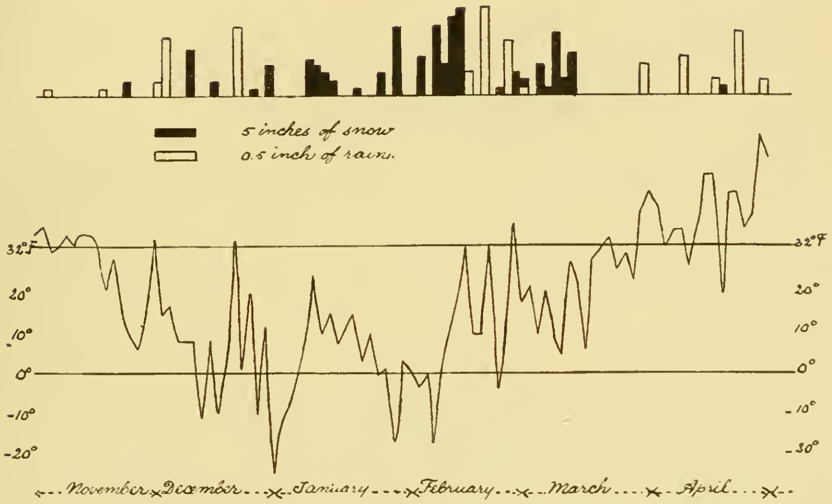
Association. The soil extract gelatine was prepared according to directions given by H. J. Conn. The plates were incubated for seven days at a temperature of 14°C. before being counted.

Weather.

The weather conditions throughout the course of the experiment have been tabulated and snow and rainfall recorded on the temperature chart. The chart gives the daily mean average for the winter of 1917-18. During this winter the temperature dropped below freezing point in the middle of November and remained very low until March 1st. Four times in this period the mercury went above freezing point although only for a few hours each time, but these short periods of thaw were accompanied by heavy rainfalls. One inch of rain fell during each thaw in December, but the absence of snow allowed this precipitation to be carried off very easily over the frozen ground. The thaws in February were accompanied by a rainfall of more than two inches. The heavy snow blanket kept this moisture in special places, and one experimental plot in Experiment II was covered with a layer of water nearly two feet deep. The heavy snow prevented this water from freezing. The very mild weather in the second half of March and the total absence of any precipitation allowed the snow to disappear rapidly and heavy rain showers in the beginning of April assisted in the thawing of the frozen soil. Thus in spite of the very deep frost penetration the soil was thawed earlier than in former milder winters.

The snowfall until February was rather light, but in addition to this it fell on hard-frozen, icy ground and the prevailing high winds swept it from the fields in protected corners. Thus in the middle of January the snow covering of the different fields and plots was only two, one, two and five inches respectively, although the total snowfall for the same date was twenty-six inches. On this bare ground four severe cold spells were experienced in December only. In three the daily mean temperature was—10°F., but in the Christmas cold wave the daily mean for three consecutive days was —24°F. Under such circumstances it cannot be surprising that the frost penetrated more than three feet.

The data obtained are again arranged in five sets of three tables each, and one diagram. Table A. gives the total bacterial content per gram of dry soil; Table C. the moisture percentage at depth of sampling, and Table B. compares the number of bacteria appearing on beef peptone media with those on soil extract gelatine.



Mean daily temperatures Winter 1917-1918.

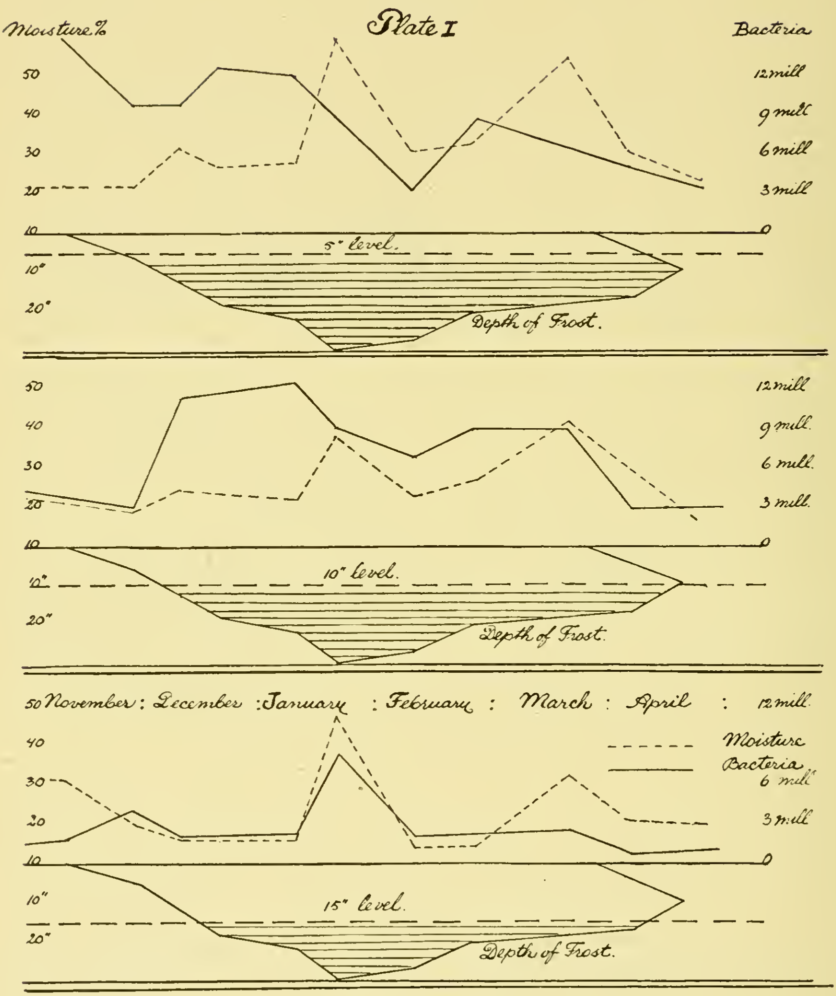


Plate I
Moisture %
Bacteria
50
40
30
20
10
12 mill
9 mill
6 mill
3 mill
0
5" level.
10"
20"
Depth of Frost.
50
40
30
20
10
12 mill
9 mill.
6 mill.
3 mill.
0
10" level.
10"
20"
Depth of Frost.
50 November : December : January : February : March : April : 12 mill.
40
30
20
10
Moisture
Bacteria
6 mill
3 mill
0
10"
15" level.
20"
Depth of Frost.

Experiment I.

Table Ia.

Field Manured and Plowed.

Average number of bacteria (in millions) per gram of soil at different depths.

Date.	Date of Snow	Date of Frost	5″	10″	15″
1917.					
Nov. 10	0″	0″	15·2	3·8	1·8
Nov. 27	1″	5″	10·4	2·8	4·3
Dec. 7	2″	13″	10·6	11·0	2·1
Dec. 20	2″	18″	13·4	11·0	2·1
1918.					
Jan. 8	2″	22″	11·7	12·6	2·2
Jan. 21	14″	30″	9·2	9·0	7·8
Feb. 10	14″	27″	3·7	7·1	2·4
Feb. 24	16″	20″	8·4	9·1	2·3
Mar. 19	12″	18″	6·2	9·1	2·5
Apl. 4	0″	4″–17″	5·3	3·2	1·0
Apl. 24	0″	0″	3·6	3·3	1·2

Experiment I.

Table Ib.

Field Manured and Plowed.

Average number of bacteria (in millions) per gram of soil at different depths on different media.

Date	Depth of Snow	Depth of Frost	5″ Media B.	5″ Media S.	10″ Media B.	10″ Media S.	15″ Media B.	15″ Media S.
1917								
Nov. 10	0″	0″	11·5	19·0	3·0	4·6	1·3	2·4
Nov. 27	1″	5″	10·3	10·5	2·4	3·2	4·3	4·4
Dec. 7	2″	13″	10·5	10·7	8·8	13·3	1·7	2·5
Dec. 20	2″	18″	11·8	15·0	11·5	10·6	2·0	2·2
1918.								
Jan. 8	2″	22″	9·0	14·4	11·9	13·4	2·0	2·4
Jan. 21	14″	30″	10·0	8·5	10·0	8·0	8·7	6·0
Feb. 10	14″	27″	2·6	4·7	3·8	10·4	1·5	3·2
Feb. 24	16″	20″	6·4	10·3	5·5	12·7	2·1	2·5
Mar. 19	12″	18″	6·0	6·5	8·2	10·0	2·8	2·2
Apl. 4	0″	4″–17″	3·8	6·8	2·3	4·2	0·9	1·0
Apl. 24	0″	0″	2·6	4·6	2·6	4·0	0·7	1·6

Experiment I.

Table Ic.

Field Manured and Plowed.

Moisture content at different depths.

Date.	Depth of		5″	10″	15″
	Snow	Frost			
1917.					
Nov. 10	0″	0″	22·4	21·4	31·0
Nov. 27	1″	5″	22·0	19·5	20·2
Dec. 7	2″	13″	31·8	23·6	16·3
Dec. 20	2″	18″	26·8	23·4	15·6
1918.					
Jan. 8	2″	22″	27·7	22·2	15·6
Jan. 21	14″	30″	60·5	38·0	48·0
Feb. 10	14″	27″	31·0	23·0	14·5
Feb. 24	16″	20″	32·0	27·0	14·0
Mar. 19	12″	18″	55·0	42·0	33·0
Apl. 4	0″	4″–17″	30·8	29·2	21·3
Apl. 24	0″	0″	23·6	18·5	20·0

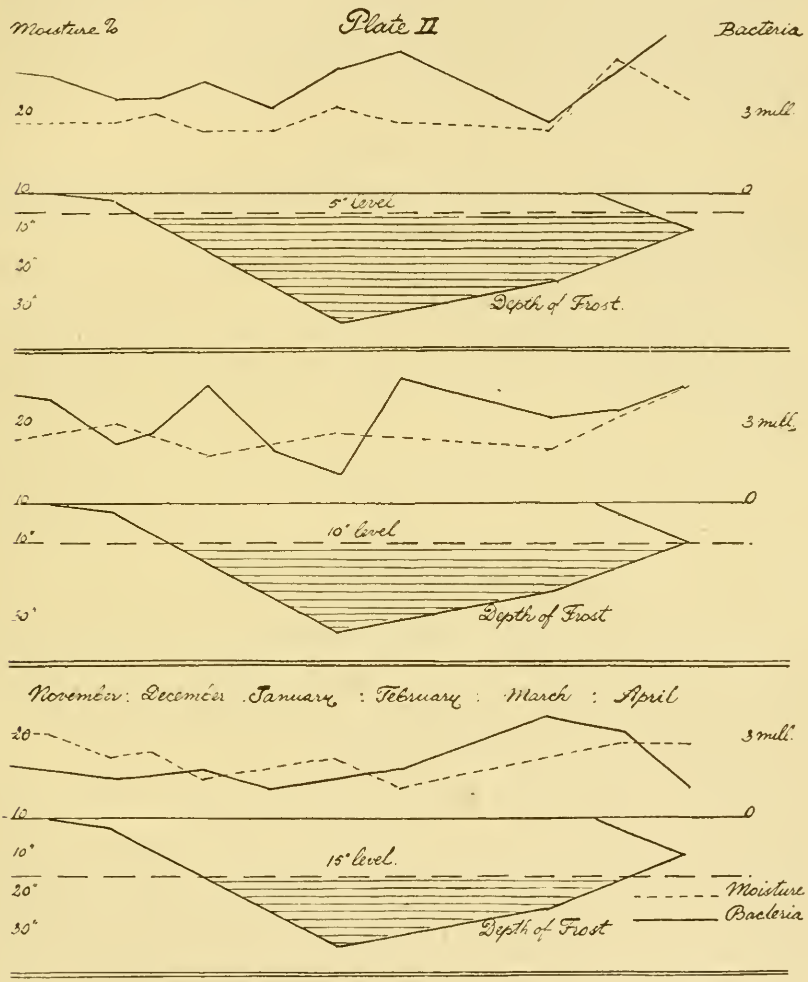
Experiment I.

The diagrams on this plate, and on subsequent plates of the other experiments, are arranged as follows:—

Each diagram represents the results of analyses of a definite level, either five, ten or fifteen inches. Above the zero line the moisture variations are indicated by the dotted curve and the bacterial changes by the solid black line. Below the zero line the frost penetration in the soil in inches is represented by the solid line; the broken line gives the depth of sampling, and the shaded area showing the depth of frost below the level of sampling gives a very clear idea to what extent the samples were frozen.

The bacterial counts in this experiment are so much lower than the counts found the year before, that only the severe frost can account for this difference. On the five inch level where the influence of the temperature was more direct than on the lower levels the general trend of bacterial count is downward. In the beginning of December we notice a bacterial increase preceded by about a week by a moisture increase. This same increase is observed on the ten inch level, although not preceded or accompanied by a moisture increase, and is probably the beginning of the bacterial action on the available raw material, culminating the year before in the large January totals, but here probably prematurely checked by the severe frost. On the fifteen inch level, where we penetrate the subsoil, this increase is not noticed and could not be expected.

In the last week of January we noticed a considerable increase in moisture on all three levels, accompanied by the bacterial decrease



on the five and ten inch levels and an increase on the fifteen inch level. From all appearances surface water here penetrated the soil, increasing the moisture percentage and washing down bacteria to the lower level, with an increase in bacteria at the fifteen inch level. However, the weather map does not indicate any precipitation at that period and registers a very severe cold spell. As the soil was frozen twenty-two inches before this moisture increase started, the frost cannot be held responsible for it. The decrease in bacteria on the five and ten inch levels runs parallel with the lowering of the temperature. The cold wave starting the second week in January and reaching its lowest point in the second week of February.

Nowhere in the diagram do we find any evidence of a considerable bacterial increase in the frozen soil, and in the same way any evidence is missing that bacteria are brought up from lower levels by the frost action.

Conclusions.

1. Severe frost stopped bacterial development entirely, causing a decrease in the numbers of bacteria.

2. Milder conditions, but still below the freezing point, allowed a slight increase in the number of bacteria.

3. A bacterial increase was noticed under moderate frost conditions in December, due to the presence of fermentable raw material in the soil.

Experiment II.

Table IIa.

Sod Covered Field Eight Years Old.

Average number of bacteria (in millions) per gram of soil at different depths.

Date.	Depth of		5″	10″	15″
	Snow	Frost			
1917.					
Nov. 11	0″	0″	4·5	4·0	1·9
Nov. 26	3″	2″	3·6	2·3	1·5
Dec. 6	0″	10″	3·7	2·6	1·8
Dec. 20	0″	18″	4·2	4·5	1·8
1918.					
Jan. 7	2″	27″	3·3	2·0	1·2
Jan. 24	0″	33″	4·7	1·5	1·5
Feb. 11	36″	30″	5·4	4·9	1·8
Feb. 25	....	Flooded.	....	....	....
Mar. 18	7″	23″	2·7[1]	3·4[1]	3·9[1]
Apl. 4	0″	3″–15″	4·9	3·5	3·4
Apl. 24	0″	0″	7·5	4·5	1·2

[1] Different place of sampling in same field.

Experiment II.

Table IIb.

Sod Covered Field Eight Years Old.

Average number of bacteria (in millions) per gram of soil at different depths on different media.

Date.	Depth of		5″		10″		15″	
	Snow	Frost	Media		Media		Media	
			B.	S.	B.	S.	B.	S.
1917.								
Nov. 11	0″	0″	2·7	6·2	2·4	5·6	1·5	2·2
Nov. 26	3″	2″	3·3	3·9	1·9	2·7	1·0	2·0
Dec. 6	0″	10″	3·4	4·0	1·2	3·9	1·2	2·4
Dec. 20	0″	18″	2·3	6·1	3·3	5·6	1·4	2·2
1918.								
Jan. 7	2″	27″	3·3	3·4	1·5	2·5	1·0	1·5
Jan. 27	0″	33″	3·0	6·3	1·2	1·8	0·7	2·2
Feb. 11	36″	30″	4·3	6·5	3·7	6·1	2·0	1·7
Feb. 25	......	......	.. Fl	ooded	..	......	......	......
Mar. 18	7″	23″	2·2	3·2	2·1	4·7	3·6	4·2
Apl. 4	0″	3″-15″	1·5	8·2	1·5	5·4	2·6	4·1
Apl. 24	0″	0″	3·9	11·0	2·9	6·0	0·6	1·7

Experiment II.

Table IIc.

Sod Covered Field Eight Years Old.

Moisture Content at Different Depths.

Date.	Depth of		5″	10″	15″
	Snow	Frost			
1917.					
Nov. 11	0″	0″	18·8	19·4	20·8
Nov. 26	3″	2″	19·0	20·0	18·0
Dec. 6	0″	10″	20·0	19·0	18·4
Dec. 20	0″	18″	18·2	15·6	15·4
1918.					
Jan. 7	2″	27″	17·6	17·2	17·2
Jan. 24	0″	33″	20·8	19·0	17·5
Feb. 11	36″	30″	19·0	17·8	13·6
Feb. 25	....	....	Flooded	....	....
Mar. 18	7″	23″	17·0[1]	17·0[1]	18·0[1]
Apl. 4	0″	3″–15″	26·7	20·8	19·2
Apl. 24	0″	0″	21·6	25·0	19·5

[1] Different place of sampling in same field.

Experiment II.

This plot was kept bare of snow from the very first until in the beginning of February high winds and drifting snow made any further snow removal impossible.

In the five and ten inch levels a slight increase in bacteria was noticed during December, due to the fermentation of dead plant roots. This increase, however, was stopped by the severe frost, and on the fifteen inch level this increase did not take place, there being no plant roots present.

Later in the winter a very slight increase was again observed, possibly due to a moderation in the frost as since the beginning of February the plot was covered with three feet of snow.

Conclusions.

1. Severe frost checked bacterial growth.

2. A slightly frozen condition of the soil allowed bacterial development.

3. In December a bacterial increase was noticed where fermentable material was present.

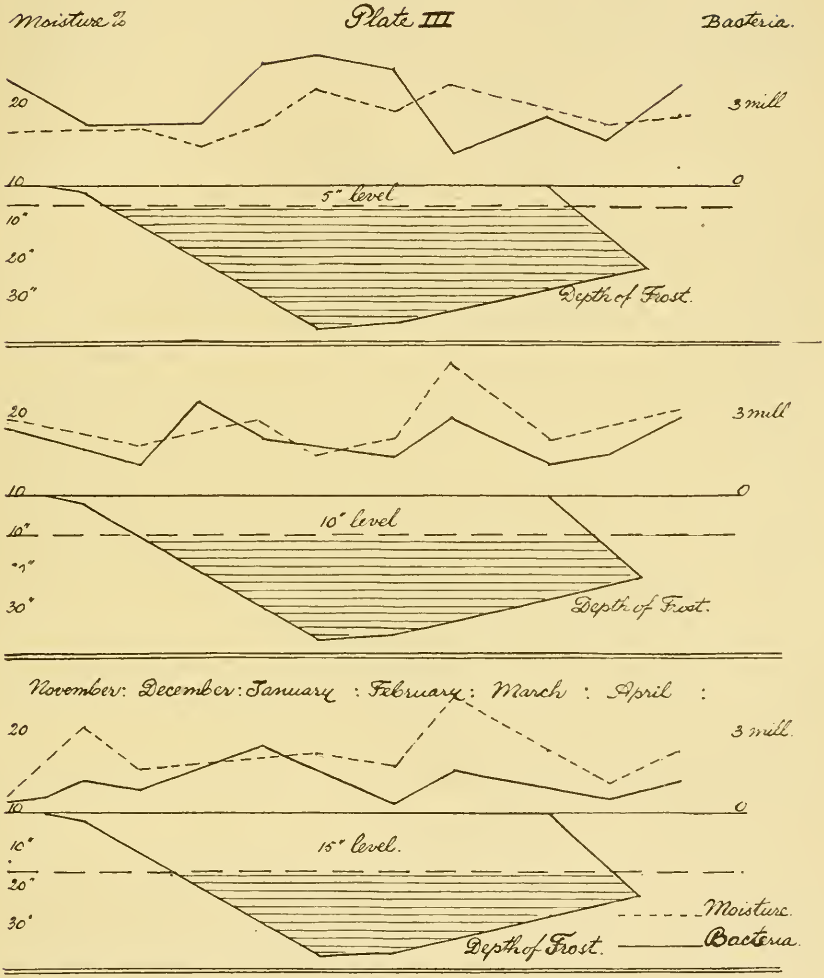
Experiment III.

Table IIIa.

Plot Fallowed for Four Years.

Average number of bacteria (in millions) per gram of soil at different depths.

Date	Depth of Snow	Depth of Frost	5″	10″	15″
1917.					
Nov. 9	0″	0″	3·2	2·2	0·6
Nov. 21	0″	2″	3·3	1·8	1·3
Dec. 5	0″	15″	2·5	1·3	1·1
Dec. 19	4″	20″	2·6	3·7	2·0
1918.					
Jan. 6	1″	27″	4·8	2·5	2·5
Jan. 21	6″	37″	5·0	1·8	1·5
Feb. 11	15″	36″	4·5	1·5	0·4
Feb. 25	7″	32″	1·3	3·0	1·6
Mar. 21	2″	27″	2·8	1·3	1·2
Apl. 4	0″	15″–23″	1·8	1·5	0·6
Apl. 23	0″	0″	4·0	3·2	1·2


Moisture %
Plate III
Bacteria.
20
3 mill
10
0
5" level
10"
20"
30"
Depth of Frost.
20
3 mill
10
0
10" level
10"
30"
Depth of Frost.
November: December: January : February : March : April :
20
3 mill.
10
0
10"
15" level.
20"
30"
Moisture.
Depth of Frost.
Bacteria.

Experiment III.

Table IIIb.

Plot Fallowed for Four Years.

Average number of bacteria (in millions) per gram of soil at different depths on different media.

Date	Depth of		5″		10″		15″	
	Snow	Frost	Media		Media		Media	
			B.	S.	B.	S.	B.	S.
1917.								
Nov. 9	0″	0″	3·1	3·3	1·5	2·8	0·4	0·7
Nov. 21	0″	2″	2·8	3·8	0·9	2·7	0·8	1·9
Dec. 5	0″	15″	1·7	3·3	0·5	2·1	0·7	1·5
Dec. 19	4″	20″	2·0	3·2	2·2	5·1	1·3	2·6
1918.								
Jan. 6	1″	27″	4·7	4·9	2·2	2·7	2·0	3·0
Jan. 21	6″	37″	4·0	6·0	1·5	2·2	1·8	1·2
Feb. 11	15″	36″	2·9	6·1	1·0	2·0	0·3	0·5
Feb. 25	7″	32″	1·5	1·1	2·2	3·7	0·8	2·4
Mar. 21	2″	27″	2·4	3·2	1·4	1·2	1·0	1·5
Apl. 4	0″	15″–23″	0·8	2·7	0·6	2·4	0·3	0·9
Apl. 23	0″	0″	3·0	5·0	2·5	4·0	0·8	1·5

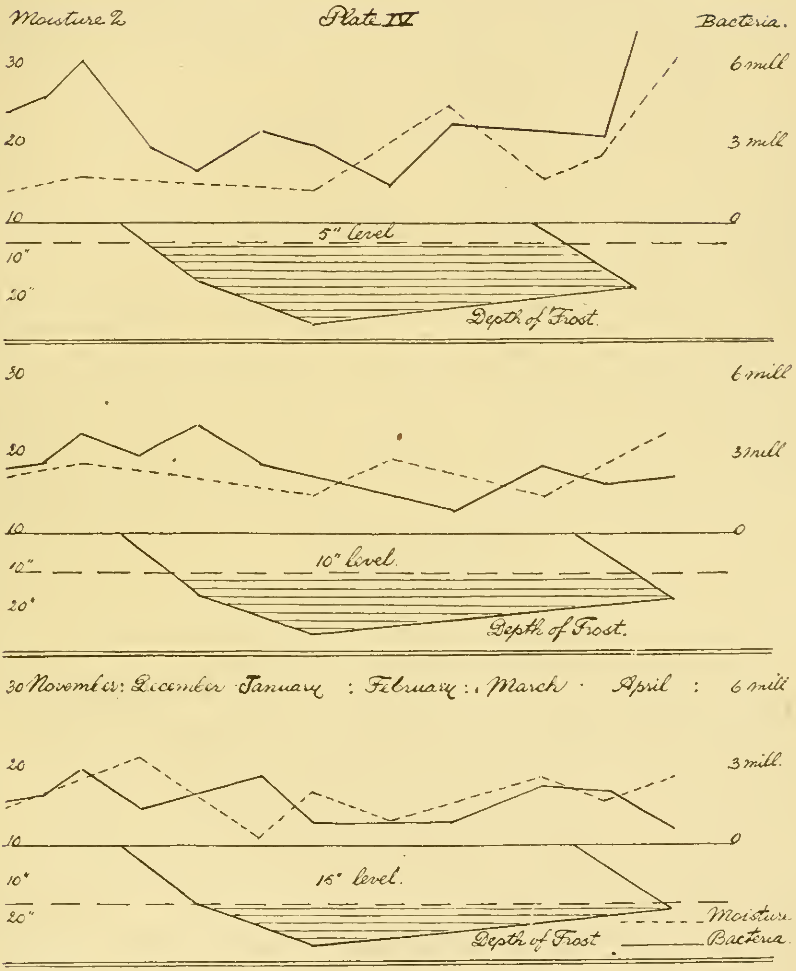
Experiment III.

Table IIIc.

Plot Fallowed for Four Years.

Moisture Content at different depths.

Date	Depth of		5″	10″	15″
	Snow	Frost			
1917.					
Nov. 9	0″	0″	16·6	18·6	15·4
Nov. 21	0″	2″	17·4	18·2	21·0
Dec. 5	0″	15″	17·3	16·0	15·5
Dec. 19	4″	20″	15·2	18·4	16·4
1918.					
Jan. 6	1″	27″	18·0	19·2	17·4
Jan. 21	6″	37″	22·6	15·0	17·6
Feb. 11	15″	36″	19·6	17·4	16·0
Feb. 25	7″	32″	23·3	27·0	25·0
Mar. 21	2″	27″	20·0	16·6	18·2
Apl. 4	0″	15″–23″	18·0	18·5	13·7
Apl. 23	0″	0″	19·0	21·0	18·0



Moisture %
Plate IV
Bacteria.
30
6 mill
20
3 mill
10
0
5" level
10"
20"
Depth of Frost.
30
6 mill
20
3 mill
10
0
10" level.
10"
20"
Depth of Frost.
30 November : December January : February : March April : 6 mill
20
3 mill.
10
0
15" level.
10"
20"
Moisture
Depth of Frost
Bacteria.

Experiment IV.

Table IVa.

Plot Sown to Grass for Three Years.

Average number of bacteria (in millions) per gram of soil at different depths.

Date	Depth of Snow	Depth of Frost	5″	10″	15″
1917.					
Nov. 9	0″	0″	4·7	2·7	2·0
Nov. 21	0″	0″	6·2	4·0	3·0
Dec. 5	0″	3″	3·0	3·0	1·5
Dec. 19	3″	16″	2·1	4·1	2·3
1918.					
Jan. 7	2″	23″	3·5	2·7	2·7
Jan. 21	4″	26″	3·0	2·4	1·0
Feb. 11	18″	25″	1·4	1·8	1·2
Feb. 25	7″	23″	3·8	0·9	1·0
Mar. 20	2″	21″	3·5	2·7	2·4
Apl. 4	0″	5″–19″	3·4	2·1	2·1
Apl. 23	0″	0″	11·5	2·3	0·9

Experiment IV.

Table IVb.

Plot Sown to Grass for Three Years.

Average number of bacteria (in millions) per gram of soil at different depths on different media.

Date	Depth of Snow	Depth of Frost	5″ Media B.	5″ Media S.	10″ Media B.	10″ Media S.	15″ Media B.	15″ Media S.
1917.								
Nov. 9	0″	0″	3·8	5·6	3·0	4·4	1·3	2·8
Nov. 21	0″	0″	3·5	9·0	2·6	5·4	3·1	2·8
Dec. 5	0″	3″	2·1	4·0	2·5	3·5	1·5	1·5
Dec. 19	3″	16″	1·5	2·8	2·6	5·7	2·1	2·6
1918.								
Jan. 7	2″	23″	3·1	4·0	2·6	2·8	2·0	3·3
Jan. 21	4″	26″	2·1	4·0	1·4	3·3	0·8	1·1
Feb. 11	18″	25″	1·0	1·7	1·3	2·2	0·8	1·5
Feb. 25	7″	23″	2·8	4·5	0·6	1·2	0·6	1·3
Mar. 20	2″	21″	2·6	4·3	2·2	3·2	1·8	3·0
Apl. 4	0″	5″-19″	1·3	5·5	1·3	4·0	1·5	2·7
Apl. 23	0″	0″	8·0	15·0	2·2	2·5	0·6	1·2

Experiment IV.

Table IVc.

Plot Sown to Grass for Three Years.

Moisture Content of different depths.

Date	Depth of Snow	Depth of Frost	5″	10″	15″
1917.					
Nov. 9	0″	0″	15·0	18·0	17·4
Nov. 21	0″	0″	16·2	18·7	18·0
Dec. 5	0″	3″	15·0	18·0	21·5
Dec. 19	3″	16″	14·8	16·6	16·8
1918.					
Jan. 7	2″	23″	14·6	15·6	11·0
Jan. 21	4″	26″	14·0	14·8	16·8
Feb. 11	18″	25″	20·8	19·5	13·5
Feb. 25	7″	23″	25·0	19·2	14·5
Mar. 20	2″	21″	16·0	15·0	18·8
Apl. 4	0″	5″–19″	19·0	19·3	16·0
Apl. 23	0″	0″	31·0	23·0	19·0

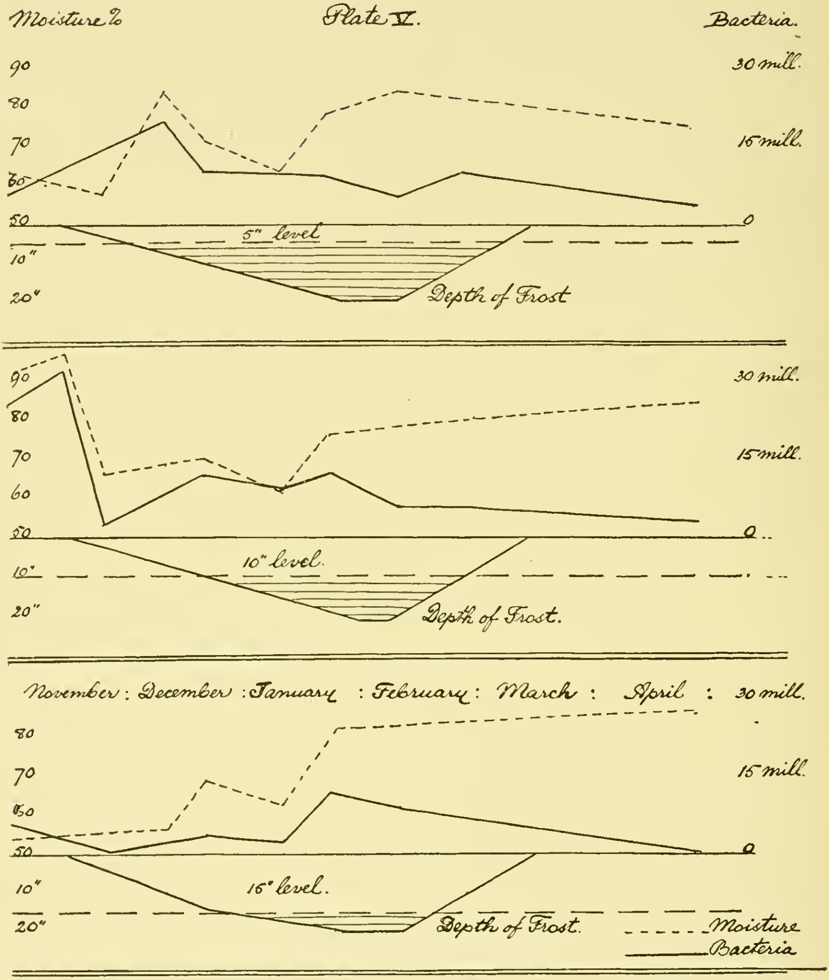
Experiment V.

Table Va.

Cultivated Black Muck Soil.

Average number of bacteria (in millions) per gram of soil at different depths.

Date	Depth of Snow	Depth of Frost	5″	10″	15″
1917.					
Nov. 13	0″	0″	8·7	32·5	3·0
Nov. 28	0″	4″	11·2	2·0	0·6
Dec. 10	0″	10″	20·5	7·2	1·1
Dec. 21	2″	12″	9·9	11·6	4·0
1918.					
Jan. 9	5″	15″	7·8	8·2	3·1
Jan. 22	0″	20″	9·0	12·1	12·9
Feb. 11	24″	20″	5·4	6·0	8·4
Feb. 27	3″	10″	9·4	5·9	Flooded
Mar. 21	....	....	Flooded	....	....
Apl. 4	....	....	Flooded	....	....
Apl. 25	0″	0″	4·6	3,2	0·4


Moisture %
Plate V.
Bacteria.
90
80
70
60
50
30 mill.
15 mill.
0
5" level
10"
20"
Depth of Frost
90
80
70
60
50
30 mill.
15 mill.
0
10" level.
10"
20"
Depth of Frost.
November : December : January : February : March : April : 30 mill.
80
70
60
50
15 mill.
0
15" level.
10"
20"
Depth of Frost.
Moisture
Bacteria

EXPERIMENT V.

TABLE Vb.

CULTIVATED BLACK MUCK SOIL.

Average number of bacteria (in millions) per gram of soil at different depths on different media.

Date	Depth of		5″		10″		15″	
	Snow	Frost	Media		Media		Media	
			B.	S.	B.	S.	B.	S.
1917.								
Nov. 13	0″	0″	9·4	8·0	15·0	50·0	1·3	4·7
Nov. 28	0″	4″	8·0	14·4	2·1	2·0	0·6	0·6
Dec. 10	0″	10″	16·7	23·4	4·5	10·0	1·0	1·3
Dec. 21	2″	12″	7·7	12·0	8·1	15·0	3·3	4·7
1918.								
Jan. 9	5″	15″	5·6	10·0	7·8	8·7	3·1	3·1
Jan. 22	0″	20″	7·6	10·5	11·3	12·9	8·8	17·0
Feb. 11	24″	20″	4·7	6·2	6·1	6·0	5·0	11·9
Feb. 27	3″	10″	7·5	11·3	5·7	6·0	Flooded	
Mar. 21	......	......	......	Flooded		......	......	......
Apl. 4	......	......	......	Flooded		......	......	......
Apl. 25	0″	0″	3·8	5·5	3·3	3·0	0·6	0·3

EXPERIMENT V.

TABLE Vc.

CULTIVATED BLACK MUCK SOIL.

Moisture Content at different depths.

Date	Depth of		5″	10″	15″
	Snow	Frost			
1917.					
Nov. 13	0″	0″	59·4	96·8	54·8
Nov. 23	0″	4″	57·5	66·0	54·0
Dec. 10	0″	10″	84·0	68·0	56·0
Dec. 21	2″	12″	71·3	70·0	69·2
1918.					
Jan. 9	5″	15″	63·7	61·0	62·6
Jan. 22	0″	20″	78·0	76·4	80·0
Feb. 11	24″	20″	83·6	78·0	83·0
Feb. 27	3″	10″	80·0	80·0	running water
Mar. 21	....	....	Flooded	....	....
Apl. 4	....	....	Flooded	....	....
Apl. 25	0″	0″	65·0	83·0	85·5

Experiments III and IV.

In these experiments we have the comparison between a cropped and a fallowed soil. In both experiments the bacterial content was low and it is hard to find any definite relations between frost, moisture and bacterial numbers, although no data obtained in these experiments contradict the main conclusions arrived at the year before and mentioned in the Introduction.

Experiment V.

In this experiment we have a soil containing so much water that it needed a very heavy frost to congeal it completely. The frost penetration was accordingly much less than in the other experiments and conditions apparently favourable for the well known increase in acterial numbers. However, on the five and ten inch levels the trend was downward and only on the fifteen inch level was there a slight increase. The moisture and bacteria curves run more or less parallel. However, some of the samples had to be thawed and drained, namely those taken on December 21st, January 9th, January 22nd. These three dates represent the depression in the moisture curve. It was not possible to estimate the influence of this water drainage on the bacterial content of the samples.

Rink Experiment.

Average number of bacteria (in millions) per gram of soil at different depths.

Date	Depth of Frost	5″	10″	15″
Mar. 19, 1917....................	25″	2·2	2·5	1·9
Mar. 25, 1918....................	2″–26″	0·9	1·9	2·4

Rink Experiment.

Moisture at different depths.

Date	Depth of Frost	5″	10″	15″
Mar. 19, 1917....................	25″	20·1	17·4	12·1
Mar. 25, 1918....................	2″–26″	19·8	18·0	23·5

RINK EXPERIMENT.

Average number of bacteria (in millions) per gram of soil at different depths on different media.

Date	Depth of Frost	5″		10″		15″	
		Media		Media		Media	
		B.	S.	B.	S.	B.	S.
Mar. 19, 1917	25″	2·8	1·6	2·2	2·8	2·6	0·7
Mar. 25, 1918	2″–26″	0·6	1·2	0·6	3·1	1·9	2·9

The bacterial content of rink soil in 1918 is slightly lower than the year before, probably due to the more severe frost. Also the Rink figures are lower than the ones obtained in Experiment II. The plot in II was only kept clear of snow until February, whilst the Rink was exposed to the frost action throughout the winter.

DISCUSSION.

In general the results obtained were disappointing, as the early and severe frost checked any bacterial action. However, winter conditions over the greater part of Canada are as encountered in this experiment, and from this systematic fortnightly soil analysis we can conclude that in winter no changes take place in the soil and that plant and crop remain during the winter in unchanged condition.

How far the millions of bacteria present in the frozen soil exercise any action at all depends on the kind of enzyme which they produce. An extra-cellular enzyme will act as long as the bacteria are alive, but for the influence of an intra-cellular enzyme active growth is necessary. This point needs careful study, but a superficial examination has indicated that ammonification and denitrification are produced by extra-cellular and nitrification by intra-cellular enzyme action. This would mean that ammonification and denitrification will continue in frozen soils even when further bacterial development is at a standstill, whilst nitrification is impossible.

The conclusions given last year stand unchallenged by any data given in this paper, and as they were mentioned in the introduction no further reference to them is necessary.

The Cretaceous genus Stegoceras typifying a new family referred provisionally to the Stegosauria

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(Read May Meeting, 1918.)

The specimens on which the Belly River Cretaceous genus *Stegoceras* was founded in 1902[2] consist of the bones forming the upper part of the brain-case. Since then other specimens pertaining to this genus have been obtained, by vertebrate palæontological parties of the Geological Survey, from the same formation in the same district on Red Deer river, Alberta. The majority of these later specimens consist of the same cranial elements as the type material, but one includes elements not preserved with the foregoing, and the remainder are cranial bones found separately and supplying additional or corroborative information regarding the structure of the skull. The more comprehensive specimen, just mentioned, is in a good state of preservation, is the best in every way so far collected, adds considerably to our knowledge of the formation of the head in *Stegoceras*, and is, for these reasons, made the subject of the following description. It is probable that other parts of the skeleton of Stegoceras are included in the collections of different years from Red Deer river but up to the present no bones except cranial ones have been recognized as pertaining to the genus.

The diapsidan nature of *Stegoceras* is revealed by the general structure of the cranium in which two distinct temporal arches are present. The laterotemporal fenestræ are large, the supratemporal ones small or closed (secondarily reduced).

Other primary characters divulged by the specimens available are:—skull small, ending squarely behind, and overhanging in occipital region, convexly elevated in parieto-frontal region. Superior cranial elements, thickened by bone of a dense, vertical, columnar structure; meeting in sutural facets of varying depth. Upper surface, except central elevation, rugose with a wart-like sculpture. Orbits large, placed well within the lateral borders. Head of quadrate received in a cotylus in the squamosal.

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[1] Communicated with the permission of the Deputy Minister of Mines.

[2] Geological Survey of Canada, Contributions to Canadian Palæontology, vol. III (quarto), pt. II, On vertebrata of the Mid-Cretaceous of the North West Territory, 1902.

The specimen to be now described, Cat. No. 138, plates I and II, belonging to the field collection of 1913, includes most of the upper back part of the skull as far forward as the fronto-nasal suture. The occipital border is preserved, and the lateral borders forward to the orbits, supplying the full breadth of the head behind. Whereas the original specimens, and a number of those collected at later dates, consist mainly of the coalesced parietal and frontal bones, the present specimen includes elements in place external to the parieto-frontal mass.

As seen from above, the specimen in outline ends squarely behind, and runs forward with a very slight diminution in breadth to the middle of the orbital rim, the postero-lateral angles being rounded. The upper surface is broadly elevated medially in the anterior two-thirds of its length, the elevation having the form of a nearly hemispherical boss which anteriorly is extended narrowly forward with an even downward slope in the longitudinal midline. The remainder of the upper surface slopes away from the base of the elevation in a broad posterior area and comparatively narrow lateral ones, the whole surface, apart from the central swelling, being decidedly convex transversely and more moderately so in a longitudinal direction. The elevation has numerous surface pits which are connected together by linear depressions which mark the sides of the columns forming the dense thickening of the cranial elements, the pits occurring at the angles of the columns. On the outer ends of the columns themselves are much smaller depressions, variable in number and shape but mostly rounded in outline. These pits, of both sizes, are the surface openings of vertical canals in the thick dermal accretion. Round the base of the elevation and over the posterior and lateral areas the bone assumes a warty or lumpy appearance with minor irregular grooves and pit markings, and with the columnar structure less in evidence at the surface. This rugose sculpture, somewhat modified, is continued down on the thickness of the posterior and lateral borders. Midway between the elevation and the posterior border are small supratemporal fossæ slightly nearer the midline than the lateral border. Distinct sutures also appear on the upper surface to which reference will be made later.

Inferiorly in the specimen are the upper and side surfaces of the brain-cavity, antero-laterally the roof of the orbital cavities, and behind them the arch of the infratemporal fossæ. The brain-cavity is preserved back to near the foramen magnum but the actual upper curved surface of that opening is apparently not present. Between the posterior end of the brain-case and the infratemporal fossa on either side is a vaulted space in the roof of which, leading to the upper surface, is the supratemporal fossa.

The cranial elements wholly or partially preserved, or indicated are determined as follows:—

Parietals and *frontals*, coalesced and forming an axial mass, most thickened and elevated in front of its posterior one-third of length.

Squamosals, constituting the overhanging postero-lateral angles of the head, bounding the parietals externally, and forming the greater part of the posterior border.

Postorbitals, external to the parieto-frontal mass in advance of the squamosals, and continuing forward the overhanging lateral border.

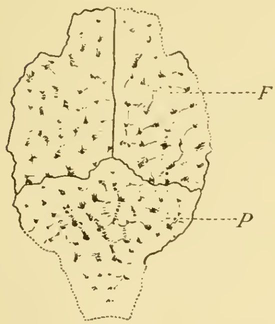
Postfrontals, external to the parieto-frontal mass, bounding the postorbitals in front, continuing the lateral border forward.

Exoccipitals, meeting above the foramen magnum.

Supra-occipital, arching back from the junction of the exoccipitals.

Otic mass, *alisphenoids*, *orbitosphenoids*, and *presphenoid* forming the side-walls of the brain-case in advance of the exoccipitals.

? *Parasphenoid.*



Parieto-frontal mass, specimen No. 2379, superior aspect, showing the interfrontal and parieto-frontal sutures, 4/10 nat. size.

The coalescence of the parietals appears to have been complete in all cases. In most of the specimens no trace is discernible, in the upper surface, of the interfrontal and parieto-frontal sutures, but in one specimen, collected in 1917 (text figure), the frontals have separated from each other and from the coalesced parietals revealing to their full depth and extent the interfrontal and parieto-frontal sutural facets; the same sutures are seen in a less perfect specimen Cat. No. 2369; also in the type of *Stegoceras validus* what appears to be an indication of the parieto-frontal suture was observed in the upper surface. In the lower surface, however, of all the specimens, the parieto-frontal sutural line is preserved, usually with distinctness, crossing the roof of the brain-cavity, and a longitudinal line toward the front generally marks the union of the frontals. The limits of the supra-occipital bone have not been fully determined. The periotics (or otic complex), the alisphenoids and the orbitosphenoids are preserved only in their upper part. A very small fragment in place (plate I, *pasp*) apparently represents all that is left of the parasphenoid.

Measurements of skull of Stegoceras, Cat. No. 138.

	Mm.
Length from middle of posterior border to fronto-nasal suture	95
Breadth at squamoso-postorbital suture	94
Breadth at orbits	84
Breadth of coalesced parietals between supratemporal fossæ	33
Distance from lateral border to supratemporal fossa	24
Depth (thickness of bone) of posterior border at midbreadth	14
Thickness of bone at fronto-nasal suture	14
Thickness of bone from roof of brain-cavity to top of parieto-frontal elevation	34
Length of brain-cavity from roof of foramen magnum to anterior end (position of olfactory lobes)	48
Length of anterior chamber of brain-cavity (position of olfactory peduncles and lobes)	14
Maximum breadth of roof of same	15
Length of main chamber of brain-cavity	30
Maximum width of same	20
Distance apart of squamosal sockets for head of quadrate	63
Breadth (transverse) of roof of orbit	31

Parietals and *frontals*. These elements are large and coalesced into a strong mass of bone which, owing to its thickness and solidity, is the form in which recognized remains of this reptile are most frequently preserved in the beds of the Belly River formation. A number of the specimens, those consisting of the united parietals and frontals, are more or less worn as if they had been rolled by water action, and present much the same appearance as those originally described by the writer in 1902.

In the parieto-frontal mass (plate I) the union of the parietals with the frontals is indicated by a transverse sutural line across the roof of the brain-cavity at about the midlength of the specimen giving the parietal contribution to the mass a length about equal to that of the frontals. The parietal portion is broadest at the parieto-frontal suture and narrows slightly backward to the supratemporal fossa, and then more rapidly to the posterior border into the formation of which it narrowly enters. The frontal portion retains its breadth forward for nearly half its length when it narrows rapidly to the anterior end. In the longitudinal midline inferiorly the suture between the frontals is obscurely shown in advance of the brain-cavity.

The parietals contribute about one-third to the margin of the decidedly small supratemporal fossæ.

Externally along the parieto-frontal mass from the posterior border to the midline in front are five sutural facets of which the posterior three are occupied in the specimen by a squamosal, a postorbital and a postfrontal. Between the postfrontal and the anterior end of the specimen are other sutural facets for elements which were not recovered with the specimen. The hindermost of these is nearly square and apparently indicates the position of a prefrontal. The whole of the sutural surface from here forward probably denotes the full extent of the contact of the nasal bone with the frontal.

Viewing the specimen from below, the frontal portion antero-externally enters largely into the formation of the roof of the orbital cavity; axially it covers the brain from the parieto-frontal suture forward, and is in sutural contact with the presphenoid, the orbitosphenoid, and the alisphenoid. In the surface supplied to the roof of the orbital cavity are a number of foramina, of variable size, the outer openings of canals debouching obliquely to the surface and directed radially outward. The parietal moiety anteriorly forms the hinder part of the roof of the brain-cavity, and is in contact with the alisphenoid and farther back with the otic mass, the exoccipital and the supra-occipital. Externally, on either side, it roofs over the inner portion of the large cavity which has the supratemporal fossa as its posterior exit above to the upper surface.

Squamosal. This bone is considerably broader than long, is thick and substantial with a rugose upper surface which is sharply defined from its nearly equally roughened, vertical borders. The bone forms the postero-external angle of the skull and enters into the formation of the supratemporal fossa to the extent of one-half of the margin of the opening.

On the upper surface of the skull the squamoso-postorbital suture runs directly outward from the supratemporal fossa, and the squamoso-parietal suture inward and backward from the same opening to the posterior border.

Inferiorly the squamosal sends a stout process forward under the mid-breadth of the postorbital, the latter being deeply channelled to receive it. Posterior to this process the bone thickens downward and in this thickening is the socket for the head of the quadrate. The line of junction with the postorbital, parietal and supra-occipital is very distinctly shown in this aspect. In advance of the posterior border is an inframarginal area extending outward from the supra-occipital and parietal and curving downward to where the bone thickens in advance of its postero-lateral angle. This area represents the amount of the posterior overhang of the squamosal.

Postorbital. Is of about the size of the squamosal and is equally heavy, with the same styles of sculpture covering its upper and border surfaces. It is four-sided in outline, as seen from above, longer than broad, narrower in front than behind, and lies external to the parietals from the supratemporal fossa and the squamosal forward to the postfrontal. It supplies about one-fifth of the margin of the supratemporal fossa.

Inferiorly it is longitudinally grooved, at a a short distance internal to the exterior free border, for nearly two-fifths of its length posteriorly for the reception of the forwardly directed squamosal process, leaving a smooth surfaced inframarginal area external to the groove. This inframarginal area and the lower face of the squamosal process together form a continuous arched surface over the laterotemporal fossa with the assistance posteriorly of the squamosal to a limited extent. Internal to the squamosal process the bone is excavated upward to form the outer half of the vaulted roof of the supratemporal cavity which leads posteriorly to the supratemporal fossa. The postorbital, at its anterior end, enters slightly into the formation of the orbital rim and the roof of the orbital cavity. Behind the orbit, next to the external border, the bone thickens downward and, judging from the shape of a broken surface here preserved, (plate I, *a*) developed a descending process to constitute the upper part of a postorbital bar separating the orbit from the latero temporal fossa. Internal to the postorbital bar the orbital cavity is confluent with the supratemporal cavity beneath an angulated transverse ridge running inward from the postorbital to the side-wall of the brain-case (alisphenoid) and defining the limits of the two cavities.

Postfrontal. This bone is small, thick, rhomboidal in outline as seen from above, with the breadth about equal to the length. It lies external to the frontal in advance of the postorbital, and has a rugose sculpture similar to that of the latter element and of the squamosal. Its external border enters the orbital rim. Its under surface is concave, continuing outward from the frontal the vaulted roof of the orbital cavity. In this surface are a number of small foramina like those of the adjacent frontal surface but directed inward instead of outward. At the front end of this bone are two sutural facets, one, next to the frontal, short, and facing directly forward, the other twice as long as the first, and facing obliquely outward and forward, between it and the lateral free border (orbital rim). The first facet in conjunction with the facet running forward and inward from it on the frontal indicates the position, it is thought, of a prefrontal. The second and larger facet is probably for a supra-orbital somewhat as in *Stegosaurus stenops* Marsh[1] which however has two supra-orbitals.

Prefrontal. A separate bone, Cat. No. 1914, referable to *Stegoceras*, and included in the collection of 1915 from the Belly River formation on Red Deer river, is apparently a right prefrontal but belonging to an individual larger than the one represented by the specimen Cat. No. 138. It has an external free border which formed part of the orbital rim supero-anteriorly. Apart from its general shape and sutural facets, its connection with and position in the orbit is indicated by its under surface which is concave and has the peculiar foraminal markings observed in the surfaces supplied to the roof of the orbital cavity by the frontal and postfrontal. As in the postfrontal the foramina, opening very obliquely to the surface, point toward the frontal. If this bone is a prefrontal the orbital rim between it and the postfrontal is completed by a single supra-orbital bone of comparatively small size at the middle of the upper curve of the rim and separated from the frontal by the postfrontal.

With the exception of a specimen, Cat. No. 2370, which may prove to be a premaxillary, no cranial elements are known in *Stegoceras* from in advance of the frontals and prefrontals but it is presumed that the facial portion was short and obtusely pointed giving to the skull, in superior aspect, a triangular outline of which the length was probably considerably less than twice the posterior breadth.

The brain-cavity of *Stegoceras* is wide in comparison with its length. Compared with the size of the skull it is small, having a total length equal to only one-half of the breadth of the skull at the parieto-frontal suture. As preserved in specimen Cat. No. 138 it consists of a main chamber, occupying the posterior two-thirds of its length, and an anterior pair of transversely placed concave surfaces which were over the olfactory lobes. The main chamber, of which the roof and most of the upper part of the side-walls are preserved, is 22 mm. long and 20 mm. in maximum width slightly in advance of its midlength. It contracts to either end, in the form superiorly of a prolate spheroid, passing posteriorly down into the foramen magnum, and expanding anteriorly into the broad, short olfactory surfaces which have a length of 15 mm. and a combined breadth of 16 mm. The olfactory tract, broadens forward, ends squarely in front, and has a median ridge, most developed anteriorly, separating the two surfaces which in their areal extent lie in advance of a line passing through the centre of the roof of the orbit on either side.

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[1] Smithsonian Institution, U.S. National Museum, Bull. 89, Osteology of the armoured dinosauria in the United States National Museum, with special reference to the genus Stegosaurus, by Charles W. Gilmore, 1914.

The roof and side-walls of the main chamber are rather smooth in front, more particularly near the midline of the roof, but elsewhere they are roughened to some extent by short irregularly disposed grooves. The shape of the chamber gives little information regarding the relative size of the main divisions of the brain behind the olfactory lobes, but apparently the cerebral hemispheres were well developed and of fair size, leaving a rather restricted space, as regards length, for the optic lobes, cerebellum, and medulla oblongata. Posteriorly the roof of the main chamber drops suddenly to the foramen magnum. At the beginning of this descent, in the midline, is a small excavation, directed obliquely upward and backward, which may indicate the position of the uppermost part of the cerebellum. Two other depressions, or openings, one on either side of, and at a slightly lower level than the one in the midline, may also represent processes of the cerebellum.

In comparison with the long, attenuated brain of *Stegosaurus*[1] that of *Stegoceras* is strikingly broad and short.

Entering into the formation of the brain-case laterally, as partially preserved in specimen 138, are a presphenoid, orbitosphenoids, alisphenoids, periotic bones, not distinguishable separately, and exoccepitals.

Presphenoid. This is a fairly large bone, in its advanced position as part of the basicranial axis, extending up on either side to form the lateral wall of the brain-cavity external to the junction of the olfactory lobes with the cerebrum. It unites above with the frontals and posteriorly with the small orbitosphenoids. Interno-superiorly, a little behind its midlength, its lateral upward extensions approach each other closely above and are separated only by a narrow frontal surface in the roof of the brain-cavity. Its external surfaces are longitudinally concave. Antero-inferiorly in the right half of the presphenoid of the specimen there is a sutural surface on which is preserved a remnant of bone which may have belonged to the parasphenoid. Inferiorly behind this sutural surface the bone is broken away so that no information is available as to its shape below.

In the specimen all of the left side of the presphenoid is missing except a small posterior marginal piece adherent in place to the frontal near the midline above. In front of this a rugose surface is preserved on the under side of the frontal representing the greater part of its sutural union with the presphenoid.

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[1] Smithsonian Institution, U.S. National Museum, Bull. 89, 1914, Osteology of the Armoured Dinosauria in the United States National Museum, with special reference to Stegosaurus.

Orbitosphenoid. Information regarding this element is derived in specimen 138 from the right side principally and that only from the upper part of the bone as it is imperfect below. The left orbitosphenoid is represented only by a remnant behind what remains of the left presphenoid. This element is narrow, and small in comparison with the presphenoid. It is wedged in between the latter bone in front and the alisphenoid behind, and meets the frontal narrowly above. Its sutures are very distinctly preserved in the specimen as shown in plate I.

Alisphenoid and *exoccipital.* Behind the orbitosphenoids are the alisphenoids which unite with the parietals and frontals above. Supero-laterally they extend outward in the direction of the postorbital bar as far as the parieto-postorbital suture. Posteriorly their boundary is not seen there being apparently a coalescence of the bones enclosing the main chamber of the brain-cavity laterally as far back as the foramen magnum. The part on either side of and above the foramen magnum is regarded as belonging to the exoccipital, the intermediate portion being composed of the periotic bones. The sutural surface separating this alisphenoid—otic—exoccipital complex from the parietal above appears distinctly both within the brain-cavity and externally. Within the brain-cavity the sutural lines meet posteriorly in the median invagination in the roof which has been already referred to as possibly indicating the position of the cerebellum. Externally the sutural lines continue inward across the occiput, meeting some distance above the foramen magnum, and marking the union of the exoccipitals with the lower end of the supraoccipital. Neither within the brain-cavity nor in the occiput is the junction of the exoccipitals, above the foramen magnum, detected. These elements, enclosing the brain-cavity laterally behind the orbitoshpenoids, are imperfect below, being broken off above the cranial foramina. None of the nerve exits is seen, in this specimen, as the brain-case is not preserved sufficiently far down to include them.

Semicircular canals. The otic mass or complex forms a convex surface internally which, protruding into the brain-cavity, reduces the width of the cavity below the level of the cerebellum. In the broken surface of the complex is indicated on each side the course of the anterior and posterior semicircular canals. The horizon semicircular canal curves outwardly within the bone and cannot be seen. In the figure, plate I, the position of the canals is shewn by the two small round openings leading up from the broken surface of the otic mass near the letters *Ot.* On the other side the surface of the bone within the brain-cavity has broken away and the two canals are seen meeting above in a curve which is foreshortened in the figure.

Supra-occipital. This bone, rising from the exoccipitals, curves backward and becomes horizontal posteriorly between the squamosals, its inferior surface facing directly downward near the posterior margin of the skull. Its junction with the parietal is not traceable, and the amount of its forward extension has not been determined.

Seemingly *Stegoceras* shows certain affiliations with the *Stegosauria* but is apparently distinct from both the *Stegosauridæ* and *Ankylosauridæ.* The observed differences separating it from both these families make it desirable to refer it to a new family, the *Psalisauridæ* which is here proposed for its reception, the name having reference to the form of the vaulted or dome-shaped roof of the cranium.

The genus *Stegosaurus* typifying the *Stegosauridæ* had an unarmoured head, but elsewhere bore plates, spines and ossicles.

The Ankylosauridæ (*'Euoplocephalus* Lambe and *Ankylosaurus* Brown) had a head covering of bony scutes, and numerous scutes on the body.

Stegoceras had no scutes on the head but probably a dorsal armature of scutes was present.

The head scutes of the *Ankylosauridæ*, forming a protective covering, became ankylosed to the underlying bones of the skull without conforming to their boundaries.

In the *Psalisauridæ* (*Stegoceras*) protection was provided by a thickening of the investing bones of the upper surface of the skull which met in sutural planes or facets of varying depth. The sutural lines can be traced on the outer surface except where they were effaced through coössification as was usual in the case of the parieto-frontal and interfrontal sutures, and constant between the parietals. The upper surface of the skull is sculptured indicating that scutes were not present.

In a right squamosal (Cat. No. 2375) obtained in 1917, from the Belly River formation on Red Deer river, the upper surface besides presenting the usual wart-like sculpture develops conspicuous, low, conical projections or spines, pointing upward, in a transverse row above and along the posterior border. This ornamental feature is not present in the type of *Stegoceras validus* but is highly suggestive of the style of sculpture to be expected, modified or accentuated, in the body scutes of the genus.

The armoured dinosaurs (*Ankylosauridæ*) of Belly River and Edmonton age, of which a number in the collections of the Geological Survey await description, have short, more or less triangular heads, flatly convex above. It is probable that among these a number of distinct genera are represented. To the general ankylosaurid shape of head that of *Stegoceras* to some extent conforms. In the *Ankylo-*

sauridæ the protective covering of scutes hides the upper investing bones of the skull so that until material representing the members of this group has been further studied a full comparison of the skull in the two families cannot be made.

Stegoceras differs from other known forms of armoured dinosaurs in the manner in which the head is protected. A marvellous thickening of the elements above the brain-case and a more moderate strengthening of the lateral elements resulted in modifications affecting the proportions of the bones as well as their mode of sutural union. Whereas in the dinosauria generally the majority of the bones of the upper surface of the skull are moderately thin and many of them have squamous sutures, in *Stegoceras* the thickness of the bones usually precludes an overlapping contact and results in a simplified contour with a reduction to a minimum of prolongations which if they do occur are heavy and robust as seen in the forwardly directed spur of the squamosal beneath the postorbital. The upper bones of the skull in *Stegoceras* show a tendency to become prismatic, meeting in vertical or nearly vertical sutural planes or facets which are generally marked by numerous irregular vertical ridges and grooves. The thick bones meet and support each other after the manner of the ice blocks in an Eskimo hut or the hewn members of a stone arch.

The thickness of the bones (parieto-frontal mass) above the brain-cavity seems quite disproportionate to the size of the cavity itself but is thoroughly in accord with the surprising weight of bone borne by most of the Cretaceous armoured dinosaurs in the form of heavy plates and spines on the back and tail.

In Stegoceras there are certain features in the form and composition of the skull which suggest a relationship to the *Stegosaurus* type. These resemblances are seen in the posterior breadth of the cranium, the well separated supratemporal fossæ, and the large size of the laterotemporal fossæ and orbits, the last looking outward from beneath overhanging rims. In both genera supra-orbital bones are developed, two pairs in *Stegosaurus* but apparently only one in *Stegoceras*.

The differences marking the divergence of *Stegoceras* from the *Stegosaurus* type are seen, in the former, in the abbreviation of the skull, in the union of the parietals and frontals in a solid mass of bone of extraordinary thickness, and in the general thickening of the remaining upper cranial elements accompanied by a horizontal expansion of the bones of the supratemporal arcade, reducing the size of the supratemporal fossæ, or entirely closing them, and causing the posterior border and the hinder part of the lateral borders to overhang.

The compactness of the parieto-frontal complex, and the denseness of the bones of which it is composed accounts for the frequent preservation of this part of the skull. Of the twelve or more specimens collected, all, with the exception of the one described and figured in this paper, Cat. No. 138, consist only of the thickened coössification of parietals and frontals from which the squamosals, postorbitals, and the more anterior bones bordering on the frontals forward to and including the nasals had dropped off, some evidently before the central mass had come to rest and been buried in sand or clay.

That *Stegoceras* attained a much larger size than is indicated by the specimen Cat. No. 138 is shown by the largest and most massive specimen collected, Cat. No. 192, which is nearly twice as thick and broad as No. 138.

The proportion of thickness of the parieto-frontal mass, at the parieto-frontal suture, to its breadth at the same suture in a number of specimens is as given below, all of the specimens with the exception of No. 138 consisting of the parieto-frontal mass only.

Specimen, Cat. No.	Thickness	Breadth	Proportion of thickness to breadth
138	34 mm.	52 mm.	about $\frac{2}{3}$
2379	40 "	60 "	" $\frac{2}{3}$
1108	36 "	54 "	" $\frac{2}{3}$
1107	41 "	62 "	" $\frac{2}{3}$
192	64 "	95 "	" $\frac{2}{3}$
121	28 "	45 "	" $\frac{3}{5}$
194	24 "	46 "	" $\frac{1}{2}$
193	23 "	48 "	" $\frac{1}{2}$

From the above measurements it is seen that the relative thickness of the bone above the brain varies to some extent. It is constant at about two-thirds of the breadth in the first five specimens which include the very large one No. 192. In specimen No. 121, referred to a proposed new species *S. brevis* (see p. 35), there is a slight variation, and in the last two, the thickness is noticeably less.

A specific determination of the above specimens is not attempted now, except in the case of Nos. 138 (*S. validus*) and 121 (*S. brevis*) which are more comprehensive and better preserved than the others, and supply the data necessary, in the present state of our knowledge of the genus, for such a determination.

Stegoceras is a diapsidan reptile differing from any described form, but apparently approaching most closely the *Stegosauridæ* (*Stego-*

saurus, *Scelidosaurus*, etc.) and the *Ankylosauridæ* (*Euoplocephalus* and *Ankylosaurus*). The new family, the *Psalisauridæ*, proposed for its reception, is provisionally referred to the *Stegosauria*, ranking equally with the above subdivisions of the armoured dinosaurs. Possibly it may be found necessary when more is known of the structure of *Stegoceras* to advance the family to higher rank among the divisions of the *Orthopoda* (*Predentata*) under the name *Psalisauria*.

For the present the characters of this extraordinary reptile may be summarized as follows:—

PSALISAURIDÆ, fam. nov.

Family characters. —Skull small, with outer investing bones greatly thickened and meeting in deep sutural facets. Bone structure dense, prismatic. No dermal head plates.

Generic characters. Skull triangular, ending broadly and squarely behind. Occiput overhanging. Parietals and frontals coössified, and thickened to form a broadly convex elevation in the upper surface of the skull. Orbital cavities large, extending far inward. Laterotemporal fossæ large. Supratemporal fossæ reduced. Brain small, broad in comparison with its length.

Stegoceras validus. Generic and specific type, Cat. No. 515. Belly River formation, Red Deer river, Alberta, east side, below the mouth of Berry creek, Aug. 15, 1898. Described and figured in 1902 (op. cit. ante, p. 68, pl. XXI, figs. 1 and 2).

Stegoceras brevis, sp. nov. Specific type, Cat. No. 1423, Belly River formation, Red Deer river, east side, below Berry creek, Aug. 24, 1901; referred to in 1902 (op. cit. ante, p. 68, pl. XXI, figs. 3, 4 and 5) under the name *S. validus* as the smaller of two specimens figured. The opinion was then expressed that the smaller specimen might belong to a species distinct from *S. validus*.

That two species of Stegoceras are represented by the specimens from Red Deer river is now made clear by the additional structural information supplied by specimen No. 138.

The second species, for which the name *brevis* is proposed, differs in the following particulars from *S. validus*:—

The parieto-frontal mass is shorter in comparison with its breadth.

The upper parietal surface between the squamosals instead of extending backward almost horizontally or at a moderately inclined downward slope to the posterior border curves convexly downward so as to become almost vertical posteriorly.

Plate I. *Stegoceras validus;* Cat. No. 138.

Figure 1. Inferior aspect; natural size.

Figure 2. Right lateral aspect; natural size.

Abbreviations.—*Als*, alisphenoid; *Exo*, exoccipital; *F*, frontal; *ltf*, laterotemporal fossa; *n*, sutural facet for nasal; *Ot*, otic mass; *orb*, orbit; *Ors*, orbitosphenoid; *P*, parietal; *Pof*, postfrontal; *Por*, postorbital; *prf*, sutural facet for prefrontal; *Pasp*, parasphenoid; *Psp*, presphenoid; *psq*, process of squamosal; *Soc*, supra-occipital; *sor*, sutural facet for supra-orbital; *Sq*, squamosal; *sqc*, squamosal cotylus for head of quadrate; *stf*, supratemporal fossa; *a*, broken surface.

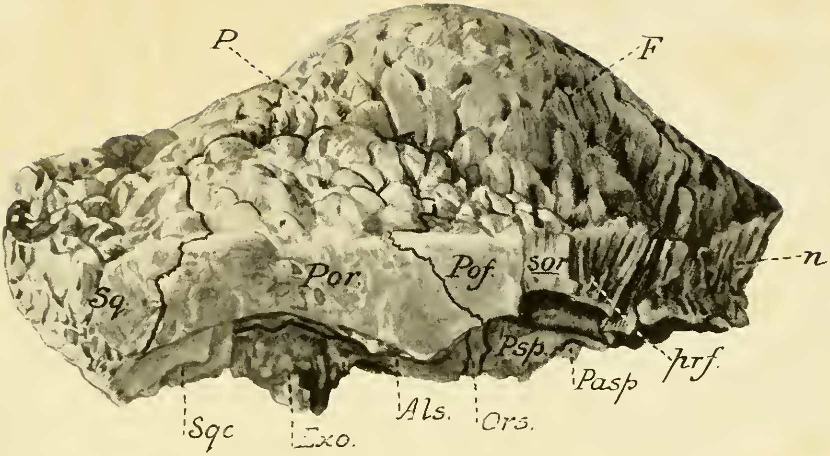


Figure 2.

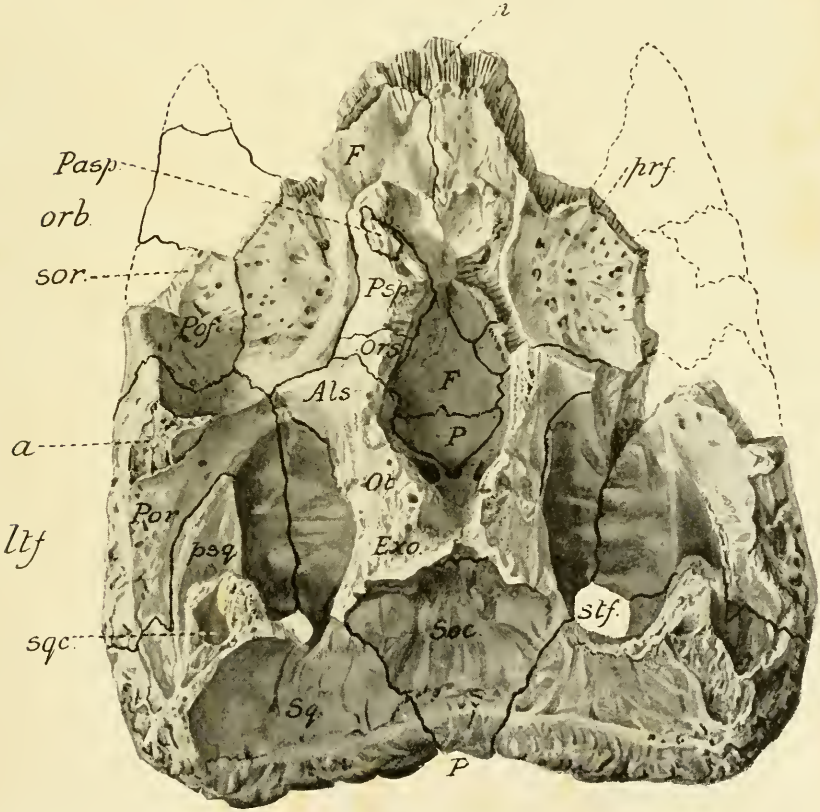
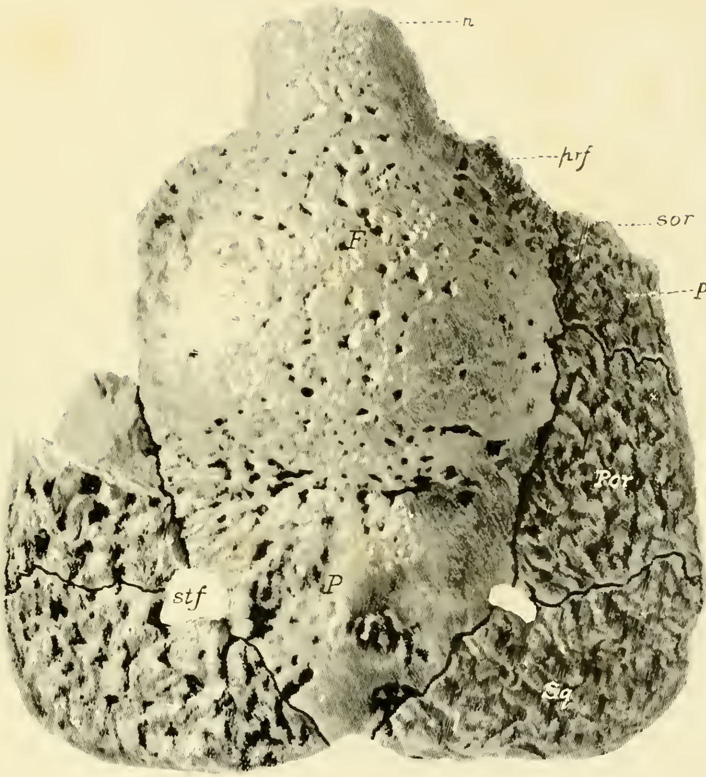


Figure 1

Plate II. *Stegoceras validus;* Cat. No. 138; superior aspect; natural size.

Abbreviations.—*F*, frontal; *n*, sutural facet for nasal; *P*, parietal; *Pof*, postfrontal; *Por*, postorbital; *prf*, sutural facet for prefrontal; *sor*, sutural facet for supra-orbital; *Sq*, squamosal; *stf*, supratemporal fossa.

PLATE II.



Notes on the Origin of Colerainite.

By EUGENE POITEVIN.

Presented by W. McINNES, F.R.S.C.

(Read May Meeting, 1918.)

In seeking an explanation of the conditions required for the genesis of colerainite, which they had identified in the laboratory as a new mineral species, the authors of Museum Bulletin No. 27 of the Geological Survey[1], Poitevin and Graham, were obliged to base their conclusions on the evidences presented by a few specimens which had been obtained on the dumps of the Standard and Union pits at Black Lake, the mineral at the time not having been found in place.

Investigations carried out both in the field and in the laboratory upon the diopside, grossularite, and vesuvianite, which occur in the same localities, had led to the theory that these minerals were in large measure recrystallizations of materials which had been dissolved from the invaded country rocks by the extremely acid and igneous magmas, which furnished the materials of the veins representing the final phases of the intrusive period. Owing to the close similarity between the mineral associates of colerainite and those of diopside, grossularite, and vesuvianite, it was assumed that all of these minerals had originated under like conditions. It was, however, noted that the pits from which the colerainite had been derived were asbestos pits and, therefore, associated with dykes which had invaded a limeless or nearly limeless region of country rocks.

Since the original article bearing on this subject was written, one of the authors, the present writer, has visited the localities in which the colerainite is found; and observations made under more favourable conditions and in the light of previous experience, while adding confirmatory evidence to former views regarding the genesis of diopside, grossularite, and vesuvianite, throw doubt upon the view that the genesis of the colerainite was similar.

Colerainite was observed in place at the Union pit and at one other pit in the vicinity, and in both instances it was found to be confined to those portions of the dykes subject to the action of surface waters. With the colerainite there were found associated in the

[1]Contributions to the mineralogy of the Black Lake area, Dept. of Mines, Geological Survey, Museum Bulletin No. 27.

dykes masses of porcellophite and aphrodite, a few flakes of brown mica, a few crystals of reddish brown garnet, and occasionally a crystal of tourmaline or zircon. Dykes at the American Chrome pit somewhat similar in character were found to contain kaolinite, which is generally regarded as a decomposition product of aluminous silicates such as the feldspars.

There are then in the dykes with the colerainite certain minerals like mica and garnet which could not have maintained themselves against the solvent action of hot magmas and still others like kaolinite, porcellophite, and aphrodite which are undoubtedly formed under the influence of cold solutions. All the evidence upon the point, therefore, indicates that colerainite has been formed near the surface of the pegmatite dykes as a result of the interaction between aluminous materials of the dykes and magnesium salts carried down by surface waters.

The alteration of aluminous silicates, chiefly feldspars, in the dykes has given rise to the formation of hydrous silicates the most clearly defined of which are kaolinite and colerainite.

The derivation of kaolinite from albite through the agency of carbonated waters has probably taken place according to the following equation:—

$$\underset{\text{Albite}}{2(Si_3O_8NaAl)} + CO_2 + 2H_2O = \underset{\text{Kaolinite}}{Al_2Si_2O_9H_4} + Na_2CO_3 + 4SiO$$

the carbonate of sodium and the silica being removed in solution.

It is quite within the realm of possibility that some such change as this takes place preliminary to the formation of colerainite, but as far as has been observed kaolinite is absent from those portions of the dykes which hold colerainite and the latter mineral may have been formed directly from the feldspar by the action of magnesia-bearing waters in accordance with the following formula:—

$$\underset{\text{Albite}}{2(Si_3O_8\,NaAl)} + CO_2 + 4MgO + 5H_2O =$$

$$\underset{\text{Colerainite}}{2(AlSiO_8\,Mg_2H_5)} + Na_2CO_3 + 4SiO_2$$

and as brucite is of common occurrence in the area there seems to be little to preclude such a reaction as is here indicated.

The evidences in favour of the hypothesis which is now suggested to account for the origin of colerainite may be summarized as follows:—

1. None of the characteristic products of pneumatolysis has been observed in the dykes carrying colerainite.

2. The presence of mica and other primary minerals in these dykes incapable of withstanding the solvent action of heated magmas is not compatible with the theory of pneumatolysis.

3. The colerainite is limited to those portions of the dykes which have been subject to the influence of surface waters.

A Report on Results Obtained from the Microdissection of Certain Cells.

By Robert Chambers, Cornell University Medical College,
New York City.

Presented by J. Playfair McMurrich, F.R.S.C.

(Read May Meeting, 1918.)

Introduction.

Cytological research has hitherto been confined largely to observation through the microscope 'at a distance' as it might be said. It has been clear to investigators that such a method may lead to erroneous conclusions and it is true that a great deal of confusion has resulted from misinterpretations of optical appearances and the description of artifacts as if they existed normally in the cell. This confusion is largely responsible for the fact that the true significance of cell anatomy is in danger of being ignored by many physiologists.

As long ago as 1859, Doctor H. D. Schmidt of Philadelphia, attempted to dissect cells by means of a 'microscopic dissector,' consisting of a base to be fastened on the stage of a microscope with a number of clamps to hold instruments, each clamp possessing three movements controlled by screws. A lever fastened in one of the clamps holds the tissue in place. Fine scissors, knives or steel needles are fastened in the other clamps. By turning the various screws, the instruments can be brought into place and be operated with remarkable accuracy. Doctor Schmidt worked with the tissue, the instruments and the lower lens of the objective immersed in water or diluted alcohol.

The principle introduced by Schmidt, viz., the use of screws to control movements of instruments lying in the focus of a microscope objective seems to have been for a long time lost sight of. It was revived in 1907 and elaborated in 1914 by M. A. Barber, lately of the University of Kansas, in his construction of an instrument to manipulate micro-pipettes. With this instrument Barber was able to isolate single micro-organisms and to inoculate living cells with bacteria. Barber's instrument was soon applied to the dissection of cells (Kite and Chambers '12) and a new field of endeavor was opened for the study of the structure of protoplasm and cell mechanics.

The Instrument.

The apparatus used in cell dissection is shown in the accompanying figure. The moist chamber, which is open at one end and with sides from 8 to 12 mm. high, is placed on the microscope so that it may be moved about with the mechanical stage. The chamber is roofed over with a specially cleaned coverslip, on the under surface of which, the specimen is mounted in a hanging drop of Ringer's or lymph fluid and held in place by surface tension. The dissecting needle is made by drawing out one end of a piece of hard glass tubing which is then bent at right angles, two or three millimeters from the pointed tip. The needle-holder, a mechanism allowing of three movements, is clamped to one side of the miscroscope stage, and the needle is adjusted so that it projects into the moist chamber with its tip pointing up into the hanging drop. By proper adjustment the cell to be dissected and the point of the needle can be brought into the same focal field. The three movements of the needle permitted by the needle-holder and the two movements of the moist chamber by the mechanical stage give the experimenter ample opportunity to carry on dissection under the highest magnification of the microscope. The dissecting needle-points can be made stiff and yet so fine that their size bears about the same relation to that of a human red blood corpuscle as an ordinary knitting needle does to the palm of the hand.

Through the courtesy of the Biological Board of Canada I was given in July 1917 the opportunity of continuing some microdissection work at the Atlantic Biological Station, St. Andrews, N.B. I have to thank Dr. Clara C. Benson for allowing me to take some material from lobsters she was using for experimental purposes.

Experimental.

The ganglion cells of the Lobster. The ventral nerve cord was laid bare and pieces of a nerve ganglion excised and placed on a thin coverslip in a drop of lobster blood serum. This liquid is expressed during a preliminary clotting of the blood and does not itself clot for a considerable length of time. The nerve cells are carefully isolated by teasing with needles under an ordinary dissecting microscope. The coverslip is then inverted and placed on the moist chamber so that the nerve cells lie in a hanging drop ready for microdissection. The cell bodies lie among the closely interlaced nerve and neuroglia fibers. When the fibers are torn away, the cell body may be isolated with ease.

The cell cytoplasm is very viscid in consistency and allows of considerable tearing without disintegrating. Highly refractive spindleshaped bodies, the mitochondria, imbedded in the cytoplasm are very prominent. The cytoplasm is very extensile and exhibits a certain amount of rigidity throughout its substance. It can be pulled out into long, viscous threads and the imbedded mitchondria are drawn in the direction of the pull.

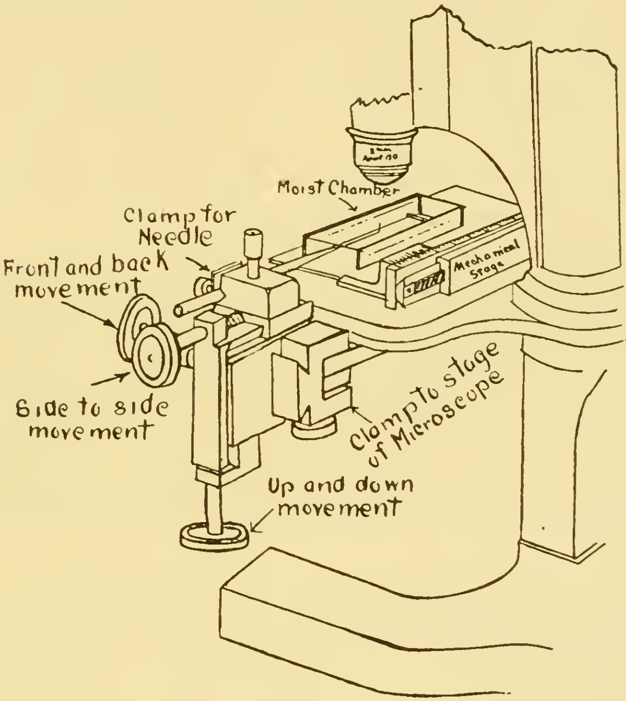


Figure 1. Barber's Three-Movement Pipette Holder, Glass Needle and Moist Chamber arranged to illustrate method of dissecting cells in a hanging drop under the highest magnification of the microscope. (Substage of microscope omitted in drawing.)

On exerting a pull on the cytoplasm in a direction away from the nucleus, a triangular space appears in front of the nucleus and persists for a few minutes. This is due to the viscosity of the cytoplasm which prevents an even flow of material around the nucleus as should occur if the cytoplasm were liquid.

There is a limit to the amount of mechanical injury which the cytoplasm can bear without completely changing its normal properties. When this limit is passed the viscid plasma sets into a coagulated, non-viscous mass which may be broken into non-glutinous pieces.

The cell nucleus is an optically hyaline sphere occupying about one-fourth of the cell. Within the hyaline substance of the nucleus lies a small body, the nucleolus, which is visible because of its high refractivity.

The extremely sensitive nature of the nucleus is evidenced by the fact that, on the slightest mechanical injury, certain changes occur which cause the nucleolus to fade completely from view. The nucleus may be pushed about in the cell without apparent injury. If the surface be torn the contents flow out and the nucleus disappears. If care be taken the nucleus may be cut in two, each portion at once assuming the shape of a sphere. This indicates a high power of extensibility and regeneration in the surface film. On pulling the nucleus out of the cell the nucleus immediately begins to swell and fades from view.

The Egg Cell of the Flounder. The immature egg of the flounder of about half a millimeter or less in diameter was selected for this study. The nucleus is a liquid sphere similar to that of the nerve cell. It, however, possesses a more persistent surface film or nuclear membrane. This may be caught by the tip of the needle and a considerable strand pulled out. The nucleus is easily cut into several pieces which immediately round up. On touching one another the portions fuse indicating the absence of a morphologically persistent nuclear membrane.

Considerable injury is necessary to bring about dissolution of the nucleus and the surface film is the last to disappear. Injury apparently causes this film to set into a definite membrane, so that when torn it often wrinkles and a fluid (apparently the nuclear sap) collects between the cytoplasm and the partially collapsed membrane.

The flounder egg is surrounded by a closely fitting tough egg membrane. This rather interferes with an adequate comprehension of the consistency of the cytoplasm, especially of that on the cell surface. Results obtained from studies made in other marine ova are more satisfactory.

The egg cell of Asterias. Work done at St. Andrews on *Asterias* confirms the views already published (Chambers '17[a], 17[b]) on the cell protoplasm of Echinoderm ova. The protoplasm consists of a hyaline fluid matrix in which are imbedded granules of various sizes. The fluid offers no perceptible resistance to the needle and an indication of its very slight viscosity lies in the fact that, when the needle is moved through the fluid, the only granules displaced are those in the immediate vicinity of the needle. The protoplasm coagulates with ease. Mere compression will sometimes cause an egg to coagulate into a solid mass.

The surface layer of the egg cell is dense in consistency when compared with the cell interior into which it merges insensibly. In the unfertilized egg, the cell granules are imbedded in it up to the very line of division between the egg and surrounding medium. With the needle the surface may be pulled out into long strands without otherwise disturbing the contour of the cell. On being released the strands tend to curl and retract slowly till they disappear. If a more rapid tear be made, and if the cell be under compression, the spot torn bulges out as the internal cytoplasm presses on the weakened surface. The surface layer of the swelling protuberance is very easily broken, upon which the interior may pour out. The cytoplasm then either disintegrates entirely in the surrounding water or, if remaining normal, reestablishes a film on its surface. When left undisturbed the new surface film gradually strengthens into a definite ectoplasmic layer and the protuberance slowly retracts until the original contour of the egg is reestablished. If the point of attachment of the protuberance be small, the protuberance may be pinched off to form a spherule of cytoplasm which to all appearances is normal.

In summary, we may say that the surface layer is a highly extensile, contractile and viscous gel capable of constant repair. Its establishment and maintenance is a property essential to protoplasm. With the film intact the mass of protoplasm maintains itself and the life of the cell is assured. When the film is destroyed the cytoplasm flows out, the cell granules swell and disappear, the whole mass completely disorganizes and disappears in solution in the surrounding water.

The egg cell of Solaster. The Solaster egg is very large when compared with other Echinoderm eggs, being well over 1 mm. in diameter. This is partly due to the fact that it is heavily laden with yolk. The nucleus, however, is also very large, so large in fact that it is visible to the naked eye and can be easily isolated with needles under an ordinary dissecting microscope. Its enveloping surface film exhibits a distinct resistance to compression. Tearing the surface allows the fluid contents to escape and the nuclear wall collapses. The *Solaster* egg appears to be the only case on record of a Metazoon cell of which the nucleus is large enough to be actually handled and dissected with ordinary needles.

Conclusion

In conclusion, one may make the following statements with regard to the consistency of the living cells which were dissected:

1. The cytoplasm of an egg cell consists of a semi-liquid interior enclosed in a jelly-like and highly viscous surface layer. The surface

layer is very extensile and contractile and is readily regenerated upon injury. Tearing of this surface, if unrepaired, results in the pouring out of the internal cytoplasm and dissolution.

2. The cytoplasm of the nerve cell exhibits, throughout its substance, the properties of the surface layer of the egg cell, viz., it consists of a highly viscous, extensile, jelly-like hyaline substance.

3. The resting nucleus of all the cells studied is a liquid sphere, the external surface of which may form a more or less temporarily rigid membrane.

4. The production and maintenance of a limiting membrane appears to be one of the properties essential to protoplasm.

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The Scale Method of Calculating the Rate of Growth in Fishes.

By A. G. HUNTSMAN, B.A., F.R.S.C.

(Read May Meeting, 1918.)

Comparatively recently the discovery was made that the age of a fish could in many cases be found out by examining its scales. In a tree can be seen revealed in the wood the story of its growth. As winter alternates with summer, so does dark zone alternate with light zone, as shown in a cross section of the trunk of the tree. Similarly in the scale of a fish the alternation of the season is reflected by an alternation of zones of rapid and slow growth. By counting these the age is readily determined.

Successive zones on the scale often differ greatly in width. The scale grows much more in some years than in others. The idea was conceived by certain Norwegian scientists that the variation in width of the zones might reflect the variation in growth of the fish in successive years. If the scale grows proportionally at the same rate as the fish, it will be possible by measuring the width of a complete zone, representing a year, on the scale, to determine by calculation the amount of growth of the fish in that year. For example, if a fish 20 centimetres long and three years old has a scale measuring 2 millimetres from centre to margin, then, if the yearly zones measure $0 \cdot 9$, $0 \cdot 7$, and $0 \cdot 4$ millimetres respectively, the growth in length of the fish during the first year was $\frac{0 \cdot 9 \times 20}{2} = 9$ c.m., during the second year, $\frac{0 \cdot 7 \times 20}{2} = 7$ c.m., and during the third year $\frac{0 \cdot 4 \times 20}{2} = 4$ c.m., Measurements of a certain scale in a large number of herring of different sizes seemed to show that the scale does grow approximately at the same rate proportionally as the fish. Following this discovery very many calculations have been made of the growth rate in individual fish of many kinds.

However, the correspondence in rate of growth between the scale and the fish is far from exact. The scale appears only after the fish has attained some size, namely at the time of transformation from the larval condition into that of the adult. The growth of the scale compared with the growth of the fish is at first very rapid, but later it diminishes. The scales do not all appear at the same time nor do they grow at the same rate and all parts of the same scale do not grow at the same rate. The difference in appearance between the winter and summer zones is brought about by a difference of growth within the scale, whereby in the slow period of growth new rings, or circuli as they are called, are formed more rapidly than the scale increases in diameter, so that the circuli are crowded together. That is, the very use of the scales in age-determination depends upon differential growth within the scale.

The importance of recognizing and allowing for this lack of correspondence in the growth of the scale and the growth of the fish will be evident from the following example. A flat-fish (*Hippoglossoides platessoides*) 132 m.m. long from Passamaquoddy Bay, captured on November 15th was completing its second year's growth. Calculation of its size at the end of the first year by the method described gave a length of 22 m.m. when a large scale from the side of the tail was used, and one of 12 m.m. when a small scale from near the posterior fin was used. Both of these values are much too small, for the scales do not appear until the fish is about 30 m.m. long. By using the method of calculation which will be described a value of 44 m.m. was obtained, whether the scale used were large or small.

This method of calculation, which takes into account the differential growth of the scale and the fish, is as follows. The part of the scale which shows the summer and winter zones most clearly is the anterior part, which is covered by the scales in front. The dimension used in length calculations is from the focus, or centre of origin, to the anterior tip, and its average value in scales of a certain kind (*e.g.* the scales from the side of the tail) is found for fishes of different sizes. As an example in the case of the flat-fish *H. platessoides* five individuals of each of the following lengths were taken—5, 10, 15, 20, 25, 30, 35, 40, 45 and 50 c.m., and for each individual five 'tail' scales were taken and the average value of the dimension found. Then the average value of the dimension for the five individuals of each size group was determined and these values plotted against the lengths of the fishes as shown by the upper series of dots in figure 1. The curved line drawn as nearly as possible through these dots represents the probable average relation of the dimension to the length of the fish. This curve originates in the base line at a length of the fish of about 3 cm. This curve may be used for the length-calculations. If from a certain fish a scale be selected with the distance from the focus to the anterior end equal to the average value of that dimension for the size to which the fish belongs, it will be comparatively easy to determine the yearly growth by measuring the successive zones and finding by reference to the curve the amount of the length of the fish to which each zone corresponds. For example,

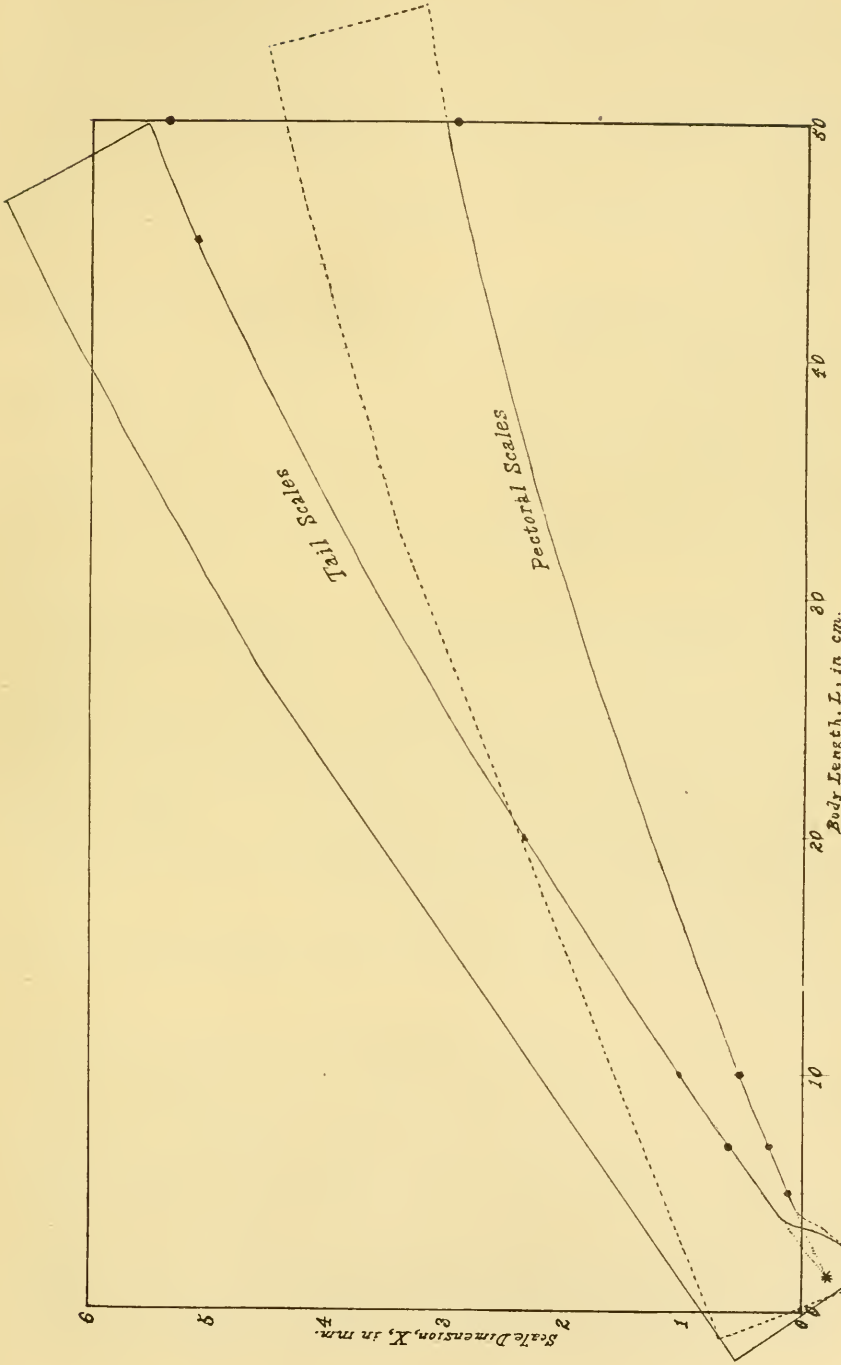

Figure 1. H. platessoides. Relation of scale length to body length.

in the case of the curve figured, if it is found that during the second year the scale grew from 0·7 mm. to 1·5 m.m. giving a width of 0·8 m.m. for the zone, this would correspond with a growth in length of the fish from 7·5 c.m. to 13·5 c.m. The great disadvantage of this method is the difficulty of obtaining from the fish a scale of the proper length showing the zones clearly. It is therefore important to have a method that can be used for almost any scale, and for that we must determine the regularity in the variation of the curves for scales of different sizes.

Curves representing the relation of very large scales and of very small scales to the length of the fish would be similar in character to the one shown, but would be placed differently, those for the large scales above, and those for the small scales below, the curve shown. We have in fact determined the curve for certain small scales, called pectoral scales, situated near the pectoral fin. The data for this determination are summarized in the lower series of dots in the figure (1), and the curve itself, which is shown passing through these dots, proves to be of essentially the same character as that for the tail scales.

The divergence of such curves from each other increases with increase in the size of the fish. that is, there is less divergence near the points on the base line where the curves commence. They all, in fact, appear to converge at a point below the base line, at least all in the same series, for there are indications that the series of scales along the lateral line from the tail to the pectoral fin, which is the one we are considering, differs in this respect from other series, as for example, those farther from the lateral line. A scale from the dorsal part of the tail may appear considerably later than the pectoral scales and nevertheless surpass them in growth.

The point of convergence of the curves in our series may be found by determining at least two of the curves and projecting them until they meet.

An alternative indirect method has given the same result. The curve, which was determined for the average tail scale, was made movable by cutting it from a piece of thin wood or cardboard. When this movable curve was made to rotate about the point where the curve intersects the base line and when length calculations were made with scales of different sizes, it was found that the values for the first year's growth of a fish were much lower for large scales than for small ones. When the curve was made to rotate about the point where it intersects the vertical line through the zero point on being produced, the values were higher for the large scales than for the small ones. By trial a point was found as a centre of rotation, for which the

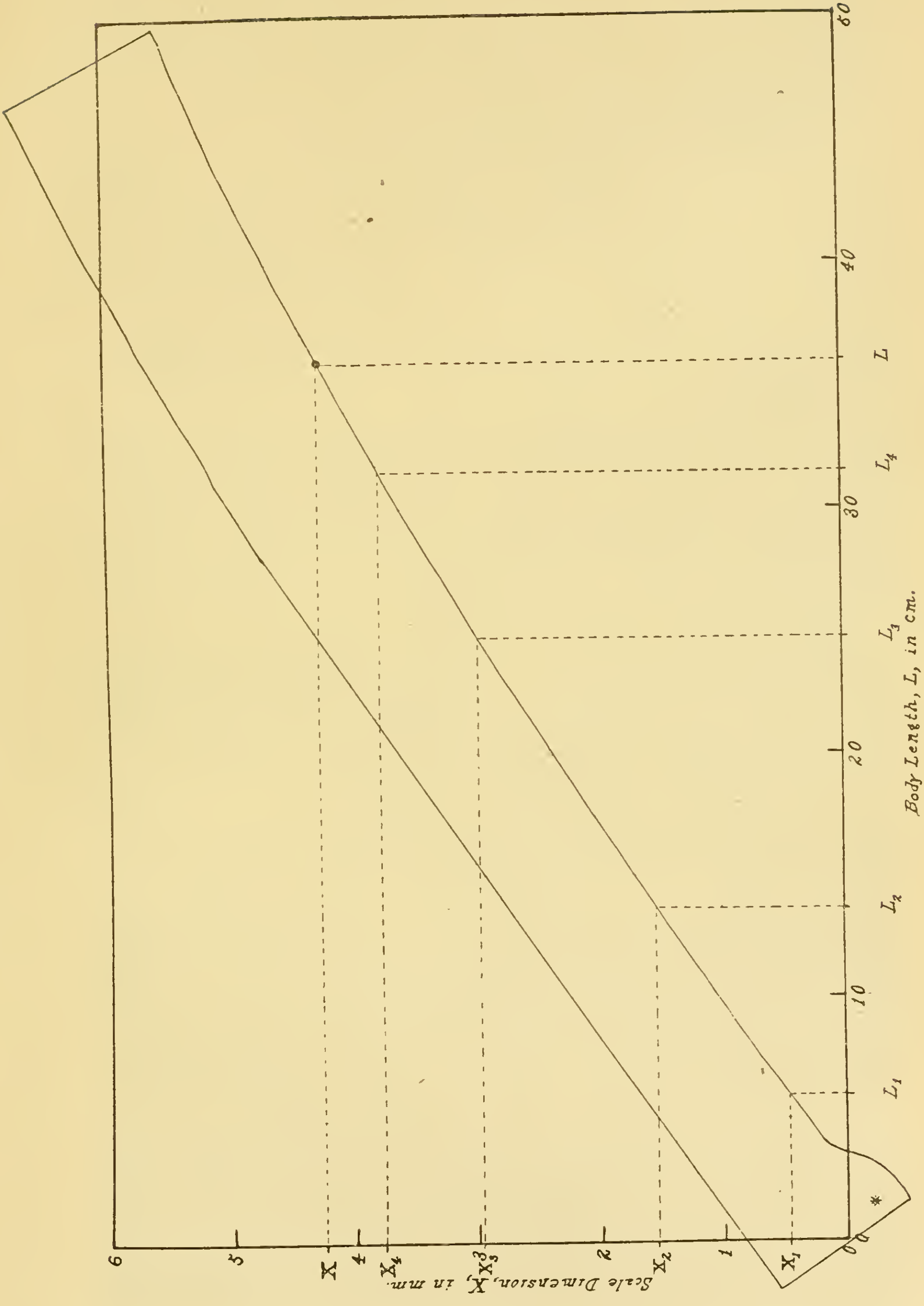

Figure 2. H. platessoides. Calculation of body length (L_1, L_2, etc.) from scale length (X_1, X_2, etc.)

values from all the scales were uniform. This proved to be almost immediately below a point midway between zero and the point of intersection of the curve and the base line, and it also proved to be the same as the point at which the curves for the tail and pectoral scales respectively met when produced.

Calculations are made by means of the movable curve rotating about the point of convergence in the following manner. A scale is taken from a fish of length L, and the distance from the focus to the limits of the successive zones measured, the final one being from the focus to the anterior tip of the scale. These are denoted X_1, X_2, X_3, X_4......X.

The curve is adjusted until it intersects X vertically above L. The values L_1, L_2, etc., corresponding to X_1, X_2, etc. can then be read off (see figure 2).

This method compensates for (1) differential growth of the given dimensions of the scale compared with the length of the fish, and (2) differences in the time of origin of various scales according to size. It does not compensate for differences between individual fishes in the character of the differential growth of the scales and in the time of origin of the scales. It is not apparent how a convenient method of compensating for these can be devised.

Other sources of error are as follows. There may be temporary variation in the growth rate of the scales as compared with the fish. The relative rate of growth may vary during the course of the yearly cycle, as the varying distance of the circuli from each other shows that the relative growth of the parts of the scale varies. Temporary conditions of another character may change the relative rate of growth of the scale and of the entire fish. If a scale be removed or dislocated the new growth of scale in the scale pocket is for several years more vigorous than in the case of neighboring scales, as is shown by the greater distinctness of the yearly zones. In this case the removal or dislocation of the scale acts as a stimulus to growth and it is probable that other local or temporary causes may act in a similar way. If scales are taken from different regions and the results averaged the error due to local causes will tend to be eliminated. Error from temporary causes affecting all the scales cannot be corrected, so far as can be seen.

The probable error from any or all of these sources must be very small. One can confidently count on the error from all methodical sources being less than half a centimetre in the length of the fish, by the method that has been described. Since individual variation in the length of fishes of the same age is so great that measurements to the nearest centimetre are ordinarily sufficient for statistical purposes, a possible error of half a centimetre is not of great importance.

The Vertical Distribution of Certain Intertidal Animals.

By A. G. HUNTSMAN, B.A., F.R.S.C.

(Read May Meeting, 1918.)

In 1917 we determined the vertical distribution of several common intertidal species at two widely separated points on our Atlantic coast, where very different physical conditions obtain. At St. Andrews, N.B., situated on the St. Croix river, an estuary of the Bay of Fundy, there is an extreme tidal amplitude of more than twenty-five feet, and the strong tidal currents produced mix the water so thoroughly that at the surface it never is of low salinity nor does it ever attain a very high temperature even at the end of summer. Dr. W. Bell Dawson very kindly established a low-water datum at the Biological Station wharf and installed a tide-gauge. We are indebted to him also for the calculation from the tidal data, obtained during the season of 1917, of the percentage of the total time that various levels above the low water datum were covered and uncovered by the water. The calculations were made in each case from the observations taken during two lunar months one at each end of the season, the mean monthly total number of hours covered or uncovered being determined, and this value subsequently reduced to the percentage of the total time.

BIOLOGICAL STATION, ST. ANDREWS, N.B.

Periods, June 15 to July 14; Oct. 1 to Oct. 29, 1917.	Uncovered.				Covered.					
Height above low-water datum	5 ft.		10 ft.		15 ft.		20 ft.		25 ft.	
Months....................	June	Oct.	June	Oct.	June	Oct.	June	Oct.	June	Oct.
	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
Total number of hours covered or uncovered...........	79 :20	96 :50	257 :05	268 :20	313 :25	303 :20	160 :10	144 :40	3:55	6:50
Mean monthly total in hours..	88:05		262:42		308:23		152:25		5:23	
Mean monthly percentage of total time..............	12.42		37.06		43.50		21.49		0.76	

From these figures we have constructed a diagram (see figure 1), which shows in a graphic manner the percentage of the total time that various levels are covered and uncovered. As it is based on only two months' observations, it is merely an approximation to the average condition, but the discrepancies must be inconsiderable and of little value for the object we have in view. In the diagram an arbitrary width has been taken to represent the entirely submerged condition

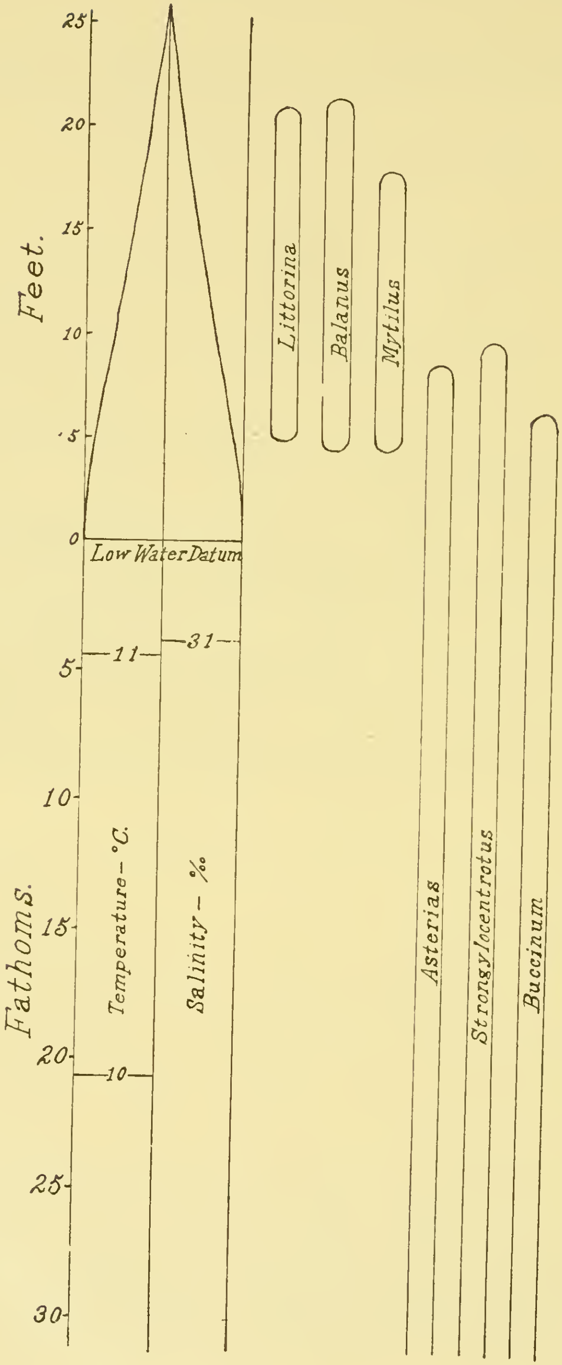

Figure 1. Vertical distribution of certain bottom species at St. Andrews, New Brunswick, September, 1917.

that exists from low tide level downwards and the uniform column shown has been marked off into five fathom intervals. Above low water datum a figure has been constucted, which terminates at an apex corresponding in height above low water mark, as shown by the scale in feet on the side, to the highest level reached by the water. The width of this figure at any level in reference to the width of the basal column is equivalent to the percentage of the total time that such a level is covered by water. The sides of this figure are almost straight.

The distribution of the periwinkle (*Littorina litorea*) was observed to be between the levels of five and twenty-two feet above the low-water datum; that of the barnacle (*Balanus balanoides*) between four and twenty-two and one-half feet; and that of the mussel (*Mytilus edulis*) between four and one-half and seventeen feet. These are to be considered as extreme limits, the zone of abundance for each species being more restricted. The distribution that has been given was observed on the sides of the wharf and not in such special situations as tide-pools.

The sea-urchin was met with at as high a level as nine and one-half feet above low-water, but only under special conditions. On the north side the wharf rests on a ledge of rock not far above low-water, and on this ledge protected from the sun the sea-urchins were able to rest at low tide. When the tide rose, they moved slowly up the side of the wharf, some of them attaining the level we have mentioned before the falling tide exposed them to the air and induced them to relax their hold on the wharf to fall again to the ledge below. In dredging in this region we have obtained the sea-urchin at various depths down to more than thirty fathoms. The whelk (*Buccinum undatum L.*) has a distribution quite similar to that of the sea-urchin, but reaches a level of only about six and one-half feet above low water. It moves to a higher level at spring tides than at other times, and is able to remain at such heights without harm at the time of low tide by frequenting soft beaches or mussel beds, in which it can bury itself and escape the heat of the sun. The star-fish (*Asterias vulgaris*) is to be found from depths as great as thirty fathoms up to a level of eight feet above low water mark. In the figure (1) we have shown the distribution of all these species graphically beside the column representing the water.

At Cheticamp or Eastern Harbour, N.S., on that shore of Cape Breton island bordering the gulf of St. Lawrence the tidal amplitude is very slight and amounts at most to only four and one-half feet. There is very little mixing of the water, which as a result exhibits during the summer a rather thick surface stratum of low salinity and high temperature. The deep water has a temperature in the neighbourhood of zero on the Centigrade scale, and frequently below that point. A low water datum used by Dr. Dawson in his tidal survey of 1915 was available as a level to which to refer the distributional data that we obtained at that point. Dr. Dawson, to whom our sincere thanks are due, has been so kind as to provide us for this locality also with calculations as to the percentage of the total time that various intertidal levels are covered and uncovered by water. These have been made in the same manner as were those for St. Andrews, and we give them below.

CHETICAMP OR EASTERN HARBOUR, N.S.

Periods, July 18 to Aug. 16; Oct. 14 to Nov. 12, 1915.	Uncovered.						Covered.			
Height above low-water datum	0 ft.		1 ft.		2 ft.		3 ft.		4 ft.	
Months	July	Oct.	July	Oct.	July	Oct.	July	Oct.	July	Oct.
Total number of hours covered or uncovered	6:00	—	44:50	29:20	305:30	185:50	98:40	175:00	—	38:30
Mean monthly total in hours	3:00		37:05		245:40		136:40		19:15	
Mean monthly percentage of total time	0·42		5·23		34·65		19·30		2·71	

Although the monthly differences here are great, the slightness of the amplitude makes this of little moment, and the figure that we have drawn with the mean monthly percentages as a basis is a fair approximation to the average condition. The figure (2) has been drawn in a similar manner to that for St. Andrews (*vide supra*) and the sides of the part representing the intertidal conditions are far from straight, for they form sigmoid curves.

The periwinkle occurs between tides to a height of over four feet above low water datum and also goes far below, down to a depth of nearly twenty fathoms. The barnacle reaches a height of about three and one half feet and is also to be found below low-water mark, but we did not determine its lower limit of distribution. The same is true of the mussel, which reached a level of nearly two feet above the low water datum. In the Woods Holl region it occurs abundantly at depths as great as nineteen fathoms and the probability is that at Cheticamp it has a similar distribution.

Although small sea-urchins were occasionally taken at slight depths, the large individuals such as we found between tides at St. Andrews, were met with only at depths of twenty-four fathoms or more, and down to fifty fathoms which was the greatest depth to be found. The whelk occurred only at depths of from twenty-five to thirty-five fathoms. As it is without a pelagic stage in its life history

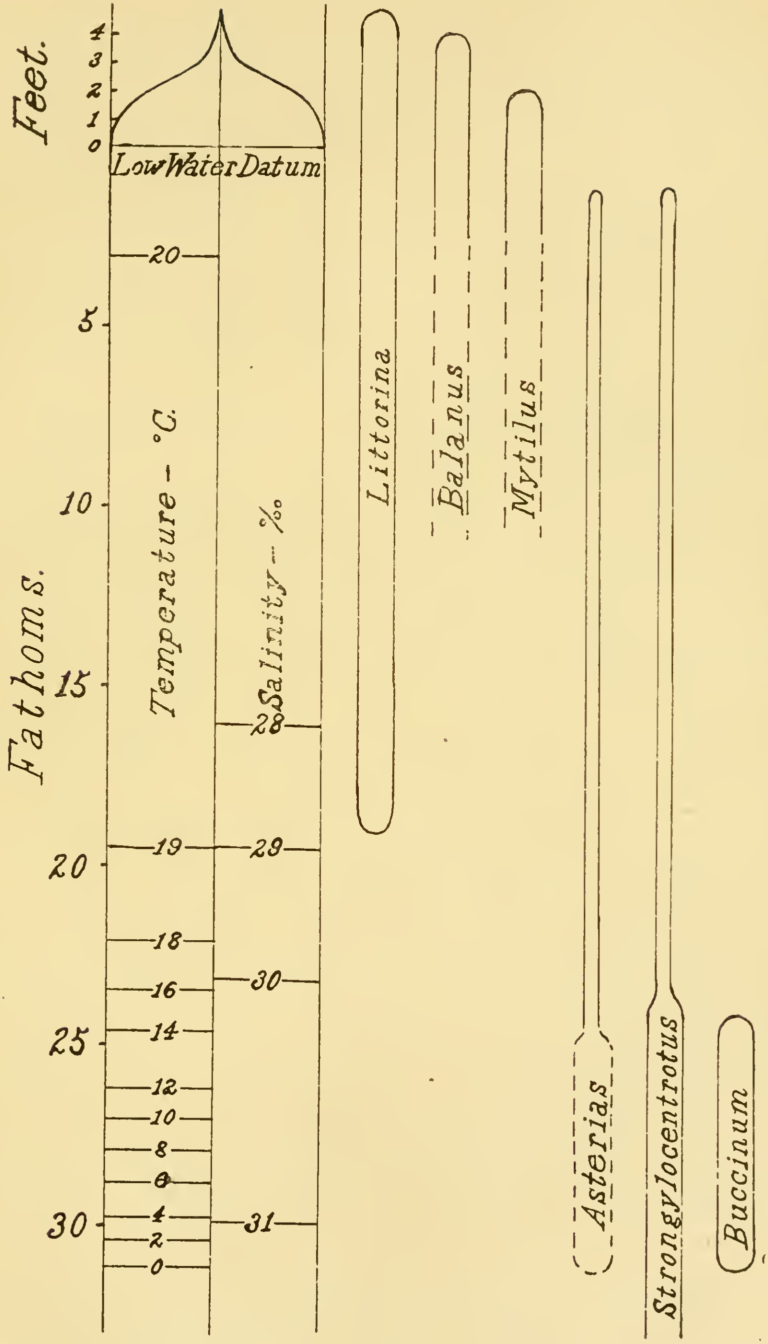

Figure 2. Vertical distribution of certain bottom species at Cheticamp, Cape Breton, September, 1917.

and is able to move only at a very slow rate, there is no opportunity for the young to have an essentially different distribution from that of the adults. It does not appear to be found in the deep ice-cold water, being replaced there by other species of the same genus. The star fish resembles the sea-urchin in having the young distributed in very shallow water, but we were unable to determine the distribution of the adults on the Cheticamp slope. At the Magdalen islands the young were found in shallow water and the adults only at greater depths, namely, from fifteen to thirty metres, at which depths intermediate conditions of temperature prevail. On the Cheticamp slope similar conditions are not to be found at any level, except temporarily, because of the extensive vertical oscillations of the warm and cold water, which are effected by the action of the wind on the warm surface water, driving it to or from the coast. Were it not for the comparatively steep nature of the slope of the bottom off Cheticamp, this would not be possible. We can explain our failure to find large starfish (*Asterias vulgaris*) on the Cheticamp slope, only by the supposition that they are killed off in early life by the alternation of very warm and very cold conditions, that slope affording them no place where the intermediate conditions necessary for their existence are to be found permanently. Seeing that their early stages are pelagic, their larvae borne from spawning grounds elsewhere in the gulf will yearly settle in the shallow water along shore, but there will be no possibility of the species obtaining a permanent foothold in the region. In the deeper ice-cold water it does not occur, but its place is taken by an arctic species,—*Asterias polaris*.

The distribution of these species is shown in figure 2 beside the column representing the conditions in the water.

The conditions of temperature and salinity in the water at the two localities, which are to a considerable extent correlated with the amounts of the tidal amplitude, are given in the figures (1 and 2) from determinations made by Professor A. Vachon for the latter part of the summer, at the time the distribution of the species of animals was investigated. The depth of the superficial stratum of warm water at Cheticamp exhibits great variations within short periods of time, these variations depending principally upon the direction and strength of the wind in the adjacent portion of the gulf. We have represented the depth of this layer in what is probably its maximum condition.

It may be considered as practically certain that the depth of this superficial stratum of water with a comparatively high temperature and low salinity, which at the same time involves a very low density, is the factor which determines the upper limit of distribution of such species as the whelk, sea-urchin and star-fish. The two latter forms show in their early stages a greater adaptability to such conditions than they do later in their life-history. This is fairly general among animals which are pelagice in their early stages, the pelagic habit usually involving a life near the surface.

These three species of animals are predatory in their habits, and for that reason their distribution will affect in an adverse manner the distribution of the animals on which they feed. The starfish and whelk are enemies of the mussel and it may well be that their presence in abundance near and below low-tide mark at St-Andrews is the determining factor for the lower limit of the distribution of the mussel in that region. The zone of common distribution is quite narrow—about three feet—and does not contain any of these species in abundance. It is to be considered the area of struggle—by the starfish and whelk against the effects of heat and exposure, and by the mussel to obtain a foothold in spite of depredations by the whelk and starfish. The lower limit of the distribution of the mussel is not determined by insufficient exposure to air, seeing that in many places it is constantly submerged, for example on floats, mooring poles, and floating breakwaters at St. Andrews. The upper limit of its distribution is undoubtedly the highest level at which it is covered with water a proportion of the time great enough to protect it and permit of its growth. The data indicate that under the warmer conditions at Cheticamp it is necessary for it to be covered a greater proportion of the time than under the cold conditions at St. Andrews. Experiment will be necessary to determine the influence of each of the varied factors that here come into play.

The lower limit in the distribution of the barnacle at St. Andrews was found to be in part at least very clearly dependent upon the upper limit in the distribution of the sea-urchin. On the north side of the wharf where the sea-urchins moved up from the ledge each flood tide, the extent of their excursions was plainly to be seen in the form of a more or less semicircular area, of which the ledge formed the centre, and which was entirely devoid of barnacles, thus forming a marked contrast with the white, barnacle-covered remainder of the side of the wharf. The barnacle is extraordinarily resistant to exposure and is able to live near the upper limit of the intertidal zone. Its upper limit of distribution appears to be higher at Cheticamp than at St. Andrews, a difference which deserves investigation.

We desire to call attention to the opportunities that exist on our coast of studying the factors that determine the abundance and distribution of many of the common marine species. Those that we have considered are all of economic importance, the periwinkle, mussel, and whelk in a positive sense as they serve either as food for man or as bait in the fisheries, and the barnacle, sea-urchin and star-fish in a negative sense as they either encumber wharves and ships or are enemies of important food species.

The effect of the Tide on the Distribution of the Fishes of the Canadian Atlantic Coast.

By A. G. HUNTSMAN, B.A., F.R.S.C.

(Read May Meeting, 1918.)

On the Atlantic coast there are two large gulfs, each connected with the open ocean by openings which are traversed by ancient river beds, now submerged a hundred fathoms or more below the surface. These are the gulf of St. Lawrence at the north and at the south the gulf of Maine which is continued into the bay of Fundy. The tidal conditions in these two bodies of water differ greatly. In the gulf of St. Lawrence the rise and fall are slight amounting to from 3 to 8 feet, while in the gulf of Maine and particularly in the bay of Fundy the rise and fall are very great, reaching a maximum of about fifty feet at the head of the bay of Fundy. We purpose contrasting this latter region with the gulf of St. Lawrence.

The heavy tides in the bay of Fundy produce strong currents, which flow over many shoals and through narrow passages. These heavy tide-rips and whirlpools mix the water very effectually so that there is little difference to be found between that at the surface and that at the bottom. This condition seems to reach its extreme on the northwest side of the bay, where in Charlotte county, New Brunswick, is an assemblage of islands of many sizes and irregular shapes, to which the name of Western Archipelago has been given.

From the earliest times the cold character of the water in this region has been noted. Rarely does it at any point reach a temperature higher than 53 degrees F. even by the end of the summer, and the mass of the water remains constantly below that temperature. In the winter the greater part of the water cools nearly to 32 degrees F. and much of it, particularly in the estuaries, goes below that temperature.

In the gulf of St. Lawrence a distinctly different picture is presented, which finds its maximum development on the Magdalen shallows, just across the Chignecto isthmus from the head waters of the bay of Fundy. A large shallow bay surrounds the Magdalen and Prince Edward islands, and in it the tides are slight, there is an absence of narrow passages, and shoals are few. There cannot be, therefore, much mixing of the water. As a result we have a definitely stratified condition, which is most prominent at the end of summer. Briefly there are two principal layers in the water of the Magdalen shallows;

and in the Laurentian channel, which runs along the north side of these shallows, there is, below these two, a third which fills up the bottom of the channel.

The uppermost layer consists of warm water of low salinity, the result of the heating action of the spring and summer as well as of the influx of large quantities of fresh water from the St. Lawrence and other rivers of the region. The layer below this is of somewhat higher salinity, and with a very low temperature, much of it being below 32 degrees F. The low temperature has been derived from the cold of the previous winter. The third and deepest layer is of still higher salinity and of intermediate temperature from 39 degrees to 42 degrees F. It appears to originate from the open Atlantic, the "cold wall" of water which is banked up against the side of the continent flowing very slowly into the gulf by way of the bed of the Laurentian channel.

These three layers of water were discovered early in the last century. Kelley, who worked with Admiral Bayfield in the gulf and river St. Lawrence during 1831, 1832 and 1836, took a series of temperatures at the surface, and in addition took the temperature of water from various depths down to as deep as 150 fathoms, brought to the surface in Woolaston's machine. The small number of observations taken by this imperfect method was nevertheless sufficient to demonstrate the presence at a depth of from about thirty to ninety fathoms of a layer of very cold water, with slightly warmer water below and much warmer water near the surface. These observations were published in the Transactions of the Literary and Historical Society of Quebec, and remained in obscurity until used by Hind in 1877. The latter drew diagrams to show the temperature zones and the seasonal changes in a section from Anticosti to Prince Edward Island.

Whiteaves, while dredging in the gulf during the years 1871 and 1872, took the temperature and the mud brought up from the various depths in the dredge, and was puzzled to find the mud from the greatest depths warmer than that from lesser depths. This method was equally imperfect. In 1895 Dr. Dawson with modern apparatus determined carefully the temperatures and densities of water at various depths down to as much as 200 fathoms, both in Cabot strait and in the channel between the Gaspé peninsula and Anticosti island. During 1915 Dr. Hjort, on the Canadian Fisheries expedition, made a very thorough hydrographic survey of the gulf both in June and again in August, the results of which have not yet been published. Last year we investigated the Magdalen shallows off Cheticamp, C.B., and also the Cape Breton side of Cabot strait. The stratified condition of the waters of this gulf during the summer has therefore been thoroughly investigated.

On considering the vertical distribution of the fishes in the gulf of St. Lawrence we find a similar stratification. In the deep channels there are only a few species, and most of these are restricted to the deep water. They are, on the bottom the four-bearded rockling (*Enchelyopus cimbrius*), the grenadier (*Marcrurus bairdii*), the hagfish (*Myxine limosa*), the thorny skate (*Raia radiata*), the sole (*Glyptocephalus cynoglossus*) and probably also the angler (*Lophius piscatorius*); in mid-water the rose-fish (*Sebastes marinus*).

On the banks, including all the deeper portions of the Magdalen shallows, which are covered by the intermediate layer of ice-cold water, we find a very different and more numerous fish fauna. The species that characterize it are, the plaice (*Hippoglossoides platessoides*), the sole, the thorny skate, the cod (*Gadus callarias*), *Stichaeus punctatus*, *Leptoblennius serpentinus*, *Neoliparis atlanticus*, *Aspidophoroides monopterygius*, *Triglops ommatistius* and *Centridermichthys uncinatus*.

In the warm layer of surface water another assemblage of fishes is to be met with, consisting in the open of the mackerel (*Scomber scombrus*) and perhaps also the dog-fish (*Squalus acanthias*), and along shore of many species, such as the cunner ((*Tautogolabrus adspersus*), the grubby (*Myoxocephalus aeneus*), the eel (*Anguilla vulgaris*), the sand flounder (*Lophopsetta maculata*), the pipe-fish (*Siphostoma fuscum*), the butter-fish (*Pholis gunnellus*), the smelt (*Osmerus mordax*), and young flounders (*Pseudopleuronectes americanus*).

Another fauna characterizes an intermediate zone between the warm surface water and the ice-cold water of the banks. Its members tend to invade one or both of these strata but occur predominantly between them. In the open is the herring (*Clupea harengus*) and on the bottom the haddock (*Melanogrammus aeglifinus*), the hake (*Urophycis tenuis* and *chuss*), the dab (*Limanda ferruginea*), adult flounders, the mutton-fish (*Zoarces anguillaris*), the wolf-fish (*Anarhichas lupus*), the lump fish (*Cyclopterus lumpus*), the sculpin, (*Myoxocephalus octodecimspinosus*), the barn-door skate (*Raia laevis*), the eyed skate (*Raia ocellata*), and the tobacco-box (*Raia erinacea*).

A fifth fauna forms the estuarial transition from the shore waters to the fresh water and it consists of the following species, the smooth flounder (*Liopsetta putnami*), the white perch (*Morone americana*), the sand-smelt (*Menidia notata*), the mummichog (*Fundulus heteroclitus*), and the stickleback (*Gasterosteus aculeatus*).

Let us compare this definitely stratified condition of the fish fauna of the gulf of St. Lawrence with that of the bay of Fundy, as exhibited in the Passamaquoddy region. In the latter the absence of stratification in the water is to some extent reflected in the distribution of the fishes. Some of them, it is true, are shallow water forms (flounder, grubby, sculpin, butter-fish) others occur only in the deep water (plaice, sole, hagfish), some are restricted to the estuaries (smooth flounder, tomcod) and others to the open coast (grubby, *Ulvaria bifurcata*). It is, however, not possible to define such distinct faunas as those of the gulf of St. Lawrence, seeing that the mackerel, cunner, and grubby of the warm-water zone of the gulf are here comparatively rare and a new shore fish, the daddy sculpin, (*Myoxocephalus groenlandicus*), makes its appearance, which species belongs to the cold waters of the Arctic and is apparently excluded from the Magdalen shallows by the warmth of the shore waters in summer. Also the plaice and sole of the ice-cold zone of the gulf are not very numerous and do not attain a large size. The grenadier and rockling of the deep channels of the gulf are here found in shallow water or are even brought to the surface, although they are rare. Professor McMurrich received in 1917 a grenadier that had been taken by a fisherman from a weir. The rose-fish of the deep channels of the gulf may be caught in company with the cunner of the warm-water zone, far up an estuary, as for example in the St. Croix River.

Goode (1884, p. 260) states that these two fishes may be caught together from the wharfs at the north, but gives no locality. However, the context seems to show that he referred to the coast of northern Maine.

The important fishes of the Passamaquoddy region are those of the intermediate zone, between the warm surface water and the ice-cold bank water, of the gulf of St. Lawrence. Such are the herring, hake, haddock and pollock, whereas the cod of the ice-cold zone, and the mackerel of the warm surface water occupy secondary positions.

We give a table which shows the total quantities of these fishes in hundredweights landed during 1916 on the coast of the Bay of Fundy in the Passamaquoddy region (from Campobello to Red Head, Charlotte county, N.B.), and on the coast of the gulf of St. Lawrence in the Cheticamp region (from Pollet's Cove to Broad Cove Chapel, Inverness County, N.S.) respectively, these regions exhibiting the contrasted conditions in their extreme forms. In each case the coast is rather bold, and the bottom, which is of rock or mud, drops rather abruptly to depths of from 20 fathoms at one end to about 80 fathoms at the other, so that the districts are quite comparable.

	Mackerel	Herring	Hake	Haddock	Pollock	Cod
Campbobello to Red Head	0	[1]21,790	58,520	13,575	37,815	5,806
Pollet's Cove to Broad Cove Chapel..........	17,165	3,741	678	1,212	144	26,766

From the available evidence it is practically certain that of these fishes the herring alone is able to breed successfully in the bay of Fundy at least in the Passamaquoddy region, but all of them, with the possible exception of the pollock, breed successfully in the gulf of St. Lawrence in the Cheticamp region. As these fishes are all migratory, their failure to breed in the bay of Fundy does not exclude them from that region, but may influence their distribution within it, depending upon the nature of their migratory habits. The extraordinary rarity in the bay of Fundy of the larvae of fishes with pelagic eggs, such as the plaice, sole, cod, haddock, hake, pollock, and cunner is evidence of the entire unsuitability of that region as a breeding ground for such fishes. The reason for this appears to be the unusual physical conditions of the water, which are connected with the virtual absence of stratification. Most floating eggs remain in the uppermost layers, which, as in the gulf of St. Lawrence, are usually of low salinity and of high summer temperatures. In any event the eggs can reach in such waters the layers that are the most suitable for them and the same obtains for the young larvae. This is not possible in the bay of Fundy. Although that region is so unsuitable for them during their embryonic and larval stages, young haddock, hake, pollock, and cod of a year or more in age can and do live in the bay of Fundy. Their migration to all parts presents therefore neither difficulty nor peculiarity, for they will be generally distributed, where conditions are favorable. It is otherwise with the mackerel, the young of which are probably able neither to enter the bay nor to thrive there. The adults are very abundant at the southern end of Nova Scotia, but their numbers, as shown by the statistics of landings, diminish rather rapidly as we pass northwards along the coast of Nova Scotia up the bay of Fundy to its head in the Minas basin, while on the New Brunswick coast they rarely appear. This indicates a limited coastal migration into the bay of Fundy from a centre off Yarmouth, N.S.

The halibut, which of a certainty migrates shorewards from the outer fishing banks, has a somewhat similar distribution, indicating

[1] In addition 63,020 barrels of sardines or young herring. These statistics have been taken from the latest available report of the fisheries branch of the Department of the Naval Service, Ottawa.

a coastal migration up the Nova Scotia shore of the bay, but in addition a moderate number reach Grand Manan and a few are always to be found still farther up the New Brunswick shore.

The cunner is able to breed just outside the mouth of the bay of Fundy in St. Mary bay on the coast of Nova Scotia and also in the bays of southern Maine. It is a shore form and although virtually non-migratory it will change its location for a distance of some miles in the course of years. A steady increase in the average size is to be seen on passing from St. Mary bay into the bay of Fundy, owing to the individuals being of all ages in St. Mary bay, and, as we pass from it, being restricted to later and later years. Very large individuals alone are to be found on the New Brunswick shore, and they are very rare.

The herring breeds in the bay and is well distributed throughout it, but shows a peculiarity in its distribution, particularly during the early years. This consists in a maximum abundance in the Passamaquoddy region, where the mixing effect of the tidal currents is at its height. This is significant, seeing that the only place on our coast outside the bay of Fundy where young herring or sardines are taken, is in the St. Lawrence river, in which also the tides are of great amplitude.

Our major conclusions are that the absence of heavy tides makes the gulf of St. Lawrence, and in particular the Magdalen shallows, an important spawning ground for many species of fishes with pelagic eggs, and the presence of heavy tides prevents the bay of Fundy serving in a similar capacity, excludes from it the mackerel, and makes it of prime importance in the fishery for young herring or sardines.

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The Inheritance of the Length of the Flowering and Ripening Periods in Wheat.

By W. P. Thompson, Ph.D.

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Presented by J. H. Faull, Ph.D., F.R.S.C.

Contents.

1. Introduction.

In genetical studies on the ripening period of wheat we have to do with a case of blending inheritance and the related fundamental problem of the constancy of the Mendelian determiners. The special value of the material lies in the fact that we have many parental races differing by many degrees in regard to the character in question. Any hypothesis of blending inheritance can therefore be tested much more thoroughly than in cases where only pairs of parental types are available. An hypothesis, which may satisfactorily explain the results of crossing variety A with variety E, can be much more thoroughly tested when we also have the result of crossing A with B, B with C, C with D, A with C, etc., where B, C and D are intermediate between A and E. The experiments reported in the following pages have been planned with this consideration in mind.

The problem, of course, has very great economic possibilities, particularly for Western Canada. A necessary characteristic of all annual plants grown in the Western provinces is the possession of a very short period of maturity. Many crops cannot now be grown there at all because sufficiently early varieties do not exist. And many crops now grown frequently suffer from frost or are totally ost in some localities. The truth of these statements is emphasized by a consideration of the meteorological data. At the very centre of the prairie provinces (Saskatoon) the average number of days between the last spring frost of 3 degrees and the first autumn frost of 3 degrees is 121 days. At other points in Saskatchewan the period varies from 88 to 132 days. And, of course, in many years the period will be two or three weeks shorter than the average.

In addition to lessening the danger from frost a short growing period is desirable for other reasons. In the case of cereals, for example, experience shows that the early ripening plant is much more likely to escape the ravages of rust because it will be nearer maturity before it is attacked. And the seasons in which there are the biggest yields are just those in which environmental conditions favor both rust development and the lengthening of the ripening period. Again the early plant is likely to escape the effect of the all-too-frequent droughts. By far the greatest precipitation occurs in June and early July and thereafter prolonged droughts are liable to occur. The plant which has neared maturity before the end of the rainy period is less likely to suffer from drought. Then, too, the development of earlier varieties would extend the area of crop production further northward.

For these reasons a thorough study of the genetics of early ripening appears to be a necessary preliminary to work of the most far-reaching character in plant improvement in Western Canada. This is particularly true in the case of wheat which is by all odds the most important crop.

2. History.

Tschermak (1911)has carried on studies on the blooming time in peas. An early blooming variety crossed with a later variety gave offspring with an intermediate blooming time. In the next generation there was great variation, some plants being earlier than the early parent and some later than the late parent. The extremes bred true but the intermediates gave various results. Tschermak explains the results by assuming the existence of two factors, one of which causes an intermediate blooming time and the second (in the presence of the first) causes the plant to bloom much earlier. The results expected in F_3 and F_4 on the basis of this hypothesis do not agree very closely with those actually obtained.

Hoshino (1915) also working with peas, obtained very different results. The F_1 plants were a little earlier than the late variety. The plants of the next generation fell into two main groups, an early and a late, separated by a group of minimal frequency. This result shows clearly that segregation has occurred and that only one important Mendelian factor is concerned. But in F_3 he found four more or less well marked groups. He therefore assumes the existence of two factors, a chief one (A) and a subsidiary (B). B makes the flowering time later than it would be if A alone were present. He further assumes that because extracted early and late plants were neither so extreme as the parents, "gametic contamination" has occurred.

Castle (1916) has reviewed Hoshino's results and given a different interpretation. He maintains that the existence of only one pair of factors along with the occurrence of gametic contamination need be assumed. The results as a whole he uses in a criticism of the multiple determiner hypothesis of blending inheritance.

Leake (1911) has made a detailed study of blooming time in cotton. The F_1 plants were again uniformly intermediate and the F_2 showed a much increased range of variation. The frequencies in F_2 formed a regular curve with mode and mean nearer the late parent. The further fact was established that early flowering is correlated with monopodal branching and late flowering with the sympodal type.

3. Materials.

In this investigation eight varieties of wheat were used. One (Prelude) is the earliest valuable wheat which we have. One (Club) is the latest which will mature in our season. The others represent various stages between these two extremes. The plants of each variety used in crossing were grown in pure lines for several years and proven to be stable, except for environmental variations, in regard to the character in question.

Table I gives the length of the ripening period in 1917 for each of the varieties used. It will be observed that the variation in each pure line extends over a period of about eight days and that the frequency distribution is that of a regular probability curve. The difference between the mean of one variety and that of the variety nearest to it varies from 1 to 7 days, and the difference between the means of the earliest and latest is 23 days. The difference between the earliest plants of the earliest variety and the latest plants of the latest variety is 29 days.

It is admitted that the term date of ripening is used very loosely in practice. The date at which different observers consider a plant to be ripe varies over several days. The reason for this is that different men emphasize different points—color of straw, color of glumes, dryness of straw, condition of endosperm, etc. In order to avoid this difficulty and to make the results as accurate as possible it was

TABLE I.

RIPENING PERIODS OF PURE VARIETIES IN 1917.

Variety.	Number of days from planting to harvest.																													
Days	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121
Prelude	2	12	19	35	25	16	9	1																						
Bobs							1	10	33	47	22	9	8	3																
Marquis													1	7	9	14	27	11	10	3										
Preston															3	5	8	8	14	12	10	2								
Red Fife																	3	8	13	16	32	11	10	4						
Alaska																						1	1	7	7	5	3	4	1	
Kubanka																						3	5	8	9	14	6	5	1	
Club																							3	6	9	11	14	6	3	1

TABLE II.

HEADING PERIODS OF PURE VARIETIES IN 1917.

Variety	Number of days from planting to heading.																				
Days	57	58	59	60	61	62	63	64	65	66	67	68	69	70	.71	72	73	74	75	76	77
Prelude	2	5	11	19	13	8	4	1													
Bobs					1	6	19	59	95	68	47	29	5								
Marquis									2	7	24	48	58	39	30	5	4				
Red Fife											1	16	23	33	20	5	4	1			
Preston											3	23	50	55	41	7	5	3	2		
Kubanka													....	....	....	....	....	....	....	....	
Alaska														....	....	....	....	....	....	....	....
Club														....	....	....	....	....	....	....	....

decided to choose one characteristic and judge each plant by it alone. After many observations and experiments the characteristic chosen was the condition of the endosperm. A plant was called ripe as soon as the central kernels reached the dough stage. In regard to this point there is very little variation in the judgment of different individuals.

In addition to the period of ripening the flowering (heading) time was also studied. This not only furnishes a different characteristic but serves as a check on the results obtained in regard to the ripening period. The length of the period from planting to heading is given in Table II. It will be observed that there is considerably less difference between the means of the different varieties than is the case in regard to the ripening period. In the latter case the hereditary differences have a longer time in which to express themselves and the end results become more different.

A special point appears in connection with Preston wheat. While its heading period is almost identical with that of Red Fife, it ripens 2 or 3 days earlier. The condition of the plants at ripening time explains this difference. The grain ripens while the rest of the plant, including the glumes, is still comparatively green. The heading period associates itself with the ripening of the plant as a whole rather than with that of the grain. The same characteristic appears in the hybrids of this plant but the hereditary basis has not yet been determined.

It is of course well known that the length of the heading and ripening periods vary from year to year depending on climatic and soil conditions. In 1916 for example all varieties were later than in 1917, as is hsown in Table III. This table also shows that the effect of climatic conditions in prolonging the ripening period was almost the same in the three earliest varieties (11 or 12 days), and that the two middle varieties were affected to the same extent (23 days) though very differently from the three earliest. The hereditary basis for this difference between the early and middle varieties has not been determined. F_2 plants of a cross between an early and a middle variety grown in a season of slow growth should be compared with sister plants grown in a season of rapid growth. The differences between the 1916 and 1917 seasons in regard to the latest varieties could not be determined with accuracy because the late varieties were not quite ripe in 1916 when frost came, though they were sufficiently matured to germinate readily the next season. They would all probably have ripened in about 140 days making the effect of climatic conditions about the same as in the case of the medium varieties. Observations

TABLE III.

COMPARISON OF RIPENING PERIODS IN 1916 AND 1917.

Season	Prelude	Bobs	Marquis	Preston	Red Fife	Alaska	Durum	Club
1917	95	101	108	110	112	116	116	118
1916	107	112	119	133	135	.....	.....	.....

TABLE IV.

RIPENING PERIODS IN PRELUDE BOBS CROSS.

Days	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106
Prelude		2	12	19	35	25	16	9	1							
Bobs								1	10	33	47	22	9	8	3	
F_1										1	4					
F_2			1	1	3	6	13	15	19	16	12	6	5	3	1	1

TABLE V.

RIPENING PERIODS IN PRELUDE MARQUIS CROSS.

Days	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111
Prelude		2	12	19	35	25	16	9	1												
Marquis														1	7	9	14	27	11	10	3
F_1													1		2	2	6	8		4	1
F_2			4	3	17	26	54	65	72	74	69	61	45	21	13	12	2	1		2	

similar to those recorded for the 1916 and 1917 seasons have been made over a series of years.

All the data given in the following pages for the parental varieties and F_2 refer to the season of 1917. The data on the F_1 plants were collected in 1916 and due allowance made for the difference between the two seasons.

4. Experimental Data.

Crosses were made between many different pairs of the eight paternal varieties. The whole work was planned so that data could be secured on crosses between parents showing all possible degrees of difference in regard to the characters in question. Furthermore, crosses involving parents differing only slightly were made over the whole range of variation. In this way it was hoped that conclusions which might be drawn in regard to hereditary differences between extreme varieties by means of direct crosses could be checked by conclusions drawn from adding up the differences between intermediate points.

(*1*) *Ripening Period.*

Some of the results in regard to the length of the ripening period are given in tables IV to XIII. These tables are arranged in the order of the earlier parents. Thus tables IV to VIII include the crosses of the earliest (Prelude) with successively later parents; IX, X, XI, include crosses of Bobs (second earliest) with successively later parents; XII gives the results of crossing Marquis (third earliest) with a later variety; and XIII, of crossing Red Fife (fifth earliest) with the latest of all.

In order to make comparison easier, each table gives in successive lines (1) the number of days from planting to harvest, (2) the range of variation of earliest parent, (3) of latest parent, (4) of F_1, (5) of F_2.

The First Hybrid Generation.—It will be observed that in each case the first hybrid generation ripened with the later parent. This result is obtained not only by making due allowance for the difference between the 1916 and 1917 seasons but also by actual comparisons with the paternal varieties in 1916 (when the F_1 data were collected). The numbers of the first hybrid generation plants are of course not large enough to reveal the extremes of variation or the form of the variation curve. Consequently one cannot state whether the F_1 variation coincides with that of the later parent. But certainly most of the F_1 plants appear to be near the mean of this parent.

TABLE VI.

RIPENING PERIODS, PRELUDE X PRESTON.

Days	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113
Prelude		2	12	19	35	25	16	9	1														
Preston																3	5	8	8	14	12	10	2
F_1																					4		
F_2				1	2	4	14	19	22	26	27	15	11	8	10	8	5	5	4	2	2	1	

TABLE VII.

RIPENING PERIODS, PRELUDE X RED FIFE.

Days	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115
Prelude		2	12	19	35	25	16	9	1																
Red Fife																		3	8	13	16	32	11	10	4
F_1																		5		4	1	4	2		
F_2			2	0	2	6	25	49	65	77	95	44	29	21	19	24	10	11	12	3	4	1			

TABLE VIII.

RIPENING PERIODS, PRELUDE X KUBANKA.

Days	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
Prelude		2	12	19	35	25	16	9	1																					
Kubanka																							3	5	8	9	14	6	5	1
F_1																							2	1						
F_2					1	3	2	2	5	8	11	10	12	10	8	7	6	6	6	5	2	3	3	1	1	2	1	1	1	3

TABLE IX.

RIPENING PERIODS, BOBS X PRESTON.

Days	97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114
Bobs		1	10	33	47	22	9	8	3									
Preston										3	5	8	8	14	12	10	2	
F_1													2	8	3			
F_2	1	0	3	7	8	11	12	15	9	7	7	8	3	4	1			

TABLE X.

RIPENING PERIODS. BOBS X ALASKA.

Days	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120		
Bobs	1	10	33	47	22	9	8	3																	
Alaska																1	1	7	7	5	3	4	1		
F														5											
F			1	4	5	8	10	9	11	7	9	10	9	7	7	4	8	8	7	2	4	2	2	3	2

TABLE XI.

RIPENING PERIODS, BOBS X CLUB.

Days	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121
Bobs	1	10	33	47	9	8	3																	
Club																	3	6	9	11	14	6	3	1
F_1																								
F_2			2	3	3	8	8	11	12	14	20	10	7	9	7	6	3	3	2	2	1	2		

TABLE XII.

RIPENING PERIODS, MARQUIS X ALASKA.

Days	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123
Marquis		1	7	9	14	27	11	10	3												
Alaska											1	1	7	7	5	3	4	1			
F_1													5								
F_2	1	3	4	5	3	9	12	12	17	16	12	11	10	12	7	6	3	3	5	4	3

TABLE XIII.

RIPENING PERIODS, RED FIFE X CLUB.

Days	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121
Red Fife		3	8	13	16	32	11	10	4						
Club								4	6	9	11	11	6	3	1
F_1															
F_2	4	7	10	14	18	23	23	28	24	13	14	9	5	2	1

From the F_1 results alone it was natural to conclude that we were dealing with a simple case of dominance of lateness over earliness. But when the F_2 results were obtained (see tables) it became clear that this was not the case. These results show that we are really dealing with a case of blending inheritance, most of the F_2 plants being intermediate between the parents. If this is true the F_1 plants should also be intermediate according to all experience with blending. The difficulty thus presented will be discussed in later pages.

Second Hybrid Generation.—In the second hybrid generation of each cross the tables show that the majority of the plants are intermediate between the parents and that there is considerable variation in either direction. It will also be observed that the plants of this generation have the frequency distribution of a regular curve of probability. There is no indication in any of the crosses of a heaping-up of the individuals in any position except the intermediate one. In other words there is no sign of dominance or segregation such as is found in simple cases. Whether the F_2 results support the contention that there is a real segregation involving many factors, will be discussed later.

The range of variation among the F_2 plants is in each case much greater than that of either parent. Unfortunately no comparison can be made with the F_1 generation because of the small number of plants available in the latter case. In general the F_2 variation extends practically from the condition of the earliest plants of the early parent to that of the latest plants of the late parent. In some cases it extends beyond the parental conditions at both extremes. In all cases it extends at least as far in both directions as the mean parental conditions.

It will also be observed that the more the parents resemble each other the more likely is the F_2 variation to extend beyond the parental extremes. In the crosses represented in the tables IV, IX, XII and XIII, there is a difference of only a few days between the parental conditions, and the F_2 variation covers practically the whole range of parental variation and even extends beyond it in IX, XII and XIII. But in crosses involving parents more unlike the F_2 variation does not reach the parental extremes (tables V, VI, VII, VIII, X, XI). This is true because the range of F_2 variation does not increase in proportion to the difference between the parents. As the parental differences increases the range of F_2 variation also increases but not so much as the parental difference. These facts are shown in table XIV.

TABLE XIV.

Cross	Difference between Paternal Means	Range of F_2 Variation
Prelude Bobs	5	14
Prelude Marquis	13	17
Prelude Preston	15	19
Prelude Red Fife	17	20
Prelude Kubanka	21	27
Bobs Preston	9	15
Bobs Club	17	20
Red Fife Club	6	15

The most striking feature of the results as a whole is their marked uniformity. No matter how unlike the parents may be, nor at what region of the general range of variation two slightly different parents may be located, the F_2 variation is strikingly uniform, varying only in extent and even in this respect not so much as the parental difference.

Another kind of experimental result is the establishment of the fact that earliness and lateness are inherited independently of other qualities. It might be expected that earliness would be correlated physiologically if not genetically with shortness or low yielding capacity. Our preliminary observations indicate that this is not the case. The earliest plants of an F_2 generation are frequently quite as large and productive as the latest grand parent. This shows that earliness can be brought into association with the most desirable qualities by the usual Mendelian methods. On account of the fact that most F_2 plants are intermediate, however, a much larger number of plants of this generation must be grown in order to secure any desirable combination than is the case in simple examples of segregation.

(2) *Heading Period.*

The results in connection with the inheritance of the heading time are very similar to those of the ripening period. Tables XV to XIX illustrate this fact. The results are not so valuable because the differences are not so great. But they are evidently due to the same hereditary causes, and confirm the correctness of the results already given. In point of experimental accuracy the heading results are superior to the ripening ones. Of course those plants which head earliest in general ripen earliest. The ripening time of the plants which head on a given day varies to a certain extent but this variation is small compared to that of the generation as a whole.

TABLE XV.

HEADING PERIODS, PRELUDE X BOBS.

Days	57	58	59	60	61	62	63	64	65	66	67	68	69
Prelude	2	5	11	19	13	8	4	1					
Bobs					1	6	19	59	95	68	47	29	5
F_1							2		2		1		
F_2	5		5		40		65		57		11		

TABLE XVI.

HEADING PERIODS, PRELUDE X RED FIFE.

Days	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74
Prelude	2	5	11	19	13	8	4	1										
Red Fife											1	16	23	33	20	5	4	1
F_1											3	1	8	1	1		2	1
F_2		2	2	4	11	22	19	96	128	157	111	74	73	40	12	7	1	1

TABLE XVII.

HEADINGS PERIODS, PRELUDE KUBANKA.

Days	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76		
Prelude	2	5	11	19	13	8	4	1														
Kubanka												....	....	....	....	....	....	....	....	....		
F_1														2	1	1						
F_2			2		3		7		16		34		24		25		12		6		3	1

[1] Records taken every second day.

TABLE XVIII.

HEADING PERIODS, BOBS X CLUB.

Days	61	62	63	64	65	66	67	68	69	70	71	72	73	74	75	76	77
Bobs	1	6	19	59	95	68	47	29	5								
Club								....	....	....	....	....	....	....	....	....	....
F_1																	
F_2			3	2	12	13	15	23	32	27	18	3	7	2	1		

TABLE XIX.

HEADING PERIODS, RED FILE X CLUB.

Days	67	68	69	70	71	72	73	74	75	76	77	78
Red Fife	1	16	23	33	20	5	4	1				
Club					....	....	....	....	....	....	....	
F_1												
F_2	1	8	9	22	37	74	40	35	11	12	4	2

5. Discussion and Conclusions.

(1) *Apparent Dominance in F_1.*

It was pointed out in describing the experimental data that lateness is apparently dominant in the F_1 generation, most of the plants ripening with the late parent. Nevertheless the F_2 plants show that we are really dealing with a case of blending, the great majority of the plants being intermediate between the parents. If this is true we should also have found blending, not dominance, in the F_1 generation.

Yoshino (1915) obtained somewhat similar results in the case of peas but the F_1 plants were not quite so late as the late parent. He interprets the result as the effect of imperfect dominance, though the data from later generations seem quite opposed to this interpretation.

Castle (1916) explains the apparent dominance of lateness in Yoshino's peas as due to the vigor of crossing. The experiments of East, Schull, Castle and others have shown that first generation hybrids are often more vigorous than either parent and that this added vigor disappears in later generations. Castle holds that this added vigor of growth has prolonged the hereditary ripening period of the F_1 plants which is intermediate between those of the parents. In the second generation, this added vigor having disappeared, the plants return to the intermediate position.

This appears to be the most logical explanation of the present case, and yet there are difficulties in the explanation. It seems strange that in almost every case there should be just sufficient prolongation to make F_1 plants coincide with the position of the late parent and even approach the mean of the late parent. One would expect on the basis of the suggested explanation that among the many crosses made (not all of which are given in the tables) a large proportion would fall short of or go beyond the parental condition. Moreover in many of the crosses there is no other indication of added vigor. The F_1 plants in these cases are not larger or stouter than the parents.

In spite of these difficulties the explanation given appears to be the most probable one in the present case. The disappearance of true dominance after a single generation would be impossible to explain.

(2) *The Multiple Determiner Hypothesis of Blending and the Constancy of the Mendelian Determiner.*

It is not necessary to review the work leading to the present difference of opinion touching the explanation of blending inheritance and its bearing on the very important question of the constancy of the Mendelian characters. One school of geneticists explains blending inheritance as the result of the action of multiple determiners, the intermediate individuals representing combinations of determiners greater in number than that of the lower parent but smaller than that of the higher. The other school holds that a real blend of a single pair of determiners occurs. The latter consequently believe that the Mendelian determiner is not unchangeable, while the former believe that the occurrence of blending does not affect the question of unit character constancy. A great body of evidence has been brought forward on both sides.

In the present case according to the multiple determiner hypothesis a difference of sixteen days for example is due to several genes, each being responsible for a fraction of the total difference. In the second hybrid generation combinations of different numbers of these genes will segregate out. If there are four genes concerned each responsible for a four days' difference then segregates will be formed ripening (1) with the earliest, (2) four days later, (3) eight days later, (4) twelve days later, (5) with the latest. If the homozygous condition for a given gene has double the effect of the heterozygous condition the classes will be still further increased. And most of the segregates will be in the middle grades. Environmental variations will smooth out the curve.

The chief argument in favor of the hypothesis that multiple determiners are involved is the increased variability in the second hybrid generation, this being taken to indicate Mendelian segregation. In all the crosses reported in this paper this great variability is very evident. The F_2 generation is much more variable than either parent and in fact often varies from the lowest extreme of the lower parent to the highest extreme of the higher parent. Unfortunately comparison with the F_1 generation is impossible because of the small numbers of the latter. Moreover when the parents are very unlike the F_2 variation does not reach the parental extremes. Under these conditions the parents supposedly differ by a larger number of hereditary factors than when they are more alike, and consequently the extreme combinations in F_2 will occur much more rarely.

The multiple determiner hypothesis may thus explain satisfactorily the results of each individual cross considered alone. But we have yet to determine whether it will explain all the results of the various crosses considered as a whole. We must apply the hypothesis to each successive pair of parents and determine their hereditary differences; then we must sum up these differences and see whether the expected result is the same as we obtained in a direct cross of the earliest with the latest parents.

Since we are dealing with typical blending inheritance we must make the postulate that the difference between each pair of parents is more than one pair of determiners. Otherwise there would be segregation and no constant intermediate race. This is true whether the difference be small or great. Where the difference between the parental means is small the F_2 variation curve might be considered to indicate merely a lack of dominance along with segregation of one pair of determiners. But if this were the case there would be no true breeding intermediate race but segregation in each generation. Other experiments show that true breeding intermediate races do result.

Now crosses involving a difference of only five or six days were made at different regions in the whole range of variation. In each case the result was typical blending with the F_2 variation covering the parental range. Consequently for each five days' difference there must be at least two pairs of hereditary determiners. Therefore in crosses involving a parental difference of twenty or twenty-one days there should be an hereditary difference of at least eight pairs of factors. But in order to recover the extreme conditions in crosses involving eight pairs of factors it would be necessary to raise about 65,000 plants (Mendel's 4^n where n equals 8) and yet we find that in the cross represented in table VIII the parental means are recovered in fewer than 120 plants and one of the parental extremes is exceeded. In the cross represented in table XI, in which the parents differ by about 17 days the parental means are exceeded among fewer than 150 plants of the second hybrid generation. Assuming the minimum number of determiners (6 pairs) we should expect to recover these among not less than 4,096 plants. Considering the crosses of the earliest parent only, we have cases involving parental difference of 6, 12, 15, 17 and 21 days. Nevertheless F_2 plants more extreme than the average of either parent are recovered among fewer than 200 individuals in each case, even though each successive parent must differ from the preceding by at least two factors.

It is evident from the tables that it is somewhat more difficult to recover the extremes in cases where the parents are very different than in cases where they are more alike. But apparently it is not nearly so difficult as it should be if the multiple determiner hypothesis is correct.

It should also be stated that there is good evidence (not yet in a condition to be published) that crosses involving differences of less than five days give similar results to those reported. If this is the case it is necessary to assume that more than one pair of factors are responsible for even these slight differences. In this case the difficulties of the multiple determiner hypothesis are greatly multiplied. In general it appears that no matter how great or small the parental difference, the F_2 variation is very uniform, covering nearly or entirely the whole range of parental variation. The number of hereditary determiners which it is necessary to assume as distinguishing the earliest from the latest parents may thus be increased indefinitely.

One might put the argument in the converse form. The recovery of the parental conditions in a small number of F_2 plants of crosses involving a wide difference limits the possible number of factors to a very few. Subtracting two pairs of factors for each 5 or 6 days difference, we find that all the possible factors are used up long before the smaller differences are reached.

What has been said concerning the ripening period applies also to the heading period except that the differences are smaller.

The conclusions just reached should be tested more thoroughly by raising F_3 and F_4 generations and thus determining the exact constitution of the F_2 plants. They can further be tested by crosses involving on the one hand wider differences than 20 days and on the other hand differences of less than 5 days. But the data already given when taken as a whole seem to be quite unexplainable on the multiple determiner hypothesis. On the basis of this hypothesis AB+BC+CD+DE is greater than AE.

(3) *Economic Application.*

The economic value of early ripening varieties in Western Canada has been explained in the introduction. In the F_2 generation of a cross between an early and a late variety there are found combinations of earliness with various characteristics of the late parent and of lateness with various characteristics of the early parent. The experimental results have shown apparently that no valuable qualities are correlated with lateness and no undesirable qualities with earliness. Early segregates are often quite as large and productive as late ones. Earliness can therefore be brought into association with other desirable qualities by the usual Mendelian methods. But on account of the large proportion of intermediate plants in the second hybrid generation it would be necessary to grow much larger numbers than is the case in simple examples, in order to secure any desired combination of characters which includes extreme earliness. And the greater the parental difference the more plants must be grown. Of course it would often be of great value to substract a few days only from the ripening period, and in this case the intermediate plants themselves would serve.

6. Summary.

1. The results are reported of crosses between many pairs of wheat varieties differing by many degrees in regard to the length of the ripening and heading periods. Crosses between parents differing only slightly were made over the whole range of variation, and crosses were also made involving successively greater parental differences.

2. The F_1 plants matured with the late parent. This appears to be a case not of dominance but of postponement of the hereditary maturation period due to vigor of crossing though there are difficulties in this interpretation.

3. The F_2 plants formed regular curves of probability with intermediate means. In most cases the variation extended from below the mean of the lower parent to above the mean of the higher parent. Where the parents differed only slightly the parental extremes were sometimes exceeded. Where the parents differed greatly the parental extremes were not always reached though the parental means were usually exceeded.

4. Interpreting the results on the basis of the multiple determiner hypothesis of blending, the sum of the differences between each successive pair of parents seems to be much greater than it should be on the evidence of direct crosses. This hypothesis therefore fails to explain satisfactorily the results as a whole though it may explain satisfactorily the results of each individual cross.

5. Earliness can be combined with other desirable qualities by Mendelian methods, though it is necessary to raise very large numbers of plants because the great majority are intermediate.

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Preliminary Study of the Western Gas Fields of Canada.

By D. B. DOWLING, B.Sc., F.R.S.C.

(Read May Meeting, 1918.)

Power and fuel seem to be necessary for the upbuilding of great manufacturing industries, but only in late years have they appeared necessary to the industries connected with the production of food. By the introduction of internal combusion engines and the rapid development of their use in transportation and, largely, in the supplanting of the use of animal power, the tilling of large areas on the plains has been made possible without a corresponding increase of man power. The increase in this form of energy has made great demands on the store of the lighter oils; and this, in conjunction with similar demands for war purposes, has made the search for other oil fields a question of national importance. The supposition that gas fields are an indication of underlying oil reserves has drawn attention to the gas fields of Alberta, and there have been many exploratory wells drilled. Unfortunately many of these were in improbable areas; but a few have demonstrated large extensions to the known gas resources of the plains.

As new uses are being found for this natural gas, which indicate that from it some measure of relief may be found for a possible shortage in the fuel for internal combustion engines, the importance of the reserves and the areas in which they may be found is constantly increasing. In the early history of the plains little value was attached to the presence of gas unless it could be piped to centres of large population to be used as fuel to replace coal. As noted above, researches into the possible use of the gas for other purposes may succeed in establishing industries at the wells for manufacturing many compounds of value with the natural gas as the raw material.

The discovery of natural gas at Alderson (Langevin) on the Canadian Pacific railway in a well drilled for water about the year 1883 may be said to have been accidental. Another well was bored at Cassils, but the flow at these wells was not considered important. Small seeps of gas in the Saskatchewan river near Medicine Hat led to the putting down of shallow wells there, and in the report of the Geological Survey for 1900 it is mentioned that there were two wells with a pressure of 115 pounds, which were providing gas for lime-burning. These were comparatively shallow wells with small flow.

Deeper drilling was then undertaken and a better supply obtained at a depth of 1,000 feet. By 1904 there were six wells and the industrial development of the town began. Several wells were started about 1905 at other points but proved unproductive; two at Langham and three at Edmonton. Wells were also bored at Calgary in which very little gas was found; but greater success attended the boring on the anticline south of the Langevin and Cassils wells which gave in the Bow Island well an enormous flow. This well was completed in the latter part of 1908 and immediately interest was aroused again in Calgary, but on advice from the Geological Survey no further drilling at Calgary was to be attempted. The western edge of the syncline was advised, but the next well unfortunately was not located there but very near Calgary and was unsuccessful. In 1913 an anticline on the south branch of Sheep creek was located on the western edge of the syncline, and as the location conformed to that previously advised fresh boring was started by Calgary interests. This developed into the present Sheep Creek oil field, an area of small extent though the oil recovered is of high grade. The oil boom of 1914 will long be remembered on account of the indiscriminate location of oil properties without reference to the underground structure and the consequent very large useless expenditure in drilling. The general failure of the disturbed area of the foothills in providing many favourable structure areas, has directed attention to the more gentle structure underlying the plains, and a small measure of success has been obtained in the Peace and Athabaska valleys. Other drilling has shown the presence of gas at various places. In order to estimate the extent of these new fields extended study of the general structure is necessary.

In the general geological study of this very large area attention has, hitherto, been paid very largely to the beds outcropping at the surface, so that the geological maps have been prepared with a view to illustrating the mineral possibilities within reach of the ordinary mining operations, largely with the coal reserves as the main basis. By carefully observing the attitude of the beds at the surface predictions can be made for the shape assumed by the beds beneath, since there seems a great thickness of quite conformable strata underlying the plains which include those supposed to contain the gas and oil reservoirs. By extending the study of the surface formations plans of the lower beds can be compiled, but as perfectly evenly deposited beds are rare variations in thickness must be looked for. The only absolute check that can be made on the thickness is by the drilling records; consequently in order to adjust any general plan of the formation the aid of the driller must be sought. This at first was given with suspicion, but as the general plan developed into a case of mutual aid a more ready response was met with. We have on the plains area a great number of shallow wells and a few deep enough to give stability to parts of the area mapped.

The first approximation to the shape of the beds at present composing the groundwork of the plains indicates that the various layers conform to a very large basin form; that is, a bed which outcrops along the edge of the Cretaceous plateau and is found again in the foothills will be found at various lower levels between these points. In Canada there seems to be two very low points in the basin separated by a slight upraise. Neither of these depressions is open, so that unless since the deposition of the sediments in the sea there had been periods of elevation and local tilting, the porous measures would still contain the original sea water that was not expelled by the load above, and parts of the basin could be considered as saturated and, therefore, of little value for gas production.

A study of the various wells has shown that this line of saturation exists and is to be found at various levels. The variations may be due to structural causes or the possible addition of water from the surface, or even from gas pressure in the higher parts, but it can be assumed that salt water will be encountered below sea-level. It is necessary then to map the undersurface structure of the various porous beds which may contain gas or oil, but as these beds range from land deposits to offshore sandy silts their continuity cannot be relied upon; so that, as a preliminary, a horizon at the approximate base of the Colorado group has been assumed and structure contours for this plotted in the diagram, Figure 1. From this it is apparent that the areas of the sandy measures from which gas may be expected are reduced by the elimination of all the area below sea-level in so far as the lower sands are concerned, and by the elimination of successively smaller areas of the sands of the Colorado group. The size of the areas of the Colorado group eliminated varies with the elevation as shown in the figure. For example, a sand 500 feet above the approximate base of the Benton formation or above the top of the assumed Dakota horizon may be saturated by salt water and, therefore, of doubtful value in all areas outlined by the contour given on the diagram as 500 feet below sea-level.

The elimination of large areas as undesirable is thus indicated, so that detailed study and prospective drilling may be directed to the most promising parts at once.

In reference to the assumed horizon called the top of the Dakota it seems necessary to refer to the difficulty in making, even at the present time, an accurate correlation of the beds underlying this large area. The Dakota formation is now restricted in the type locality to a subaerial formation containing a certain flora. As it is difficult to conceive of land conditions as being continuous across a plain which had been at least in part submerged during the Jurassic period, we are obliged to try to trace the marine silts which the Cretaceous sea deposited above these sands. Probably this sea was shallow and parts of it persisted through the time represented by the Dakota; it is quite certain, therefore, that there will be, especially in the areas at a distance from the known land deposit, sands of both earlier and later age. Those sands found along the western margin below the Benton shale are known to have been deposited in successive layers from the close of the Jurassic to the Dakota. On the north, the exact age of the lowest Cretaceous bed is not definitely compared as yet with any American deposit, but may be of Lower Cretaceous age, and as the direction of the transport of the material was from the north the sand beds may not be traced throughout the basin. There seems, however, to be a sand bed or beds beneath the dark marine shales and even in these shales there appear to be some sandy layers. This sandy infiltration is apparently traceable to the western side of the sea where the mountain building was in progress, and is absent in the eastern part. In these sands the best gas accumulations seem to be in beds included in the Benton shales, that is, above the assumed Dakota horizon. Below this there have been traces of oil in some of the lower sands. Whether this is from one horizon or not is not clear, but apparently along the western edge of the basin this oily horizon is Lower Cretaceous, as is also probably that of the Athabaska and Peace River valleys. In the plains area the impregnations seem to be of a very heavy oil.

In considering the question of oil fields, therefore, the areas probably saturated with salt water are those outlined as having the Dakota horizon beneath sea-level, thus eliminating a very large part of the plains.

For gas, however, there are larger areas, since the gas is found above the Dakota horizon, but the absence of the Benton sands in the eastern area which apparently includes a large part of Saskatchewan again reduces the probable parts. Small amounts of gas have been found in the sands above the Benton, so that gas fields of limited extent or flow are possible often where the lower beds cannot be reached. Small flows of gas such as supplied from wells at Castor and Tofield are obtained in the sandy beds of the Belly River formation around the eastern edge of the Alberta syncline. Another instance is the Medicine Hat supply which comes mainly from sands at the top of the Benton.

The fields that have been studied in some detail include the foothills area, the Bow Island anticline, and the terrace structure on the eastern side of the basin from Battle river to Peace River landing.

THE FOOTHILLS.

The western part of the Alberta syncline descends to probably great depths, and as comparatively low beds appear in the foothills the upward slope of these beds is steep. The presence of possibly even a heavy oil in the bottom of the basin under very heavy pressures and higher temperatures due to depth should be favourable to some form of distillation or alteration. The short limb of the anticline offers least frictional resistance to its migration, and an increased impulse through steep slope, so that were the beds outcropping instead of concealed by overthrust faults, leaks of gas or oil might be looked for. In the area selected for testing for gas southwest of Calgary, the edge of the western limb of the syncline is overturned in anticlinal form, thus forming a natural reservoir. This seems also to have acted as a condensing chamber, and the oil found bears no resemblance to crude oil, but is generally considered as a condensation product. It contains about 60 per cent gasoline and that found in the higher strata is much lighter.

The main difficulty in finding other fields along this margin is in the broken nature of the structure. The edge of the syncline is very rarely bent over into arch form and is generally broken by faults and concealed by a heavy covering of overthrust strata, making the physical difficulty in reaching the productive measures very great.

BOW ISLAND ANTICLINE.

The lower measures in this structure are exposed in the upthrust of the Sweet Grass Hills in Montana, but the area exposed is not large and the vent thus possible seems to have been sealed by dykes radiating and surrounding the central masses. Wells at the boundary line have proved the presence of very thick oil and some gas and wells farther north great gas flows and sands impregnated with heavy oil that resembles an asphalt. The wells supplying Calgary are near the saturation line for the gas sands and may be considered as being very near the northern end of the field. The gas is in sands that appear to be in the Benton. The sands at the top of these shales outcrop in the valley of Milk river and over a wide area provide artesian water. The presence of this water obtained from Milk river seals the gas in the outer rim of the structure and is the supply obtained in the first wells at Langevin, Cassils, and that now used at Medicine Hat.

The Northern Gas Fields.

Wells in Manitoba and Saskatchewan have demonstrated the presence of shales from which gas and probably oil could have been accumulated, but so far have shown the absence of sands in the near proximity to these shales; hence probably the impossibility of there being any large gas or oil field. The western and northern portion may have possibilities. The development or search should wait until the better possibilities of the western part have been fully tested. In the study of the structure a terrace has been found along the north-eastern edge of that part of the basin approaching sea-level. At Peace river it is above sea-level for the lower sands and at Battle river somewhat below. The slope along the length of the terrace may not be uniform, and irregularities may provide localities of greater value as containers. The same irregular form may be repeated in the higher slopes toward the outcrop of the Athabaska, so that the McMurray sands which contain heavy oil at McMurray, known generally as the Tar Sands, may provide oil, as seems proved at Peace river. At this latter place the upward escape of the oil along the beds is prevented by the replacement of the sands in that direction by shales. Good flows of gas seem possible over a very wide area, but the search for oil is of the first importance to the parties interested, and as far as known the oil so far obtained is very thick and heavy. The utilization of the gas, as before mentioned, will, no doubt, receive early attention, as this seems to indicate the greatest value that the gas fields will be to the people of the provinces.

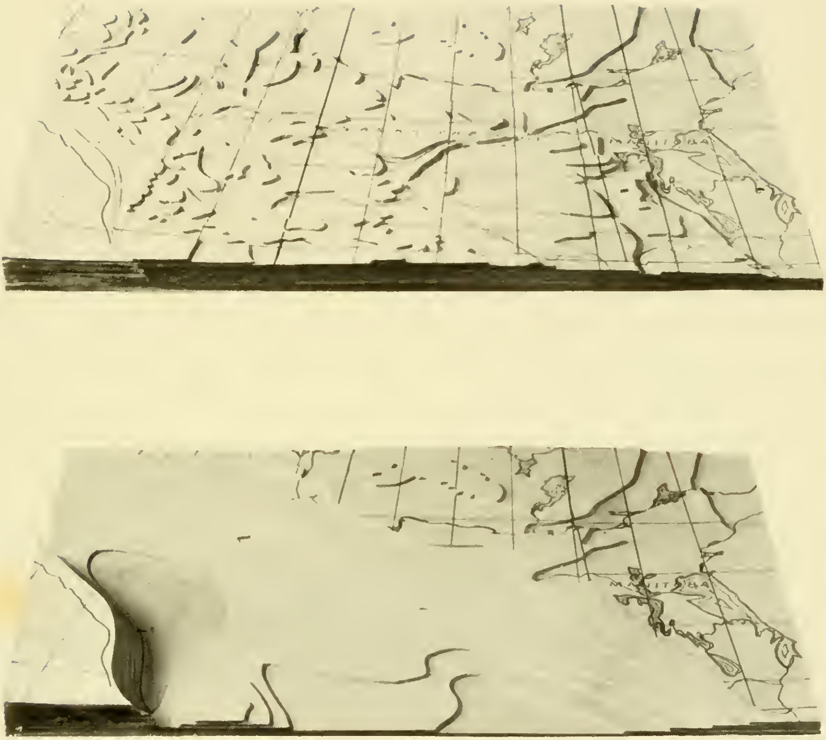

Figure 1. Upper diagram, a representation of the general slope of the surface as shown by 500-foot contours. Lower diagram, a representation of the shape of the basin occupied by the Cretaceous beds, as shown by 500-foot subsurface contours.

Branchioderma and Branchiotrema

By PROFESSOR A. WILLEY, D.Sc., F.R.S.C.

(Read May Meeting, 1918).

With respect to such classification as we are here concerned with, it might be more proper to speak of *a* classification than of *the* classification of the animal kingdom.—T. H. HUXLEY.

In this paper an attempt is made to use the respiratory organs as the basis of a binary system of zoological classification. It is of the essence of the theory of evolution that descent by heredity is associated with ascent in organization, just as the cell-lineage of the embryo leads to cell-differentiation in the adult. The many instances of partial and complete degeneration do not invalidate this general issue, inasmuch as the extreme of degeneration implies the extreme of adaptation to a conditional existence. Hence a synopsis of classification should exhibit both of these aspects in different ways, namely, as lines of descent and as grades of organization. The history of zoology is, in great measure, the history of classification and of its underlying principles, so that if it is possible to contribute towards clarity of expression on this subject, no apology is needed for the effort.

In 1873 Sir Ray Lankester proposed the terms Diploblastica for coelenterate animals, and Triploblastica for bilateral animals. For certain reasons they were, subsequently, replaced by Enterocœla and Cœlomocœla respectively, these being the two grades into which Lankester (1900) divides the branch Enterozoa. An attempt to establish the binary cleavage of Triploblastica has been made by Professor Hatschek (1911). In this author's phyletic table, two branches of bilateral animals are distinguished by their modes of formation of the third germinal layer or mesoblast, namely, Ectero-cœlia and Enterocœlia. The latter, which are not to be confused with Lankester's Entercoœla, are further subdivided into Dipleuridia and Chordonia; they include Chætognatha, Echinoderma, Tunicata and Vertebrata. Some discrepancy is unavoidable owing in part to the circumstance that at no period has physiological adaptation kept even pace with morphological differentiation. It remains to be seen whether alternative methods may not possess sufficient merit to warrant separate treatment.

By bringing out in classification the contrast between the two leading modes of obtaining oxygen, through the skin and its derivatives on the one hand, and through the pharynx and its derivatives on the other, the maximum importance is assigned at the earliest moment to the respiratory processes in evolution. It may seem singular that such an apparently obvious point has not been brought out in previous schemes. To some extent it has been implied, though not with the precision of a decisive cleavage. John Hunter (1728-1793) attempted to set up a classification, known as Hunter's Cardiac System, based upon the characters of the heart and respiratory organs. Mammals and Birds with their four-chambered heart were Tetracœlia; Reptiles and Amphibians, with three-chambered heart, were Tricœlia; Fishes with two-chambered heart (undivided atrium and undivided ventricle) were Dicœlia. Hunter had detected the existence of two auricles with one ventricle in the bivalve Mollusca, but as Owen remarks in the preface to Hunter's *Animal Oeconomy* (edition of 1837): "His perception of the physiological relations of these different cavities prevented him from associating the mussel with the tortoise on account of this tricœlous structure of the heart." The two auricles of the mussel's heart perform the same function of returning oxygenated blood from the gills to the ventricle; the auricles of the reptile's heart perform different functions; all play a vital role in promoting the circulation of oxygenated blood.

Huxley's three provinces of Vertebrata: Ichthyopsida, Sauropsida and Mammalia, were based primarily upon the respiratory apparatus, that is to say, upon the presence or absence of functional branchiæ. The progress of palæontology has tended rather to accentuate the breach between fins and pentadactyle limbs, which Huxley's system ignored, his Ichthyopsida embracing both fishes and batrachians. Accordingly I venture to suggest a modification in the extension of this term; but under the altered application it retains a fundamental part of its original meaning in so far that Huxley's Ichthyopsida, then as now, included Amphioxus, in which the persistent notochord extends beyond the cerebro-spinal axis to the anterior end of the body, whereas in all other Vertebrates the notochord stops short behind the pituitary gland. Instead of ranging amphibians alongside fishes, the course that seems to be indicated at the present juncture is to employ Ichthyopsida as a middle term in a series, placing Amphibia under Tetrapoda. In order to establish this proposition a long discussion would be necessary, were it not that the need has been met to a large extent in an essay by W. K. Gregory (1915). The continued use of Ichthyopsida in Huxley's sense has also been criticized by Gadow. In the new sense it may be contrasted with Helminthopsida (Enteropneusta), thus bringing into relief the radical cleavage between soft-bodied worms and firm-bodied chordates.

The name Branchiotrema[1] was introduced as a phyletic term to include all animals possessing gill-clefts, whether functional or not, at any period of their life-history (Willey, 1899). These are now contrasted with Branchioderma which are the triploblastic invertebrates, containing both the Chitinophora (vermes, arthropods, molluscs) of E. Perrier (1893) and the Echinoderma.

That the cleavage between Branchioderma and Branchiotrema goes very far back is rendered probable by the relationship which the Echinoderma and Enteropneusta ("Balanoglossus") bear to each other through their larval forms and body cavities. The special analogy between adult echinoderms and vertebrates has also been enlarged upon. E. Hæckel (1896) remarked that echinoderms approach vertebrates above all in their peculiar skeletal system; they are almost the only invertebrates which, like vertebrates, deposit lime in great quantity in the corium and, by the union of calcareous plates, produce a skeleton of dermal scutes. The placoid scales of fishes and the cranial shields of the Stegocephali have the greatest resemblance to the dermal armour of echinoderms. Early in the same year, E. W. MacBride (1896) made similar comparisons independently concerning the skeletal and nervous systems.

The Branchiotrema have pharyngeal respiration with endodermal respiratory epithelium; the Branchioderma have cutaneous respiration with ectodermal respiratory epithelium. In coelenterate animals, both ectoderm and endoderm, amongst other functions, act as respiratory membranes.

Amphibia still exhibit a vicarious functional relationship or correlation between cutaneous and pharyngeal respiration, such as may have obtained before the cleavage took place. Necturus, the "Mud Puppy," has a pair of lungs and two pairs of gill-clefts, neither of which functions in ordinary respiration. The lungs of Necturus are first and foremost hydrostatic organs. When kept in shallow water, two to three inches in depth, the animals will remain submerged indefinitely. If placed under circulation (either in running water or in water through which bubbles of air are passed) in a vessel covered with a perforated zinc plate, the plate being accurately fitted to the jar and immersed in the water so that the imprisoned Necturus cannot reach the surface, there is no diminution of activity. Under these conditions of close confinement it often touches the zinc diaphragm in its excursions, as if trying to reach the top; but this is an escape-movement and is not the result of oxygen hunger. If placed

[1]This term has since been accepted by Professor Butschli (1910), though in a more restricted sense than was originally proposed for it.

in an insecure vessel of water, they will always escape from it overnight and be found dead in the morning. Under other circumstances I have occasionally seen them open their mouths above the surface; this yawning movement may be a reaction to the dearth of food, but it has nothing to do with functional inhalation, the ensuing air-bubbles being discharged through the gill-clefts or mouth. When exhibited before a class of students, the gills are sometimes moved actively, at other times relaxed, but never is any attempt made to reach the surface, if the container is not too small.

Eycleshymer (1906) states that when the animals are retained in aquaria "they are frequently observed to thrust their snouts above the water, open the mouth widely, and then return to the bottom where they soon expel the air both through the gill slits and from the mouth." No evidence is brought forward to show that any of the air enters the lungs through the diminutive glottis.[1] When swimming about in an aquarium they more frequently thrust the snout above the surface without opening the mouth. From the passage quoted above from Eycleshymer, it might be inferred that the behaviour of *Necturus* in the water resembles that of *Diemyctylus*. This would be far from the truth.

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[1] It is difficult to obtain direct evidence on this point as will appear from the following experiment. On February 12, 1914, a Necturus, which had been kept for about three months in a large aquarium, was placed in a cylindrical glass jar, eight inches deep, into the mouth of which was fitted, three and a quarter inches below the surface, a perforated zinc disc. Aeration was effected by allowing water to trickle from a tap into the funnel of a thistle tube which reached to the bottom of the vessel; the water carried bubbles of air with it. Under these conditions the Necturus remained in normal activity for the next ten days. Every night the tube became slightly displaced by the nocturnal movements of the animal so as to stop the aeration, but this had no ill effects. On February 22 the jar full of water was transferred bodily to the aquarium and the latter was filled with water to a depth of one foot, thus bringing it four inches above the level of the glass. The zinc disc was removed and a minute afterwards the Necturus swam over the edge into the tank without coming near the surface. It descended to the floor of the tank and walked slowly round it, gently respiring with its gills. After twenty-five minutes it swam to the surface, protruded its muzzle into the air, opened its mouth and then descended again, whereupon about half a dozen large air-bubbles issued from the right gill-openings. Two minutes later it ascended once more to the surface, gulped in air as before, descended and at once emitted a quantity of air-bubbles in rapid succession from the right gill-openings. Henceforth the ventral surface of the trunk no longer came into contact with the bottom, for the entire abdominal region was arched upwards and it walked along the bottom in an awkward digitigrade manner. During the next two hours it became active, swimming in mid-water, making frequent excursions to the surface and protruding its muzzle but never again opening its mouth nor emitting air-bubbles in its descent. Two young individuals were in the tank at the same time, walking and resting prone on the bottom, not once rising to the surface.

The movements of the external gills of Necturus are very irregular and those of one side can be waved independently. Whether they move together or separately, with a single movement or with consecutive rhythmic action, the flapping of the gills is the sole respiratory movement of Necturus. Neither in the abdominal wall, the floor of the mouth, nor in the external nares is there any respiratory twitch. Necturus, although an Amphibian in grade, is not in any sense amphibious in habit, but is purely aquatic. It has been captured on hooks and in nets, but there is no record of its having been seen swimming near the surface in the open. It seems highly probable that it does not normally make periodical visits to the surface for the express purpose of breathing air. Necturus does not hibernate but remains active through the winter; Eycleshymer has repeatedly taken them through the ice on set lines during the months of January and February.

The arrangement of the vascular system points to the same conclusion. The pulmonary arteries of Necturus arise from the last pair of efferent branchial arteries, whilst all the blood which leaves the heart passes through the afferent branchial arteries to the gills, except that the first afferent artery on each side gives off an external carotid artery. Boas (1882) was able to inject the pulmonary artery from the *radix aortae*. Perhaps it may be presumed that the lungs are filled with air by gaseous diffusion from the blood as with the air-bladder of fishes. Apparently when this air accumulates in excess, it can be got rid of through the minute glottis which lies far back and has no relation to the internal nares.

Hunger may drive Necturus to acts of cannibalism. This fact alone shows how necessary it is to discriminate between different kinds of behaviour in captivity. After having been kept through the winter months almost entirely without food, a Necturus of moderate size was found in the act of swallowing a smaller one, the hind-legs and tail of the latter projecting out of its mouth. Twenty-four hours later, the hind-legs had disappeared down the throat and, after a few hours more, only the posterior moiety of the tail was still protruding to a length of $1\frac{1}{4}$ inches. All this time the mouth of the larger individual was necessarily kept permanently open under water.

Very different is the behaviour of the aquatic salamander *Diemyctylus*. According to Inez L. Whipple (1906), when retained in an aquarium, *Diemyctylus* requires frequently to take air into the lungs during the brief period when, by a rapid swimming to the surface, sufficient momentum has been acquired to force the head for an instant out of water. The nostrils are then useless as air-passages, being full of water. The method employed is a quick, gulping motion, immediately followed, as the head returns under water, by a forcible swallowing motion, by which air is forced from the mouth partly into the lungs and partly out through the nostrils. There is abundant visible proof that air has entered the lungs, in the increase of girth and especially in the immediate increase in buoyancy. The authoress gives many other details regarding the hydrostatic habits of *Diemyctylus*. On the other hand she has never observed *Necturus* to float except upon one or two occasions when the water had become very foul: "occasionally it will swim to the surface and take in air through the mouth by a gulping motion," but again there is no evidence that any of this air is passed into the lungs; it escapes through the mouth and gill slits as the animal sinks slowly to the bottom.

Kneeland (1859) kept a Necturus for an hour out of water during which time it occasionally opened its mouth "as if to swallow water or air." I have also seen this act of gasping out of water but it is not accompanied or followed by any visible act of swallowing. In June 1858 Kneeland placed two individuals into an aquarium in company with half a dozen minnows. The fish were frequently seen nibbling at the expanded gills of the Necturus. In about ten days the branchial fringes had all been nibbled away. The fish were then removed and in the course of six months the fringes had been regenerated to half their normal size. The temporary loss of the gills did not incommode them in any way, since the general cutaneous respiration remained unimpeded. This observation I have indirectly confirmed by ligaturing and extirpating the external gills, an operation which has no apparent effect on their habits or activities. The gills regenerate in due course.

The lungs of Necturus are like the air-chambers of Nautilus. A floating Nautilus is a moribund Nautilus, and it is doubtless the same with Necturus. More observations, accurately timed and recorded, are required to settle various questions which arise in connection with the behaviour of Necturus in captivity. It is a matter which consumes much time, so rarely does anything happen to disturb its equanimity when resting quietly at the bottom. One cause of the floating of fasting Necturus in adverse surroundings is the formation of gas in the intestine, a pathological condition. Finally when Necturus casually swims to the surface and protrudes its snout, whether the mouth be opened or not, there is no increase in buoyancy nor in girth.

In the summer time frogs can survive a moderate duration of immersion; in winter they voluntarily submerge themselves and hibernate under water, becoming inactive. A male frog (*Rana virescens*) was placed in a shallow dish covered with a perforated zinc plate weighted down securely, the whole being completely submerged in an aquarium on December 31st, at a temperature of 19°C. On January 8th the cover was raised and the frog remained motionless in the resting attitude. On being stimulated with a glass rod it failed to react at first, but within a minute it became aroused from its lethargy, raised its head above water, came out of the dish and then swam vigorously away. The next day it was perfectly normal and very active. The cutaneous artery of the frog impinges upon the skin in the region corresponding to that where the afferent branchial

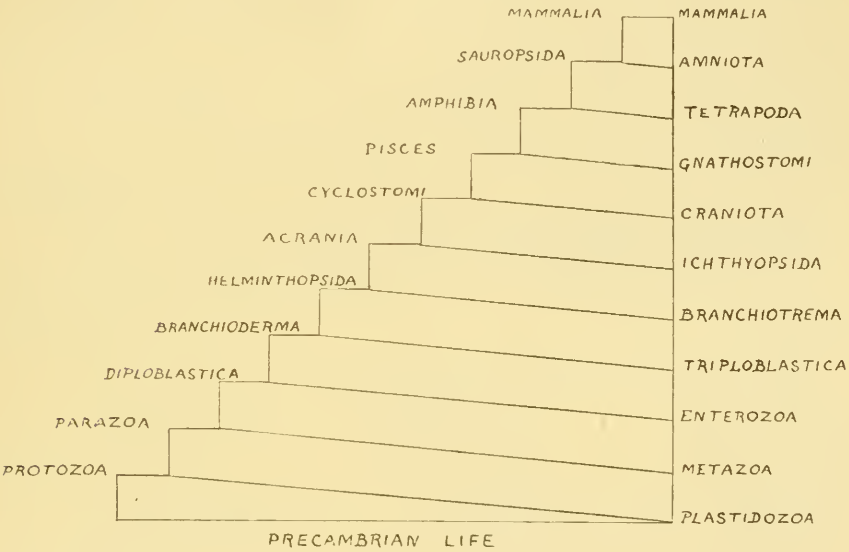

Fig. 1

arteries of Necturus enter the cutaneous gills. The winter submergence of the frog (*R. temporaria*), as observed under laboratory conditions, was described by G. Newport in 1851.

The accompanying chart, which may be called a phylograph, without aiming to be exhaustive, has the temporary advantage of being complete in itself. Incidentally it illustrates the principles of divergence, parallelism, gradation and convergence. Collective organization is determined by parallel lines of rectilinear descent, and divergence is expressed by the binary cleavages which produce these lines. Plastidozoa break up into Protozoa and Metazoa; Metazoa into Parazoa (sponges) and Enterozoa; Enterozoa into Diploblastica and Triploblastica; the latter into Branchioderma and Branchiotrema; these into Helminthopsida and Ichthyopsida; and these again into Acrania and Craniota. Acrania include both

Urochorda (Tunicates) and Cephalochorda (Amphioxus), terms which were introduced by Lankester in 1877 and adopted by F. M. Balfour in his *Comparative Embryology*.

The grades of organization are represented as the steps of comparative anatomy; they are determined by the characters of the organs. Convergence is the condition where an organ, developing along a particular line of descent, tends towards the level of that attained along a parallel line. In the diagram it is expressed by the parallel lines of descent tending to meet the horizontal lines of gradation in respect of particular organs. For example, the gizzard of certain fishes attains a high level of development along the piscine line, far surpassing that of the average fish stomach and approaching that of birds. If the oblique line of descent of fishes and the horizontal grade of birds be produced, they will eventually meet at the cross-roads of gizzard-convergence, while the lines of genetic descent remain parallel and remote. Convergence is, therefore, found whereever one line of descent tends to encroach upon another average grade of organization belonging to a different line.

As a typical example of remote parallelism we may take the case of Mollusca and Vertebrata, comparing them as regards the ingestion of food.

MOLLUSCA.	VERTEBRATA.	FOOD.
Scolecomorpha (Solenogastres)	Helminthopsida (Enteropneusta)	Scolecine ingestion
Acephala	Acrania	Ciliary ingestion
Gastropoda	Cyclostomi	Suctorial ingestion
Cephalopoda	Gnathostomi	Raptorial ingestion.

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SECTION IV

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Some Problems of New Brunswick Geology.

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(Read May Meeting, 1918)

The publication of an Official Geological Map, if not considered final as regards the age and relation of the geological formations included in its limits, is apt to be looked upon, especially by the general public, as representing a consensus of opinion upon the part of those concerned in its production, and is appealed to as though the views embodied in it were not open to any further question.

Such has been the case with the Geological Map of New Brunswick which begun in 1880 and issued from time to time in successive sheets, was completed in 1890. By most persons interested in the subject it is still appealed to as giving the most reliable information with regard to the large and very complicated region to which it refers. But even during its preparation, as indicated by the accompanying geological reports, the authors from time to time altered their views as regards important questions involved, while there was far from an entire agreement among the many investigators who took part in its production, viz.: Bailey, Matthew, Ells, McInnes, Chas. Robb and others. Moreover, since its completion, some of the debated points of age or structure have acquired increased importance, while many new questions have arisen requiring investigation and solution. In fact at present there is hardly a group of rocks found in New Brunswick about which it would not be easy to ask questions without the possibility of a satisfactory answer. It is to the enunciation of some of these problems and the question of their possible removal that it is the purpose of this paper to refer.

The formations will be considered in ascending order.

PRE-CAMBRIAN

The questions which arise in connection with the supposed Pre Cambrian of New Brunswick are the following:—

(1) Are the rocks referred by the authors of this paper to the Laurentian and Huronian and which are represented as Pre-Cambrian on the Geological Survey Map, wholly of such antiquity or are portions of them, as asserted by the late R. W. Ells, really of much more recent origin ?

(2) If some of the rocks in question are really *Post*-Cambrian, is it possible to separate these clearly from those which are Cambrian or Pre-Cambrian ?

(3) If a portion of the rocks in question can, without doubt, be shown to have the high antiquity at first assigned to them is it possible to establish any real or probable correlations between them and any portion of the Pre-Cambrian succession as formulated by the International Geological Committee of 1905, as found in the region of the Great Lakes, or as recognized later by other geologists ?

(4) What evidences of *diastrophism* are to be found among the rocks in question, and what bearing have they upon the time and extent of earth movements in these early eras ?

(5) What were the *sources of the material* constituting the supposed Pre-Cambrian rocks, and what information do they afford as to the probable physical conditions, geography and climate of the periods to which they belong ?

(6) What evidences of *life* are afforded by the sediments antedating the Cambrian era ?

The above questions relate solely to the supposed Pre-Cambrian rocks as found in the vicinity of the city of St. John and their extension eastward and westward. To them may be added the following:—

(7) Is there any reliable proof that the large areas which in other parts of the geological map are represented as Pre-Cambrian are really referable to the latter, and, if so, can they also be brought into correlation either with the rocks of St. John or with those of the typical regions about Lakes Superior and Huron ?

We may endeavor to answer these questions *seriatim*.

(1) The rocks about the City of St. John which (in 1870) were first referred to the Pre-Cambrian consist of two formations, the first and older embracing mainly a series of imperfect granitoid gneises, finely exposed in the vicinity of Indiantown, a suburb of St. John, and in the Narrows of the St. John river, with which, in unconformable superposition, was associated a thick series of quartzites, limestones and dolomites, often serpentinous, and highly disturbed and metamorphosed, together with large areas or inclusions of granite and syenite; and secondly a series which consisted mainly of volcanic

ejecta, together with some schists and other clastic rocks. The first of the two divisions, under the name of the Portland Group, was referred to the Laurentian and the second or Coldbrook Group to the Huronian. The ground for this reference was the evident parallelism which the groups bore, both in their lithological characters and order of succession, to the Laurentian and Huronian as established by Logan and others in the region of the Great Lakes, while portions of them at least were unconformably overlaid by fossiliferous Cambrian strata.

The above view of the age of these rocks remained undisputed for over thirty years, but, about the year 1906, the late Dr. R. W. Ells, as the result of certain examinations made by him, stated, with great positiveness, that the greater part, if not the whole, of the lower group was intrusive and of late origin, while the crystalline limestone and associated quartzites, forming the upper division, were not a part of the Laurentian formation but probably Cambrian or possibly even Devonian.

To the view thus advanced by Dr. Ells, the writers of the present paper and by whom the Archaean age of the rocks in question was first asserted, cannot subscribe. No doubt the larger part of the coarsely crystalline rocks of the lower division are of intrusive origin, occurring in the form of more or less extensive batholiths, and to their intrusion is due in great measure the highly crystalline character of the associated rocks and even the development in some portions of the latter of a quasi-gneissic character, while the same extrusion would also indicate that they were of later age than the rocks which they invade; but though such batholiths occur in connection with what are probably Huronian rocks to be presently noticed, they have nowhere been observed to penetrate the overlying Cambrian and they (the granites) are lithologically different from those which, at a very much later date, penetrated the Silurian and Devonian.

For the above reason the authors of this paper are still disposed to adhere to their original belief that the crystalline rocks of St. John and its vicinity are of Pre-Cambrian age and to be more particularly correlated with the group (the Laurentian) to which, in the classification of the International Committee, that name is now restricted.

We come now to consider the calcareous rocks of the upper division which by the writers of this paper were also referred to the Laurentian System. This reference too has been questioned by Dr. Ells, mainly upon the ground that certain limestones in Charlotte County which were also so referred, were found by him to carry Silurian fossils, He even advanced the view that the highly altered banded slates and quartzites which at St. John are associated with the limestones of this upper division may be of Cambrian age, at all events older and not newer than the rocks, intrusive granite, diabase, etc., which constitute the bulk of the lower division, thus doing away with the existence of all Pre-Cambrian rocks in the St. John district. To this view the authors of this paper find it impossible to accede. For the fact that some of the limestones of Charlotte County, distant some fifty miles from the region under discussion, have been found to be Silurian rather than Laurentian, as was at one time conjectured, does not prove that those of St. John are also Silurian, while a variety of facts tend to show the contrary. The limestones of Charlotte County are of very limited extent, they do not, like those of St. John, alternate repeatedly with heavy beds of quartzite, nor are they, as at St. John, directly overlaid by fossiliferous Cambrian strata. The St. John limestones, etc., would appear, like the Grenville Series of Ontario, to occupy narrow synclinal troughs in the lower division of the Pre-Cambrian, though penetrated in part by granite batholiths of the latter, as well as by numerous dykes which also penetrate the later Huronian strata. In character also they bear much resemblance to the rocks of the Grenville series, but as the exact position of the latter in the Pre-Cambrian succession is itself still a matter of debate, no positive correlation between the two is possible. The evidence, however, of a Pre-Cambrian origin is as strong in the one case as in the other.

(2) and (3) To answer these questions some reference must first be made to another group of rocks which, about St. John, intervened between those already discussed and the fossiliferous Cambrian. They are those to which the term "Huronian" was applied in the Geological Survey Report of 1870-71, but which in the Geological Survey Map are designated simply as Pre-Cambrian. They were subdivided by the present writers into two groups, of which the lower or Coldbrook Group was described as mainly composed of volcanic and semi-volcanic rocks, while the second or Coastal Group consisted mainly of clastic rocks (chloritic and hydro-mica schists, slates and conglomerates, with some limestones) though also including many beds of igneous origin.

Where these supposed Huronian rocks are exposed at St. John they have but an insignificant thickness, being only about thirty feet at the Suspension Bridge, and embrace only the lower or Coldbrook division, but widen rapidly to the eastward, where the so-called Coastal rocks occupy a very large area. Where, as at St. John, the Coldbrook rocks are directly overlaid by the basal Cambrian, no doubt can be entertained as to their true position and the same is the case about the Loch Lomond Lakes, some few miles eastward, where they enclose a trough or syncline of richly fossiliferous Cambrian beds, but where these are absent, as in the case of the Coastal rocks, the only data for determination are their lithological characters, which, as is well known, may easily lead to error. It can only be said that they are probably Pre-Cambrian and that in their main features they nearly resemble the Pre-Cambrian rocks of the Eastern Townships of Quebec. Like the latter they are copper bearing at many points, and with similar beds occurring along the coast west of St. John, contain nearly all the localities in New Brunswick in which ores of that metal have been obtained. They are highly disturbed and metamorphosed and towards their eastward extremity hold a considerable batholith of granite. Though holding some beds of limestone they have as yet revealed no fossils, and their true position is still one of the unsolved problems of New Brunswick geology.

(7) We may now consider some of the areas, more or less remote from St. John, which, in the Geological Survey Map, are represented as Pre-Cambrian, but in which the evidences for such reference are less direct and convincing than in the district already discussed.

One of these is a considerable tract of more or less altered rocks found near the border of Kings and Queens counties, and which presents great diversity of lithological character. It would be impossible and probably useless to discuss these here in detail—(such details are given in the published Geological Survey Report for 1871) but it may suffice to say that while a portion of them, largely volcanic, lithologically resemble those of the Coldbrook group as seen in St. John County, embracing porphyritic felsites or rhyolites and diorites, more or less vesicular, other portions more nearly resemble the so-called Coastal rocks, embracing greenish and purplish chloritic and felspathic schists, argillites of various colors, felsite breccias and especially a grey rock resembling granite in aspect and composition but which is evidently clastic and recomposed. Nothing bearing any resemblance to the limestone-quartzite series of St. John is met with. At many points Upper Silurian strata carrying fossils rest upon the supposed Huronian strata unconformably, proving the Pre-Silurian age of the latter, and in places beds of undoubted Cambrian rocks are found not far removed from these, but no cases of actual superposition have as yet been observed. We can only say that the facts now on hand strongly favor the idea that the rocks under debate are Pre-Cambrian, with basins of Silurian slates, but much careful work is needed before all the intricacies of this complex region can be regarded as satisfactorily settled.

The next group of supposed Archean sediments to which reference must be made is that which, lying mainly between the parallel lake-like expansions of the St. John river, known respectively as the Long

Reach and the Kennebecasis, and occupying the peninsula of Kingston, has been described as the Kingston Group. It consists to a very large extent of alternating beds of felsite and intrusive diorite, and is therefore mainly of igneous origin, but associated with these as a distinct division, is a considerable body of argillites. Being at many points bordered by fossiliferous rocks and at others apparently enclosing strata which are also fossiliferous, it was at one time supposed that they were wholly Silurian; but notwithstanding such evidence as applying to certain portions or certain strata of the Kingston rocks as originally described, there is still good reason to believe that a considerable portion of this group is really of Pre-Cambrian age. This remark applies not only to the rocks of the Kingston peninsula, where they were first studied, but to their apparent extension westward to Beaver Harbor and the islands of Campo Bello, Deer Island and Grand Manan. In each of these Silurian fossils have been found but it is still a question whether the formation as a whole is Silurian or whether the occurrence of such fossils may not be the result of folding and enclosure among strata of greater antiquity. The fact that at many other points the Kingston rocks or portions of them are overlaid by Silurian deposits tends to indicate their greater antiquity. In the Nerepis region and towards the head of the long Reach they are also apparently overlaid by the basal beds of the Cambrian.

The last region in New Brunswick which has been described and mapped as consisting mainly of Archaean or Pre-Cambrian rocks is that of the Northern Highlands, a rugged and semimountainous tract from which many of the larger rivers of the Province, such as the Miramichi, the Tobique, Nepisiquit, Upsalquitch and others draw their water supply. In the present connection they are of interest as showing how readily serious mistakes may be made by giving too much weight to lithological resemblances, when unsupported by other evidence. For there is now good reason to believe that much of the region thus referred to a Pre-Cambrian (probably Huronian) horizon, is really Silurian or even more recent.

The rocks which compose very many of the hills bordering the Tobique and Nepisquit rivers, and to which reference was made by the writer as long ago as 1862, are felsites (really rhyolite), associated with various other products of igneous origin, and being from their reddish color very conspicuous and forming the summit of numerous eminences, were rightly supposed to give character to the whole; but their first assignment to a definite age, viz. Pre-Cambrian, was not until a short time prior to the publication of the Geological Map, when, from their evident likeness to the Coldbrook Huronian rocks of St. John, they were described as their probable equivalents. That resemblance is certainly very marked, so far as superficial features are concerned, but not more than to very similar deposits which, in Charlotte county, around the shore of Passamaquoddy Bay, unquestionably overlie, and in a nearly horizontal attitude, fossiliferous strata of Silurian age. When therefore, the writer several years later made a second and more detailed survey of the Tobique-Nepisquit region, having previously become familiar with the aspects of the Silurian as seen in Aroostock County, Maine, where precisely similar relations are revealed, he naturally felt a doubt as to whether the great antiquity which had been assigned to the region could be accepted as correct. It was not long before the suspicion aroused by the general aspect of the rocks received definite confirmation, for at one point, (on the slopes of Mt. Teneriffe or Bathurst Mt.) the felsites exposed on the summits of the hills, and wrongly supposed, except in some instances, to form their entire mass, were really underlaid by or rested upon beds of conglomerate and sandstone, closely comparable with similar rocks which both about Ashland, Me., and again upon the Beccaquimic, N.B., overlie fossiliferous Silurian strata. Thus a part at least of the felsites and associated rhyolites which cover so large an area on either side of the Tobique and Nepisiquit rivers are clearly much more recent than they had previously been supposed to be, and are to be regarded either as Silurian or Post-Silurian in origin. Dr. Ells, to whom the early reference to the Pre-Cambrian is due, after a visit to the spot, admitted the facts as stated, but endeavored to explain the super-position of the felsites as due to an overthrust; as however, the beds are conformable and lie, as around Passamaquoddy Bay, in nearly horizontal attitude, such a supposition cannot be entertained. It may be added that a typical series of rock specimens collected from the volcanics of the region and associated strata, and subsequently examined petrographically, gave entire confirmation to the view here advanced.

The problem then in connection with these rocks is to distinguish the limits occupied respectively by the igneous and sedimentary deposits, to ascertain whether any other rocks, older or newer, are to be found in the large area concerned, and to map these accurately. The solution of the problem will be a difficult one, for the region is remote and comparatively difficult of access, thickly forest-clad and showing, except on the streams, most of which cannot be ascended by canoe, very few exposures; but whether thoroughly surveyed or not, it is desirable that in the issuance of any new map of the region this should no longer be represented as wholly Pre-Cambrian but as composed largely of volcanic rocks of uncertain, but comparatively recent age. In the lower part of the Nepisiquit River (below Partage

Brook) are gneissic and schistose rocks, which may well be much older.

(4) Evidences of diastrophism are everywhere to be met in connection with the Archaean rocks of Southern New Brunswick, though it is by no means easy to fix the time of such disturbances. As regards the deposits (granites, syenites, etc.) to which the name Laurentian has been here restricted, these are so largely of batholithic origin that the time of their production and the movements to which they have been subjected can only be conjectured, and even the accompanying gneisses may owe their appearance to similar causes; but, it is certain that we have not in New Brunswick anything in the way of a stratified formation distinct from and unconformable to the Laurentian such as has at some places been found beneath the latter in the region of Lake Superior. On the other hand granitic batholiths, similar to those of the Laurentian, penetrate, in the St. John region, not only the upper or limestone division of this system as first described, but also the overlying Huronian and even Cambrian. They may therefore be, in part at least, of any age earlier than Silurian, but are to be distinguished from the great batholiths which, as stated in the sequel, were one of the most distinguishing features of late Devonian times.

As regards the upper or limestone belts associated with the Laurentian area, these show everywhere evidences of profound displacement and metamorphism. They abound in folds, faults and slickensides, and though containing no conglomerates, the limestones of the series, which vary greatly in colour, texture and composition, are sometimes so shattered as to have become, after reconsolidation, a coarse breccia. No discordances, such as would mark time-intervals or periods of erosion are found between different portions of the series but the latter unquestionably rests upon Laurentian rocks and is itself similarly covered by the Huronian and Cambrian sediments, whose lower conglomerates were in part derived therefrom.

(6) What are the evidences of Life in connection with the Pre-Cambrian rocks of New Brunswick? The answer is still negative with the possible exception of the upper or limestone group about St. John. The occurrence of heavy beds of very pure limestones is in itself a presumptive proof of the existence at the time of their origin of lime-secreting organisms, and to this presumption force is added by the fact that many of these limestones are graphitic and even contain considerable beds of impure graphite. The only form, however, excepting sponges, as yet met with to which an organic origin has been definitely assigned is one to which Matthew has given the generic name of *Archæozoon*. It occurs in the form of masses nodular in

cross section, five or six inches in diameter and exhibiting concentric layers, which by weathering are made to project and to give to the whole the appearance of a rosette. If really organic it would seem to be of rhizopodan or foraminiferan origin, but there are those who prefer to regard that origin to be mechanical and concretionary. If we admit their organic derivation still another supposition is possible, viz. that the limestones are due to the growth and accumulation of certain types of seaweeds, as is now believed to have been the case with the limestones of the Grenville series. Even Bacteria may have played an important part. The occurrence of serpentine with the limestone at St. John, as at Grenville, is significant, as the magnesian silicate may be only the altered form of the glauconite or greensand which is so extensively associated with the foraminifera of Cretaceous and later seas.

The fossil alga (*Newlandia*) described and pictured by Walcott as found in Algonkian rocks of Montana, bears in outward appearance, great resemblance to the *Archæozoon* of St. John. See "Origin and Evolution of Life," p. 102.

Cambrian

Some problems connected with the Cambrian of Southern New Brunswick are the following:—

(1) The relations of the Cambrian beds of the St. John basin to the underlying Pre-Cambrian, and the evidences or otherwise of a diastrophic break between the two.

(2) The relations of the Cambrian to other systems as found in the Kennebecasis and Belleisle valleys. The former distribution of the Cambrian rocks, with evidences of extensive erosion.

(3) The sources of the material constituting the several divisions of the Cambrian series, with the probable geography of the era, its currents and climate.

(4) Sources and probable migrations of the fauna.

Some of the above questions have been discussed at length in various articles by one of the writers, and need not be further considered here. A few additional observations on other points may, however, be made.

Relations of the Cambrian to subjacent strata

At the foundation of the Cambrian rocks near and at St. John, we find an old "massif" or assemblage of strata certainly Pre-Cambrian and probably of much greater age than the Cambrian rocks. At the time that the Cambrian strata began to be deposited this old "massif" had already been metamorphosed and hardened, as well as elevated above the sea, showing marks of profound weathering when, in the beginning of Cambrian time, it was again brought down to the sea-level; for its felspathic rocks were kaolinized, its graphite beds turned to a black mud, and its mica schists rendered soft and crumbling.

These conditions can only be recognized where the contact of these basal rocks with the Cambrian can be seen. They are noticeable where the two sets of rocks come together near the outlet of Lily Lake, in Rockwood Park, St. John. Exactly the same conditions are visible at Dugald Brook in Cape Breton, where also the base of the Cambrian is in contact with granitic rocks of a similar ancient "massif." These and other indications point to the probability that for a long period before the deposit of the Cambrian basins along the shores of Southern New Brunswick, there were extensive areas of the earth's crust in this part of the world raised above the sea, and forming a barrier to the extension of the Cambrian sediments to the north-west.

Base of the Cambrian. At one time it was claimed by one of the writers of this paper that what was then known as the "St. John Group" was the base of the Cambrian system, certain red beds, known as Etcheminian, being of an older series. And there were several reasons for this. First, in the Eastern part of the St. John basin, conglomerates with quartz pebbles were found at the base of the red beds, and on the other hand, in the middle basin of Cambrian sediments the red beds were absent. But when the Cambrian rocks of Cape Breton were investigated, fossil bearing beds were found to the very base of the system there, and with one exception, the genera of brachiopods which they contained were found to be the same as those which elsewhere characterized the Lower Cambrian rocks. Hence their lowest beds were regarded as members of the Cambrian system.

While the St. John Group as originally understood was, as there stated, subsequently made to include the basal rocks first separated as Etcheminian and Huronian, with their several faunas, there was also a change in an upward direction, the highest faunas of the group being looked upon as Ordovician, and therefore outside of and above the Cambrian strata as recognized in Europe. These Cambro-Silurian or Ordovician deposits will have further consideration presently.

Distribution of the Cambrian. Only three basins of Cambrian rocks have been definitely recognized in the southern part of New Brunswick, all in or near St. John, of which the one whose rocks underlie the city is the most important. This is covered at each end by deposits of a later age; and on each side it is bounded by hill ranges of volcanic rocks.[1] Within the basin lateral pressure from the SE has compressed the yielding rocks into several folds, which at its SW end have been reduced to a part only of one fold, showing only the southern half of a syncline of overturned measures from the base to the summit of the series.

The Second basin of Cambrian rocks is developed in the valley of the Kennebecasis river, but shows itself only in isolated outcrops along the course of this river towards its mouth. Although in this basin only detached portions of the series of deposits which make up the Cambrian group are visible, the relations of these parts to each other show that the dip of the rocks in this basin is to the northwest, and the rocks which separate it from the St. John basin are of the same Pre-Cambrian series of schists and limestones, with intrusive batholiths of granite, as is found in contact with the lower beds of the St. John Cambrian basin; so that the two Cambrian basins were formed on opposite sides of an old "massif." And this is further emphasized by the fact that conglomerates with pebbles of the rocks of one of the hills in this "massif" have been deposited at the base of the hill, and in the paste of this conglomerate are remains of Trilobites of the upper part of the Paradoxides zone.

The Third basin of Cambrian rocks in this region is that of the Long Reach of the St. John river, which, like that of the Kennebecasis, is somewhat fragmentary; and as, in its lower part, the Cambrian of this basin, like that of the Kennebecasis, disappears under sedimen s of later date, both basins are imperfect. But both dip towards a great band of old dioritic and schistose rocks remarkable for their regular width and length, but, like the Cambrian rocks covered at the eastern end by Carboniferous sediments. The geological relations of this great belt of effusive rocks show it to be of later date than the "massif" of limestones and schists, but older than the Cambrian rocks of the basins we have named.

The series of strata which we find to characterize the opening of Palæozoic Time in this region is the following:—

Coldbrookian.....................Volcanic. No fossils.
Etcheminian.....................Mostly red slates and sandstones. Hyalithes. Obolella.

[1] The relation in this respect reminds one of the basin in the Bay of Fundy 100 fathoms deep, which lies between the volcanics of the island of Grand Manan and those of Briar Island and Long Island in Nova Scotia.

St. John Group—Mostly gray slates, with gray flags in the middle part, and dark gray slates in upper.

Protolenus Fauna	Lower Cambrian.
Paradoxides "	Lower Cambrian.
Lingulella several species	Middle Cambrian.
Parabolina Fauna	
Peltura, etc. "	Upper Cambrian.
Dictyonema "	
Tetragraptus Fauna	
Leptobolus "	Lower Ordovician
Parabolinella "	

The upper part of the Ordovician is not represented in this region.

Cambro-Silurian

A portion of the St. John Group has already been referred to as of Cambro-Silurian age. Under the same designation we may refer to several other areas as to whose geological age and relations there still exists much doubt.

The most important of these are the great belts of slaty and quartzose rocks which traverse the central portions of the Province through its entire extent, lying on either side of and more or less penetrated by the great central granite batholiths, as represented in the Survey Map. Prior to the issue of the latter, these rocks had been regarded by all observers (Gesner, Dawson, Hind, Robb, etc) as older than Silurian, being variously designated as Transition, Cambrian, Lower Silurian and Quebec group, but the subsequent finding of fossils of more recent age having shown that such reference did not apply to the whole district thus represented, the name of Cambro-Silurian was coined to overcome the difficulty. But the difficulty still exists, for while strata have been found containing well preserved fossils of Silurian or more recent origin, others have also been found carrying equally well preserved Cambrian remains. The trouble is to isolate these from each other and to map their separate distribution, but as the districts in question are almost without settlements, thickly forest-clad and with few exposures, progress in this direction is necessarily slow. The rocks over the area in question are also thrown into innumerable small folds, often of an intricate character, and even fossiliferous beds may at times have become included between the plications of older strata. This was at one time supposed to be the case with the Lower Devonian fossil-bearing beds found by Chas. Robb in the Nashwaak district, but the occurrence of limestones carrying Silurian corals as observed by the writer in the settlement of Waterville, of double graptolites, also found by the writer in Kingsclear, and of plant remains by Reed on Spring Hill Brook near Fredericton, all widely separated points, seem to render this idea improbable. Indeed one would be disposed at first to think that the whole area is Silurian instead of Cambrian or Quebec, as once supposed, were it not for the fact that this conclusion is negatived by the finding of Cambrian graptolites in slates of this belt near Bathurst, and of *Dictyonema sociale* in similar black slates at Benton, York Co. (Bailey).

Nothing but an extended and painstaking survey can unravel all the intricacies of this puzzling complex, and this is the more desirable, as it has in later years been found to be the carrier of most important metallic ores, including Antimony, Copper, Lead, Zinc, Tungsten and Molybdenum.

Another area to which the term Cambro-Silurian has been applied, and which is so represented in the Geological Map, but whose real age is still a matter of doubt, is that which, along the north side of the Nerepis granite batholith, lies between the latter and supposed Devonian strata. It consists mainly of dark argillites, in which as yet no fossils have been found. With these, about the town of St. Stephen are considerable areas of stratified dioritic and horneblendic rocks, which are traversed by veins of serpentine and like the beds of Sudbury, Ontario, hold extensive deposits of nickeliferous pyrrhotite, but the facts so far gathered in relation to these rocks are not sufficient to admit of their profitable discussion.

Silurian

No geological formation in New Brunswick is more widely spread than the Silurian or presents more varied aspects. In general the abundance of recognizable fossils removes all doubt as to the age and distribution of the rocks containing them, and where these are absent their relations to the fossiliferous rocks can usually be made out without much difficulty. The problems arising out of the consideration of this group, with two exceptions to be presently noticed, have chiefly to do with the palæogeography and climate of the era, the source of its materials, the distribution of its volcanic activities, and the evidences afforded by it of diastrophic movements. A few remarks may be made upon each of these subjects.

(*a*) The character of the Silurian fossils where found, affords abundant evidence of the presence of the sea during the deposition of the beds containing them, and we thus learn that for much of Silurian time the ocean had free access to the greater part of Northern New Brunswick, this being in fact a portion of a great sea-filled strait or basin extending from the Gulf of St. Lawrence about Anticosti to western New England, the waters, though shallow, being sufficiently clear and deep to permit of the growth of corals (*Favosites*, etc.). In southern New Brunswick also the sediments, as found in Kings and Charlotte county, are marine, but they are argillaceous and arenaceous rather than calcareous, contain few if any corals, and are evidently made up mainly of what were originally sand and mud beds of littoral origin. Their disposition with regard to the rocks on which they rest seem to indicate that southern New Brunswick, in contrast with its northern portion, was in the condition of an archipelago, among whose islands, such as the Pre-Cambrian hills of Kingston and the Long Reach, together with certain portions of Charlotte Co., the deposits were laid down by shallow shifting currents, suited mainly to the life of brachiopodan and lamellibranch shells.

(*b*) From the presence of corals it may be inferred that the temperature of the Silurian seas was at least warm temperate. That of the land may be judged from considerations to be presently discussed.

(*c*) The source of the material, so far as ordinary sedimentary deposits are concerned, but excluding limestones and igneous rocks, was evidently that of the erosion of the pre-existing beds, Archæan and Cambrian, on which they now rest. In northern Kings, and about the Long Reach, they still lie, in nearly horizontal beds, at the foot of high and nearly perpendicular hills, such as Blue Mt. and Brokeneck, of Huronian age, as though laid down by currents sweeping around and wearing down the latter.

(*d*) On the other hand, the evidences of igneous activity during this age in New Brunswick are most remarkable.

Reference has already been made to the fact that in the Northern Highlands very large areas, formerly looked upon as Pre-Cambrian, are now believed to be occupied by igneous and pyroclastic rocks, either Silurian or Post-Silurian in age. They consist very largely of rhyolites and felspar porphyries occurring both as dykes and beds, together with ash rocks, and which are unconformably underlaid by conglomerates and sandstones of the Silurian. In southern New Brunswick again, beds which most closely resemble these are found around Passamaquoddy Bay resting upon fossiliferous strata, as seen especially on the Mascarene shore and about the town of Eastport. Their distribution and thickness as found in this region, where they form prominent eminences such as Chamcook Mt., indicate that the latter was in the Devonian age a center of intense volcanic activity. The shores of the Bay Chaleur and other parts of Gloucester county, as shown by Ells, mark another area of intense vulcanism, while the disposition of the igneous and other deposits here are such as to indicate that this depression, like that of Passamaquoddy Bay, was already in existence in Silurian times.

The Plant Beds of St. John County

The exception mentioned in foregoing remarks as to the ease with which Silurian strata, when containing fossils, may be recognized, is to be found in connection with the celebrated plant beds found on the Carleton shore near the city of St. John and elsewhere in St. John county, these having long been the subject of serious and even somewhat bitter controversy. First collected largely by the late Prof. C. F. Hartt, who always believed in their Devonian age, they were subsequently studied by Sir Wm. Dawson not only on palæobotanical but also stratigraphical grounds, and were by him referred to the Upper Devonian, and later to Middle Devonian. With this view the present writer, as well as Matthew, Ells and Fletcher, in fact all who were familiar with the stratigraphy of the region, were in complete accord, though still later, with the same downward tendency, Matthew expressed the opinion that they were Silurian. On the other hand, Dr. David White, of the U. S. Geological Survey, Dr. Ami of the Canadian Survey, Mr. G. A. Young of the same survey and Mrs. Mary C. Stopes, of the British Museum, maintain, mainly on palæobotanical grounds, and in most instances with little or no personal familiarity with the stratigraphy or the character of the Carboniferous as found elsewhere in the Province, that they are not even Devonian, but well up in the Carboniferous (Lower Coal Measures).

We do not propose to discuss here the botanical side of the question. We admit freely that, with one or two exceptions, the organic remains, including both plants and insects, are made up of types which are usually regarded as Carboniferous; but this does not prove that such types may not, under favorable conditions, have come into existence at periods earlier than generally supposed, much as the first appearance of fishes has been successively moved backward until it has now reached the Middle Cambrian. But we do wish to state clearly the grounds, derived from the character and stratigraphical relations of the beds, which justify the belief, first entertained by us more than fifty years ago, that the rocks in question are of Pre-Carboniferous origin.

In the earlier investigation of these beds the examination of the containing rocks was somewhat cursory, and the determinations of Drs. A. Gesner and Jas. Robb did not result in anything more than a declaration that the beds containing plants were of Transition or Silurian age, meaning older than the Old Red Sandstone (or Devonian).

The later studies of the region where these beds occur by the late Prof. C. F. Hartt and G. F. Matthew resulted in the discovery of a large number of species of plants and some insects. The plants were referred for study to the late Sir Wm. Dawson, at that time the highest authority we had on plants of the Palæozoic formations, and the insects to Dr. Scudder. Sir William at first thought the plants to be of Upper Devonian age, but subsequently referred the whole of these plants to the Middle Devonian. Sir William studied the succession and relations of the associated strata in coming to this conclusion. He visited the section at Courtney Bay and thence to the highest beds of the Little River formation, of which the Plant beds form a part. These, in ascending order to the southward are

Dadoxylon Sandstone
Cordaite Shales, etc.
Mispec Slate

Sir William also visited the Kennebecasis River, where an overlying series of strata in its middle part contains a flora equivalent to the Pocono and Sub-Carboniferous of Pennsylvania. This series is also found at various places further to the S.W. until it reaches the United States border, where it contains the flora of the Perry sandstones, which have been so fully described by Sir William and later by Mr. David White. Both of these palæobotanists agree in referring the contained flora of the Perry beds to Upper Devonian. As Sir William found this flora to be Upper Devonian one can easily see why he called the underlying plants of the Fern Ledges Middle Devonian.

When, under the auspices of the Provincial Government, the writers of this paper, in association with Prof. Hartt, turned their attention to the study of the geology of New Brunswick, they found all the Pre-Devonian strata in the southern portion of the Province strongly folded into parallel ridges, with axes running NE and SW, with many sharp folds; and also that the beds were considerably changed by metamorphism, the plants graphitised, fossil trunks of trees converted into anthracite, and the disseminated lime of the sediments largely removed and replaced by silica, so that the sandstones were no longer "freestone" but hardened and approaching the condition of quartzite. No such conditions were found in the Upper Devonian-Lower Carboniferous beds which were held together by a cement lining chiefly calcareous.

Another feature in which the Devono-Carboniferous (or Perry) rocks and succeeding Lower Carboniferous beds were found to differ from the underlying Little River group, was that the former were not folded but divided into blocks by faults, and in St. John county as a rule dipped northward at a low angle; whereas the older rocks were often closely folded and dipped at a high angle southeastward.

Thus a discordance of dip and strike as well as other conditions everywhere distinguished these two series.

It was some time before evidence was found for separating the Mispec Group from the older part of the Little River group. The Mispec begins abruptly in a volcanic breccia, resting upon the grey slates and sandstones of the Cordaite group both on the Black River and the Red Head roads several miles apart; but there was very little change in the dip of the two groups at the lines of contact. The Mispec slates were all of a deep red color, whereas the underlying slates of the Cordaite series were gray.

A similar relation between the Cordaite and Mispec groups was found to hold not only in the St. John basins and in the next basin westward (Lepreau) but in the third basin, that of Beaver Harbor. The Mispec was here found to be entirely separate and distinct from the plant bearing beds, and so continued to L'Etang Harbor, which is protected by Bliss's Island. This island consists of similar red slates with layers of conglomerate. In the conglomerate, along the shore line at the eastern end of the island, were found rolled fragments of the corals which are in place as constituents of the Upper Silurian beds of shale on La Tete island on the opposite or northwestern side of L'Etang Harbor. In the harbor is a small island of the Red conglomerate and calcareous sandy slate, which belongs to the overlying Upper Devonian-Carboniferous series, which is more fully displayed in the next bay (Passamaquoddy) where the Perry plant beds are found. Thus we find that the Mispec group is really an intermediate series separating the plant beds of Perry from the older plant beds of St. John and unconformable to both.

Only fragments of plant stems and no marine fossils have been found in the slaty part of the Mispec beds to determine their exact age, nor are there any near-by localities which have yielded marine organic remains through which the exact age of the Mispec group could be determined, but the physical relations of the group appear to indicate that it is near the horizon of the Lower Devonian. If this inference be sustained, the Plant Beds of the "Fern Ledges" should be Upper Silurian.

Assuming the above inference to be correct, i.e., that the plant beds are Silurian, we may ask whence came the materials that formed the mass, some thousands of feet in thickness, in which the plants are imbedded? Large areas to the North and West in this part of New Brunswick are composed of Lower Devonian and Silurian slaty rocks, of marine origin, that would not have furnished any material to a river capable of building up a delta of such bulk and extent as that which carries these old plants. We have, therefore, to look in the opposite direction for the dry land of Silurian age, and in that direction find the great Meguma Pre-Cambrian series of Nova Scotia, of great thickness and which evidently suffered enormous denudation throughout Silurian time. This may have been one of the chief areas for the supply of the products of erosion at this time, though the old Pre-Cambrian ridges of southern New Brunswick may also have furnished their quota.

A sketch map to be published later will show the spread of the known remaining area of this Delta, and the change of conditions from a coarse sandstone (1) with a few plant remains (and those of the denser and more resistant kinds) to the finer sediments (2) showing well preserved plant remains, to (3) a portion of what appears to have been the delta-margin, and finally, to the area where typical Silurian marine forms are found. The coarse beds (1) with poorly preserved fossils are present on the Mispec River and the east branch of Black River. The finer shales (2) with well preserved plants are found at St. John and Carleton, and the third type (3) is that of the Beaver Harbor beds.

As regards the marine Silurian, (or Lower Devonian) drift fragments of plants are known in it from Oak Bay and Flume Ridge in Charlotte county, and at the base of the series in Queen's county, near Gaspereau station, there are sandstones with plant remains. It is also to be noted that on the south side of the granite ridge which separates the last named locality from a more southerly band of Silurian on the Nerepis Road, is a locality where Silurian fossil fish are found, together with other indications of brackish or fresh water organisms. But these may be in the upper portion of the Silurian beds.

It should be borne in mind that the confirmation of a Silurian age for the Plant-beds of St. John and its vicinity involves the admission of the existence at that time of several orders of animals, which, according to many geological text books, appeared first in Carboniferous time. Among these are the mailed fishes, long known as Silurian in European deposits, Batrachians, Snails, Neuropteroid and wingless Insects, Myriapods and other forms of the forests and river banks.

Still further evidence of the Pre-Carboniferous age of the Plant beds at St. John is to be derived from a comparison of the latter as to nature, color, attitude, etc., with the rocks of Perry, Lower Carboniferous, and higher groups.

Another considerable area of Pre-Carboniferous rocks requires brief notice in this connection. It is that of the area which, north of the great Nerepis granite batholith, lies between the latter and the southern margin of the central coal-field. The rocks here are mainly argillites, but have been divided into two groups, known respectively as the "dark" and "pale" argillites. The age of both is still problematical. In neither have any determinable fossils been found, but in the upper or paler series occur indistinct traces of plants recalling those of the Little River group, and for this reason they were, in the Geological Survey map, represented as Devonian; while the lower dark argillites, which are often flinty and more or less altered by granitic contact, were compared with the Mascarene (Silurian) deposits of Passamaquoddy Bay. Should the plant remains of the argillites prove to be the same as those of the Cordaite shales, the fact would afford further evidence that these latter are Pre-Carboniferous.

The Devono-Carboniferous or Perry Group

This series of strata is readily distinguished from all below by the condition of the cementing paste in the coarser beds, as well as their evident superposition. This paste is not slaty, and, when exposed to the weather, the lime in it is usually sufficient to cause the rock to crumble.

The greater part of the lowest beds of this series is of a dull red color in the district around St. John, owing to the red color of the clay of the paste. Here also there has been high land at the opening of the stage, probably with ice tearing off and rolling down blocks of Pre-Cambrian limestone from exposed ridges such as now lie between the Bay of Fundy and the Kennebecasis river. At other points, as on the Hammond River in Upham and again in Westmoreland county, their appearance has been almost wholly determined by that of the pebbles (granite, etc.) composing them, a resemblance so strong that only a close view reveals their clastic origin.

Plant remains are rare in the part of the series near St. John, but at Perry, in Maine, just across the Canadian border, there are plant remains at two horizons, and in these beds, which are chiefly gray sandstones, is contained the Devonian flora which has made the Perry rocks famous. This flora was first studied by Sir J. W.

Dawson, and later by Mr. David White of the U. S. Geological Survey, both of whom referred the plants to the Upper Devonian.

Wherever we find this series of beds in full succession, we find on the top of the red beds or intercalated with them in their upper part, a set of gray beds, with more abundant plant remains, which recall the Pocono forms of Pennsylvania or the Sub-Carboniferous fossils in other parts of the continent. Here we meet with the same difficulty at a higher horizon as meets us in the upper part of the St. John group, viz., the difficulty of separating parts of series which in Europe are sufficiently distinct, but which, in this district are so closely linked that in the map it would be quite impossible to separate the two. We therefore can only say that the underlying red beds contain a Devonian flora and the upper or gray part of the series is marked by the presence of a Pocono or Lower Carboniferous flora.

On the margin of the Coal-measures further to the North, this question of age of the overlying gray beds is solved by the occurrence of a band of limestone with well known species of Lower Carboniferous Brachiopods and other forms of marine life which show that this portion at least is to be referred to the Lower or Sub-Carboniferous Age.

Carboniferous

In the earlier reports and maps of the present writers, the following was adopted as the succession of Carboniferous rocks, in ascending order:

1. The Perry group, embracing conglomerates, sandstones and shales, mostly coarse, of red or brownish red color, but including some gray beds, with numerous plant remains of Devonian type. About St. Andrews the Perry rocks contain numerous dykes and sills of amygdaloidal diabase or dolerite.

2. Volcanics. Igneous rocks of both acidic and basic types, appearing partly as dykes or pipes and partly as overflows, including basalts, diabase, rhyolite, amygdaloid, etc. In the lower part of the groups the volcanics are mainly rhyolites.

3. Limestone and Gypsum. With salt springs. Also red sandstones and shale. The limestones hold brachiopods, orthocerata, and corals. The beds are usually nearly flat, and the limestones, where penetrated by volcanics, are more or less converted into marble.

4. Millstone Grit. Coarse gray non-calcareous sandstones and conglomerates, of which the lower beds are often almost completely made up of rolled pebbles of white quartz. They are but slightly inclined, and may rest on either of the above series, to which they appear to be unconformable.

5. Coal Measures. Gray, non-calcareous conglomerates, sandstones and shales, in nearly horizontal beds, wholly unaltered and holding numerous typical Carboniferous plants and thin seams of coal.

Of the groups tabulated above, the first or Perry Group has already been sufficiently discussed. It is also unnecessary to consider individually the groups which follow; but it is important to notice that the character of these groups is very constant, that they are found widely spread, with essentially the same features, over nearly all parts of the Province, and that it is impossible to establish any correlation or parallelism between them and the Little River Group, already discussed on paleobotanical grounds.

Thus, in a vertical section of nearly horizontal beds, exposed in bluffs overlooking the St. John river a few miles above Fredricton, the succession is the same as that of the table, except that there are no limestones, their horizon being represented by gypseous beds. About Red Rock settlement and Stanley, the fossiliferous limestones may be seen in place, while in Harvey the volcanics acquire great prominence. At Wickham and near Long Island in Queens county, both the limestones and volcanics occur together, the limestones being partly altered into marbles. Essentially the same succession may be seen on the Newcastle River in the center of the great coal field. It is found on the Beccaquimic and Tobique rivers in northern New Brunswick, and again along the coast of the Bay of Fundy at St. Martin's and Gardner's Creek, only a few miles east of St. John and in Albert county. In all cases the sedimentary rocks including and following the Carboniferous limestones, are, except locally, wholly unaltered; the coals are caking coals, surcharged with bitumen, there is an entire absence of slaty cleavage and the soft shales upon exposure crumble into mud. If dipping at all, it is usually at very low angles, and though, especially in the Bay of Fundy trough, the strata show frequent dislocations it is in the form of blocks rather than folds, the orogenic movements to which they have been subjected having been of a very moderate character. The question therefore may well be asked "Is it possible that with the Carboniferous succession as above given, and with characters which are essentially the same over every part of the Province, including even the Bay of Fundy, these can be correlated with the Little River group, which, except in its plant remains, differs in every one of the particulars mentioned ?

The writers of this paper think not.

Diastrophism

It may well be supposed that in a region which, geologically, is as complex as New Brunswick, evidences of physical movements and disturbances, with consequent changes of level, changes of sedimentation, and changes, it may be, of geography, climate and life, should make themselves apparent. And this is actually the case. All the formations, even including the coal measures, have been subjected to orogenic changes and are broken by innumerable faults. But while the greater number of these are slight, affecting only a small thickness of strata or producing correspondingly slight upward or downward movement, others were of much greater magnitude, and led to far more important consequences. Thus if not actually determining, they are so intimately connected with geographic and life evolution, as to help in the subdivisions of geological time and the formation of a time-scale. It will therefore not be out of place to emphasize a few of these here.

1. *Post Laurentian.* The highly folded character of all the sediments referred to this system, including the upper limestone-quartzite series, abundantly prove the diastrophic influences to which they have been subjected. Unconformity between the limestones and underlying gneiss is clearly shown, as also with the overlying Cambrian. An interval of extensive erosion and weathering of land surfaces separated the Laurentian from the Cambrian era.

2. *Post Huronian.* The rocks which have been referred to under the name of the Kingston Group are, for distances of thirty or forty miles, bordered by profound faults, whose influence is readily recognized in the present physiographic features of the region. But these same faults conceal the relations of the Kingston rocks to the other groups in the region, and except to say that they are Pre-Cambrian, highly crystalline, and in attitude nearly vertical, but little can be predicated from them. They are extensively invaded by volcanics.

The relations of the so-called Coastal group are also involved in much obscurity. It is certain, however, that they are unconformably overlaid by the fossiliferous Cambrian, and have themselves been subjected to extensive orogenic movements, as well as to the extrusion of much igneous matter and of granite batholiths.

Post Cambrian. The rocks of the St. John group, as seen in the city of that name, show the position of more than one overturned and compressed synclinal, but there is nothing to show at what time that overturn took place, except that the Cambrian rocks are folded with and in parallel folds with the Upper Silurian. So, in the Cambrian belt of the Kennebecasis, the fragmentary and isolated position of the outcrops, and the want of contacts with other groups, leaves this question in doubt; but in the parallel trough of the Long Reach tilted Cambrian beds are overlaid by moderately inclined strata carrying Silurian fossils, and therefore show that the disturbances affecting the former antedate the Silurian era.

The Cambrian rocks of northern New Brunswick as far as recognized, are also highly tilted and unconformably overlaid by Silurian strata.

Post Ordovician. The rocks which in southern New Brunswick carry a Cambro-Silurian or Ordovician fauna are of too limited extent to justify drawing from them any general conclusions. The same is true of their exposures in Carleton county and York, except to say that they, in common with all other rocks of the region, have been profoundly affected by diastrophic movements of uncertain date. The same is true of the "dark argillites" which in portions of Queens and Charlotte counties flank the northern slopes of the great Nerepis granite batholith.

Silurian and Post-Silurian. The Silurian rocks which are so widely spread over the province give at many points evidences of profound diastrophism. One of the most marked of these physical breaks is to be seen in the northern Highlands where the greatly folded fossiliferous and calcareous slates of Gloucester, Victoria, and Madawaska counties come into contact with the nearly flat volcanic plateau at the head of the Nepisiquit and Tobique rivers. The course of this great dislocation is approximately SW and follows in part that of the Nictor Branch of the Tobique, and further west that of the upper part of Eel River to Monument settlement on the border.

Somewhat similarly, in southern New Brunswick, we have the fossiliferous Silurian strata of Queens county lying in some places nearly horizontal around the old Pre-Cambrian hills on the north side of the Long Reach, while on the south side of the same sheet of water they accord with the nearly vertical position of the Kingston group with which they are here so intimately associated.

Finally, around Passamaquoddy Bay, the Silurian rocks, sandstones below and volcanics above, are, as at Chamcook Lake and Eastport, nearly flat, while on the Mascarene shore, and in the Western Islands they are uplifted at considerable angles. Between the town of St. George and Bocabec river, the beds would appear to be several times repeated by successive and concentric downthrows in the direction of the Bay.

Siluro-Devonian. According to views advocated in this paper, the Plant-bearing beds at St. John are Silurian. If this view is correct it will follow that at some period subsequent to their deposition they were made subject to uplift and extensive alteration, their present position being somewhat highly inclined, with strongly developed slaty cleavage and the organic remains converted either into anthracite or graphite. As the latter part of the Devonian age is known to have been a period of great disturbance both in New Brunswick and Nova Scotia, producing great uplifts and intense metamorphism on all rocks affected, it is difficult to suppose that it was not at the same period that the rocks of the Little River group acquired the characters which they now exhibit.

Devonian. The Devonian age was in the Maritime Provinces of Canada a time of special disturbance, as above remarked. Diastrophic and orogenic movements took place in New Brunswick as in Nova Scotia on a scale of great magnitude, and were accompanied by or resulted in, changes of the highest importance in the physiography, climate, and life of the regions affected. All groups of rocks up to, but not including the Perry group, were uptilted or thrown into folds, profound dislocations occurred, slaty cleavage was universally developed, and sandstones were hardened into quartzites, volatile hydrocarbons were removed and extensive batholiths of granite penetrated and altered the sedimentary rocks.

On the other hand the Perry and later rocks show no evidence of such excessive alteration. If tilted, it is at comparatively low angles, and with the exception of the Albert shales, they are never closely folded, and show little or no metamorphism. Even in their lowest portion, such as the Albert series, with its bituminous shales, oil, and gas springs, they are surcharged with bituminous matter; their conglomerates, especially those of the Perry group, are mainly made up of pebbles from the Silurian and older rocks, and include large boulders of granite, a rock comparatively rare in the conglomerates of greater age. Hill ranges, such as the Nerepis Hills, the York granites and, in Nova Scotia, the Cobequids, were brought into being, intervening valleys were deepened, entire changes took place in the geographical condition of the region, and, with these, changes in the climate and life of the time.

Lower Carboniferous. The rocks of this series are unconformable alike to the underlying and overlying groups, but the unconformity in relation to the carboniferous is shown rather by the evidence of extensive erosion than by any marked discordance of the dip. The period was also one of pronounced volcanic activity, manifested mainly towards the end of the period, but not extended into that of the Millstone Grit. As in the case of other formations, diastrophic movements were more marked in the vicinity of the Bay of Fundy, always a subsiding trough, than elsewhere.

Carboniferous. Except in the Bay of Fundy trough, the Carboniferous rocks all over New Brunswick lie at very low angles, and show little evidence of deformation. They have, however, been very extensively eroded, and are found resting, nearly horizontally, on members of all the older groups, with or without the interposition of the Lower Carboniferous. In the Bay of Fundy trough the axes of disturbance lie parallel to the old Pre-Cambrian range of Caledonia Mt., but eastward of the latter, show a tendency to cross the Bay and to connect with the Carboniferous rocks of the Joggins in Nova Scotia.

Post Carboniferous. The only two formations found in New Brunswick which are more recent than that of the Coal Era, are the Trias (or Jurassic) and Quaternary, but, though with these also some unsolved problems suggest themselves, it is not considered possible or desirable to discuss them here.

Summary. The general results of the foregoing observations, as regards the distinction and succession of formations and intervening disturbances are given in the following table.

Table of Formations and Unconformities in New Brunswick.

TABLE OF FORMATIONS AND UNCONFORMITIES IN NEW BRUNSWICK

I. *Laurentian*

Lower. Fundamental Gneiss and batholitic Granite.
Unconformity.

Upper. Limestone-quartzite Series. Mica schists, Argillites, etc.
Unconformity, with production of hill ranges and basins, extensive weathering and erosion of land surfaces. Intrusion of basic dykes, granodiorite, etc.

II. *Huronian*

Kingston Series. Mostly effusive rocks, with schists, etc.
Unconformity.

Coastal Series. Conglomerates, sandstones, schists, etc.
Unconformity.

III. *Cambrian*

Coldbrookian. Volcanic.

Etcheminian. Red sediments and volcanic effusives.

St. John Group. Gray sandstones, flags, clay slates, etc.
Unconformity. with plication.

IV. *Ordovician*

Gray sandstones and gray to black slates.
Unconformity.

V. *Silurian*

Calcareous slates and limestones in northern N.B., sandstones and argillites in southern and central counties. Volcanic effusives. Warm coral growing seas mainly in the north.

VI. *Siluro-EoDevonian*

Argillites of Queens County. Little River Group.

VII. *Middle Devonian*

Wanting in this region.
Unconformity.

VIII. *Upper Devonian*

Perry Group in part. Red sediments. Volcanics. Conditions cold and acid with ice action. Plants of Devonian type. Albert series.
Unconformity.

IX. *Lower Carboniferous*

Gray sediments, with fossil plants (Perry Group in part). Limestones and Gypsum. Red sediments. No slaty cleavage in finer sediments.
Unconformity.

X. *Carboniferous*

Millstone Grit.
Coal Measures.
Permo-Carboniferous.
Unconformity.

XI. *Trias-Jura or New Red Sandstone.*

Monobrachium parasitum and other West Coast Hydroids.

By C. McLEAN FRASER, Ph.D., F.R.S.C.

(From the Pacific Coast Biological Station, Nanaimo, B.C.)

(Read May Meeting, 1918)

In the material collected during 1915 some species of hydroids merit special notice. None of them are new species, but three of them, *Monobrachium parasitum*, *Thuiaria carica* and *Lictorella cervicornis*, have not been reported from the west coast of North America. A fourth species, *Plumularia plumularoides*, has been reported from Alaskan and Californian waters but not from the Vancouver island region and a fifth, *Obelia dubia*, appeared in colonies, larger than any hitherto described. On account of pre-occupation, a new name is introduced for *Thuiaria distans*.

MONOBRACHIUM PARASITUM Mereschkowsky

Fig. 1

Monobrachium parasitum MERESCHKOWSKY, Hydroids from the White Sea, 1877, p. 226.

Monobrachium parasitum LEVINSEN, Meduser, Ctenophorer og Hydroider fra Grœnlands Vestkyst, 1893, p. 151.

Monobrachium parasiticum BONNEVIE, Den Norske Nordhavs-Ex. 1899, p. 51.

Trophosome.—Colony consisting of many zooids, about 20, growing from a reticulate stolon which appears on the surface of small living shells. The zooids appear at the hinge of the shell but the network extends over the surface to the margin, with a number of free ends projecting beyond it. The terminal portion of these free ends consists of a globular mass of large thread cells, or cells having a similar appearance, having no perisarcal protection. They look not unlike the defensive zooids in *Hydractinia* and possibly they may have the same function. The individual zooid is small, 0·7 or 0·8 mm. in height, fusiform, possessing great freedom of movement; the proboscis is approximately half as long as the remainder of the zooid; the mouth is terminally placed, around it thread cells are closely arranged but not in groups; further down on the proboscis they are much less numerous; there is no constriction corresponding to the neck of *Lar.* The one tentacle comes out almost at right angles to the body but except for the basal portion no definite position can be given for it as it contracts and expands readily and moves about freely; when extended it is longer than the body, about 1 mm.; the surface is well provided with thread cells but these are scattered singly over the whole length.

Gonosome.—The medusa-buds grow from the stolon, supported on a very short pedicel. The number of buds in any one colony seems to be rather limited, never more than four in any of the colonies obtained, two being the usual number. But one medusa is produced from each gonophore; it is almost globular, with four radial canals.

Color.—Main portion of the body and proboscis dirty brown, tentacles transparent.

Distribution.—On small bivalve shells that appear in large numbers in muddy bottom in Nanoose bay, at a depth of 10–15 fathoms.

This unique and interesting species has been found at various points in the Arctic regions from Spitzbergen and the White sea to Greenland and Stafford has reported it off Gaspe but hitherto it has not been recorded from the Pacific. All the specimens have been obtained by dredging in muddy bottom at 10–15 fathoms in Nanoose bay. In material obtained on June 21 there were a number of small bivalves on some of which Dr. Mortensen noticed a brownish growth which proved to be the hydroid in question. The colonies at that time had no gonosome present but in dredging over the same ground on August 26 and again on September 22 much material that made up the shortage was obtained so that the development of the medusa could be followed through the early stages. The molluscs to which the hydroids were attached belong to the species *Axinopsis sericatus* (Carpenter) for the diagnosis of which I wish to thank Dr. C. F. Newcombe. They are quite small, most of them but little more than 2 mm. in diameter. A large percentage of the whole number of live shells collected had hydroid growth. In the last instance, out of 346 living shells picked from the dredged material, 142 had hydroid colonies attached. The hinge margin serves for the attachment of the hydroids but the stoloniferous network passes across the surface of the shell. The species of mollusc on which the hydroid is found in this locality is not the same as that on which it is found elsewhere.

When Mereschkowsky first described *Monobrachium parasitum* he placed it in a new family *Monobrachiidæ* and some authors since have followed his example. To me it would seem preferable to place it in the family *Laridæ*, as Levinsen has done. Anyone who has seen live specimens of *Monobrachium* could not fail to notice the resemblance to the attitudes figured and described by Gosse[1] and later by Hincks[2] for *Lar sabellarum*. The most striking resemblance is in the continued movements of the body of the zooid and of the tentacle so that a great variety of postures is assumed. The stoloniferous network is similar in the two species and both produce medusæ somewhat similar in shape. The differences are well marked but not sufficiently so as to require a new family for *Monobrachium*. There are two tentacles in *Lar* to one in *Monobrachium* and in the latter there is no constriction corresponding to the neck in *Lar*, the mouth is terminal not lateral, the thread cells are arranged differently, the medusa buds are not borne in the same manner and, perhaps the most important of all, there are but four radial canals in the medusæ instead of six as in *Lar*. If it were not for this difference in the medusæ it would scarcely be necessary even to put it in a new genus. Bonnevie has shown that the gonads of the *Monobrachium* medusæ are placed along the radial canals. Hincks, the only one who has described the medusa of *Lar*, apparently did not find any medusæ far enough advanced to have gonads developed, hence we have no information as to their position. If the gonads are placed similarly to those of *Monobrachium*, the two genera should certainly be placed in the same family and hence until this question is settled there is no necessity of separating them.

OBELIA DUBIA Nutting

Fig. 2

Obelia dubia NUTTING, Harriman Hydroids, 1901, p. 174.
Obelia dubia FRASER, Hydroids of Vancouver Island Region, 1914, p. 151.

In giving the original description of this species Nutting mentions three-quarters of an inch as the height of the colony and I found that to be the maximum for all earlier specimens.

On June 15, a campanularian colony, which had the appearance of *Obelia dubia*, was obtained in some material dredged in about 25 fathoms, from rocky bottom, near Entrance reef, Nanoose bay, but as it was two inches high it did not agree in size with the known specimens of that species. There were no gonangia on the specimen but the hydrothecæ, with the pedicels and mode of arrangement, resembled those of *O. dubia* so much that it can scarcely be doubted that it is this species which was here represented. The unusual length of the colony seems worth recording.

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[1] Gosse, P. H., Trans. Linn. Soc., 1857, p 113-116.

[2] Hincks, T. British Hydroid Zoophytes, 1868, p. 35.
On the Hydroid Lar sabellarum, 1872, p. 317-319.

LICTORELLA CERVICORNIS Nutting

Fig. 3

Lictorella cervicornis NUTTING, Hawaiian Hydroids, 1905, p. 934.

Trophosome.—Colony with a continuous main stem, reaching a height of nearly 50 mm. in largest specimen; branches given off alternately, at a wide angle with the stem; most of them, in some cases all of them, unbranched; main stem and larger branches fascicled. Nutting says the branches are divided into regular internodes, but there is no sign of nodes in these specimens; the processes which support the hydrothecæ, however, are regularly arranged. Hydrothecæ deep, almost tubular; the proximal end narrows into the pedicel and the distal end broadens slightly; just proximal to the margin there is a distinct but short curve in the tube, with the abcauline side convex, aperture round, margin entire; pedicel short, making a distinct joint with the process from the stem or branch. Hydrothecæ given off from the fascicled portion of the stem, as well as those in the axils of the branches, as a rule, have longer pedicels than those on the monosiphonic branches. There is a nematocyst present in the axil of each pedicel process.

Gonosome.—"Gonangia forming a coppinia mass on the main stem, the distal ends being the broader on account of the opposite shoulders, which are quite conspicuous and end in round apertures. Midway between these shoulders there is a short neck ending in a third aperture. The individual gonangia are borne on short branchlets, which continue beyond them, arching over each gonangium so as to form a protecting network of such branches over the aggregated gonangia. This structure seems to resemble quite closely the phylactogonia found in certain general of plumularian hydroids." (Nutting).

Distribution.—North of Gabriola island in 30 fathoms and north of Snake island in 60 fathoms.

The hydroid fauna of the west coast of North America has little in common with that of the Hawaiian islands. Nutting has pointed out that the relationship is much closer between the Hawaiian forms and those from Australia. Of the 51 species he records, only 8 have been reported from the coast and 7 of these are cosmopolitan forms. The eighth, *Plumularia corrugata* Nutting, is somewhat common in the Vancouver island region and has been found off the California coast. Now this species, *Lictorella cervicornis*, must be added to the list. When the specimens were obtained it seemed scarcely possible that they should belong to the Hawaiian species but closer examination failed to reveal any reasonable excuse for placing them in another species.

As *L. cervicornis* has not been recorded from this coast, a description is here included. There was no gonosome present hence Nutting's description is quoted and his figure copied.

THUIARIA CARICA Levinsen

Fig. 4

Thuiaria carica LEVINSEN, Meduser, etc., fra Grœnlands Vestkyst, 1893, p. 213.

Thuiaria carica BROCH, Hydroiden der Arktischen Meere, 1909, p. 176.

Trophosome.—Colony consisting of a long and rather rigid stem which is but slightly sinuous where the branches are given off; branches regularly alternating, straight and stiff, either not branched again or having but few short branches resembling the main branches; internodes in the main stem and in the branches varying much in length and in the number of hydrothecæ given off from each, although the hydrothecæ are placed at quite regular intervals. The number of hydrothecæ between two branches in succession also varies although three is the usual number. There is a distinct process on the stem for the support of each branch, and a distinct joint at the place of attachment. Hydrothecæ curved strongly outward so that the margin is vertical; the margin is somewhat sinuous; the abcauline side does not extend so far outward as the adcauline side.

Gonosome.—(From Broch's description) The male gonangia appear on the upper branches of the colony where the stem is turned so that the median plane of the hydrothecæ is placed almost horizontally. They grow upward from the surface of the branch; the point of attachment is just proximal to the base of the hydrotheca, the gonangia alternating from side to side to correspond to the position of the hydrothecæ. The gonangium is obliquely pear-shaped but the margin is at right angles to the axis.

Distribution.—Some fragments were dredged in Bull passage, north of Lasqueti island, in rocky bottom at 25 fathoms.

This record, new for the coast, is quite interesting on account of the fact that hitherto the species has been found only in the Kara sea region. It is not unusual for a species to be found in the Kara sea and also on the west coast of North America because many of the hydroids are circumpolar in their distribution, but the majority of these species have been picked up at intervening points as well. It is not a solitary case, however, and it may be that the distribution of such species extends from the Kara sea eastward through the Bering strait instead of westward.

There were no gonangia on the specimens obtained, but Broch has given a figure and a description of these.

THUIARIA GENICULATA new name

Thuiaria distans FRASER, Hydroids of Vancouver Island region, 1914, p. 197.

The fact that the name *Thuiaria distans* was used by Allman in describing a new species from the Gulf Stream in 1877 was overlooked when the 1914 paper was prepared. As "*distans*" was preoccupied, "*geniculata*" is now given to replace it, as in this species both the stem and the branches are geniculate.

PLUMULARIA PLUMULAROIDES (Clark)

Fig. 5

Halecium plumularoides CLARK, Alaskan Hydroids, 1876, p. 217.
Plumularia plumularoides NUTTING, Am. Hydroids, Pt. I, 1900, p. 62.
Plumularia plumularoides TORREY, Hyd. of the Pacific Coast, 1902, p. 78.
Plumularia plumularoides FRASER, West Coast Hydroids, 1911, p. 84.

Trophosome.—Colonies growing together in bunches, reaching a height of 30 mm.; stem simple, divided into regular internodes by well marked nodes, each bearing a single hydrocladium on a prominent process near the distal end, the hydrocladia alternating from side to side but in the same plane. The first hydrocladial internode is short and does not bear a hydrotheca, but all the other internodes, as many as five, are hydrothecate, each bearing one hydrotheca; hydrotheca nearly equal in length and breadth; septal ridges absent; two supracalycine nematophores, one mesial nematophore on each hydrocladial internode and one or two at the axil of the hydrocladium on the cauline internodal process; all monothalamic.

Gonosome.—Gonangia attached either to the process that supports the hydrocladium or to the hydrothecate internodes, just lateral to the hydrothecæ; similar in size and shape to those of *P. lagenifera*, oval, but greater in one transverse diameter than in the other, narrowing to a small process of attachment proximally and extending into a bottle neck with a small circular opening, distally. The male and the female gonangia are similar in size and shape; the male blastostyle has a pair of processes near its centre, projecting outward and slightly backward.

Distribution.—On *Macrocystis* near the south shore of Hope island, west of the entrance to Bull harbor.

The published descriptions of this species have been so meagre that, as I have previously mentioned, it was impossible to distinguish it readily from *P. goodei*.[1] Clark's specimens were in such poor shape that he found no nematophores and hence he placed the species in the genus *Halecium*. Apparently there were no gonangia present. Nutting, on seeing Clark's description and figures, placed the species in the genus *Plumularia*. Torrey found a few fragments but on one of these there were some immature gonangia.

On Sept. 12, just outside of the entrance to Bull Harbor, to the south of Hope island, I found a large number of very fine colonies, growing on *Macrocystis*. They were growing in bunches of from 16 to 20, on both sides of the leaf. The trophosome bears a great resemblance to that of *P. goodei* Nutting. In fact the only constant point of difference that I can be sure of, appears in the arrangement of the hydrocladia. In *P. goodei* the normal number seems to be 2 to a node although 1 or 3 may be present but in *P. plumularoides* in every case of the many examined there was a single hydrocladium to each node. These colonies are all longer and more robust than in any specimens of *P. goodei* that I have seen but as this difference is not very great, it may be due to environment.

There is no such resemblance in the gonosome. There is a difference in the shape of the gonangia as well as in the arrangement of these. In *P. goodei* the gonangia take the place of the hydrocladia, in *P. plumularoides* they are attached to the hydrocladia, on the hydrothecate internodes beside the hydrothecæ, or more commonly on the cauline internodal process that supports the hydrocladium. There may be as many as four in a row along one hydrocladium. The gonangia of *P. goodei* are relatively large with the distal end obtuse, scarcely narrower than any other part of the gonangium while in *P. plumularoides* they are oval with a bottle neck and one diameter greater than the other.

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Explanation of Plates

Plate I

Drawings by Clara A. Fraser.

Fig. 1. *Monobrachium parasitum*

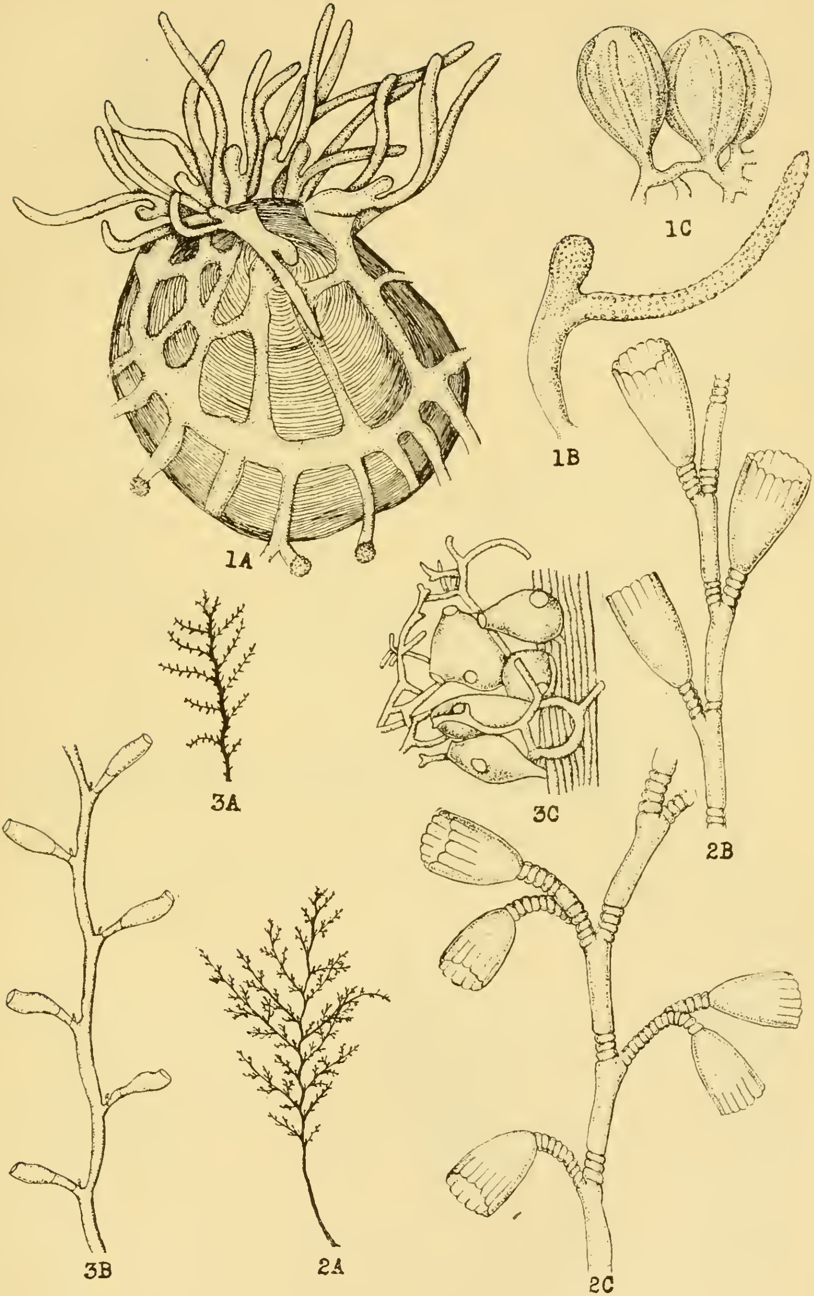
- A. Complete colony
- B. Single zooid x 40
- C. Medusa buds.

Fig. 2. *Obelia dubia.*

- A. Colony, natural size.
- B. and C. Portion of branches showing arrangement of hyrodthecæ.

Fig. 3. *Lictorella cervicornis.*

- A. Portion of colony, natural size.
- B. Simple portion of branch.
- C. Coppinia mass (After Nutting)


1A
1B
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3A
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3C

Plate II.

Fig. 3. *Lictorella cervicornis.*

D. Portion of fascicled stem.

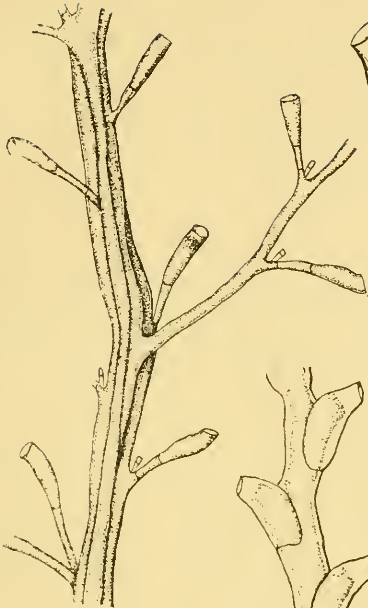
Fig. 4. *Thuiaria carica.*

A. Portion of colony, natural size.
B. Portion of branch showing arrangement of hydrothecæ.
C. Portion of stem showing method of branching.
D. Gonangia (After Broch).

Fig. 5. *Plumularia plumularoides.*

A. Colonies, natural size.
B. Cauline internode and hydrocladium showing arrangement of gonophores (male in this instance).
C. Female gonophore.

Note.—Magnification 20 diameters unless otherwise indicated.



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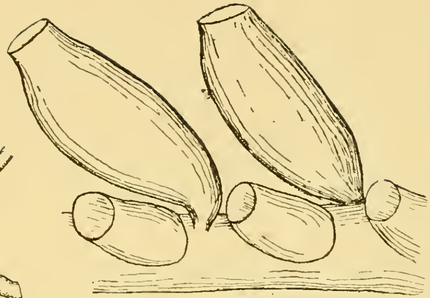

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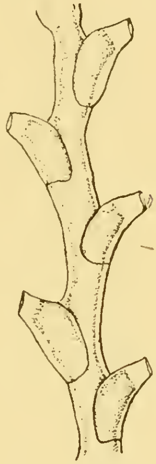

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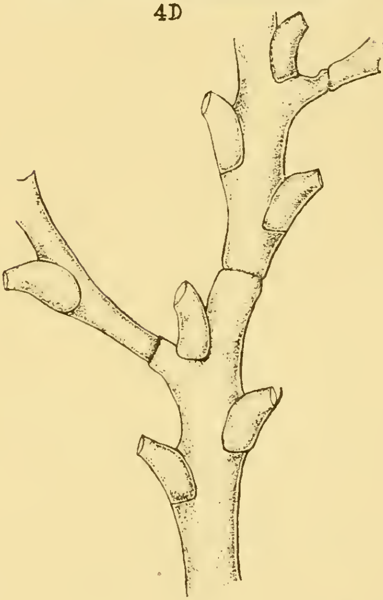

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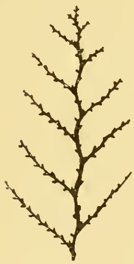

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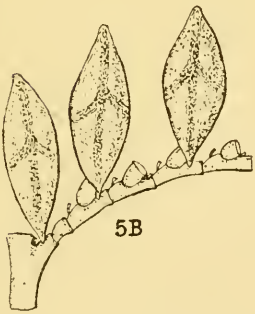

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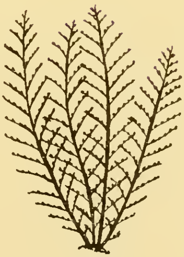

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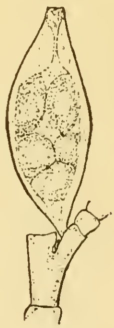

5C

Migrations of Marine Animals

By C. McLean Fraser, Ph.D., F.R.S.C.

(Read May Meeting, 1918)

In a work recently published, Alexander Meek has gone extensively into the consideration of the migrations of fish. In this the main stress is laid on a tendency of each species to migrate in one direction towards the spawning period and in the opposite direction after spawning or as fry. It is possible that if similar attention were paid to other marine forms, a similar tendency might be observed in the majority of instances although it might not be possible in so many cases to trace any relationship between these movements and the direction of tidal currents. In the case of sessile forms and others that as adults remain stationary, there cannot be any migratory movement in the adult and the free-swimming larvæ seem to be carried about by tides and currents without having any special directive movement of their own. Of course this is true of certian fish larvæ as well. The young Pacific herring, for instance, just after they are hatched out, are often found in almost solid masses in eddies or in situations where two currents meet to bring them together. There is no parallel, however, in the case of the adult and consequently these sessile forms cannot be included.

Some examples from the Pacific coast of North America and more particularly in the strait of Georgia, in the different phyla and classes, may serve to indicate that there is such a tendency.

In vertebrates, among the mammals as well as among the fishes, migration is a noteworthy feature. The migratory habits of the fur seal are so marked that the migrations are comparable in distance to those of migratory birds. From the rookeries on the Pribiloff islands the individuals wander southward, even as far as the coast of California, 1,200 miles or more away, only to return to the rookeries for the next pupping season. The return is not restricted to the breeding individuals since the immature males and females appear at the rookeries as well. Sea-lions are much similar in their habits but it is questionable if all the members of the herd go farther from the rookery than is necessary to get a sufficient supply of food. Some of them go long distances although by no means so far as the fur seals. Every spring during the time the herring are in shallow water, grey sea-lions (*Eumetopias stelleri*) are seen in the strait of Georgia as far north as the Thormanby islands on the east side and the Winchelsea islands on the west side. The nearest known rookery is on the Jagged islets, 21 miles south of Cape Flattery off the Washington coast and this must be at least 160 miles away. As no very large or very small ones are seen, it may be that these are the immature males and females, while mature individuals as well as pups of the year do not get so far away. It is quite possible that these immature individuals do not remain at the rookery during the pupping season. On July 9, 1916, two sea-lions were seen on Butterworth rocks, to the northwest of Stephens island, near Prince Rupert. This was in the pupping season and yet Butterworth rocks are 150 miles from the nearest known rookery. It is probable that these were immature individuals. If that is the case the migratory habit is not so strong in the sea-lions as in the fur seals.

Apart from the vertebrates, the ascidians are the only chordates well represented and as these are sessile they do not come under consideration.

In the Mollusca, the different classes behave so differently that they must be taken separately. Among the Pelecypods, some, like the oyster, are sessile, others like the mussel, are attached by a byssus or like the rock oyster (*Anomia*), with a byssus plug or muscle. Nearly all those that are not definitely attached, are so sedentary, that as far as migration is concerned they might as well be. Even the razor clam, with greater rapidity of movement than the others, can scarcely be classed among the wanderers. The adults of the whole class then may be considered as non-migratory. The species of Amphineura are sluggish also but they are more mobile in general than the bivalves. In one species at least there is evidence of migration. The large *Cryptochiton*, in the vicinity of Nanaimo, may be found high up on the rocks, much above low tide, in the early spring, but later in the year it is found only in deeper water. A few fathoms may not seem much of a migration, but it is relatively as much to the slowly creeping chiton as many miles would be to the rapidly swimming seal or salmon. In the Gastropods, as an example of a migratory shelled form, there is the common moon shell or large whelk (*Polynices lewisii*). During the early part of the summer it burrows in the sand or mud in the tide flats, sometimes much above low water mark. In July or thereabouts, the eggs are laid, stuck together with sand to form the large sand collars and shortly after they all go out to deeper water, and none can be found at their earlier haunts. The nudibranch species, *Chiorœra leonina*, appears in great numbers on the eelgrass just below low tide during the late winter and early spring months. In March the frill of eggs are laid on the eelgrass and soon after the animals disappear. Some of them at least swim about actively in the sea and may be seen thus during the rest of the year. Cephalopods are found at different depths but observations have not been sufficiently connected to establish the presence or absence of periodic migration. Squid have been found cast up on the beach alive in October and November, but on the other hand masses of eggs have been hauled out by the shore seine in March. Very young specimens have been found in the plankton in the spring and others slightly larger have been dredged at various depths.

Among the free-swimming crustaceans more attention has been paid to the diurnal movements than to seasonal migration, but evidence of the latter is not lacking. Of the free-swimming Entomostraca only the copepods are numerous. In the vicinity of the station very few of these are found in the plankton taken at or near the surface during the winter months. Towards the end of February, or early in March they become plentiful and almost as soon as they appear in numbers, eggs and larvæ are also found in the plankton and these may be found with the mature copepods right on through the spring and summer, different species numerous at different times of the year as well as different species at different times of the day. Among the Malacostraca migration is very evident in the Schizopods. In many cases these come to the surface to shed their eggs in such large numbers during the spring that the water is colored pink so as to be noticeable some distance away. They form the main portion of the pink feed that supplies the different species of salmon and other fish with much of the nourishment that produces such rapid growth. Even whales thrive on it. Of the Decapods some of the shrimps apparently inhabit shallower water in the summer months than in the winter months and at least two species of crabs, *Cancer magister* and *C. productus*, are often left dry at low tide when they are mating. The shallow water period of many of the Amphipods and Isopods corresponds very well with that of the Decapods.

Of the marine annelids, many of the Polychætes that live most of their lives along the shore or at the bottom of the sea, come to the surface to shed their eggs. In this vicinity swarming has not been observed in very many forms, but in one species, *Odontosyllis phosphorea*, it has induced considerable attention. Under ordinary circumstances *Odontosyllis* is found on rocky bottom at a depth of from 15 to 30 fathoms, but for the purpose of reproduction it comes to the surface just after sundown in the summer evenings when the water is calm and swims with the tidal current with a wavy, wiggling motion. This motion in many individuals brings them to quiet water where two currents meet. Here they circulate to throw out the reproductive elements, after which they gradually sink to the bottom.

In the Echinoderms it is common to find certain species in much shallower water in the early spring than at other times of the year. Among the starfish, *Mediaster æqualis* and *Orthasterias leptolena* are found on the rocks that rise more or less vertically at or above low water mark, but later on in the summer they can be got only by dredging. Some of the others do not show such migration. The commonest of all, *Pisaster ochracea*, may be found at or above low water at all times of the year. Brittle stars are found at various depths, but no definite migration has been observed. The purple sea-urchin, *Strongylocentrotus franciscanus*, comes up to shallow water, even above low tide, in the early spring, but later after the eggs have been shed takes again to deep water. Among the Holothurians, *Stichopus*, at least, has much the same habit as the purple urchin but others do not appear to have the same migratory movement. In the Crinoid species, *Florometra serratissima*, that is so abundant in this vicinity, the larvæ become attached to the adult so there is little chance of much distribution afield, even in the early stages, and the adult comes in the sedentary class.

Brachiopods, Phoronids and Bryozoa are all included under the stationary forms. Rotifers appear in great abundance at times and at others are entirely absent. There may be a periodicity with their appearance as well as with that of the Chætognaths but observation has been insufficient in either case to form the basis for any statement.

Of the Ctenophores, *Pleurobrachia bachii* appears in great abundance near the surface in July and August but later in the season and particularly during the winter months none are to be found.

Among the Cœlenterates, the Scyphomedusæ are most strongly represented by *Aurelia*, which is plentiful in Departure bay from October until the end of the year. During this period the eggs become ripe and are shed. During the remainder of the year they are not plentiful although some of them may be found at almost all times. In some other localities, e.g., Nanoose bay, Oyster harbour and Saanich arm, they are more abundant even than in Departure bay, so much so that they give the appearance of shoal water. Of the Hydromedusæ, *Gonionemus* is plentiful among the eelgrass in shallow water during May and June but is seldom seen during the remainder of the year. On the other hand, *Æquorea* may be seen at any time of the year swimming backward and forward with the tidal currents in such places as Dodds narrows where the tidal currents are strong.

Sponges have no migratory representatives. In the Protozoa periodic migration, if there is such, would be rather hard to follow. At certain times some species, particularly among the Flagellates, appear in exceedingly great numbers. The most noticeable instance of this was observed on September 21, 1914, when an area in Departure bay as least as great as half a mile square was brownish green at the surface and for at least a couple of feet below the surface due almost entirely to the presence of *Noctiluca*. On May 13 of the same year the waters of the bay, just near the station, over an area of perhaps 200 yards square, was of a dark wine color on account of the presence of a Dinoflagellate. On July 9, following this a somewhat similar area, although not quite so large, was seen in Porpoise bay near Sechelt. The color was of a brighter red and was due to an entirely different species. On September 10, 1917, an area greater than either of the last two, but not so large as the first, around the wharves and landings in Nanaimo, as well as in Commercial inlet, was so extensively filled with a flagellate species that it had the appearance and almost the consistency of pea soup. Smaller areas have been seen at various times. In any one mass, one species predominates and make up almost the whole of the life in that mass, but different species appear in the different masses. As far as observation has gone, therefore, no idea can be obtained as to the regularity of the appearance of any one species.

In practically all the main classes of marine forms represented in the waters along this coast in which the adults are not sessile or very sedentary, examples may be found that indicate a tendency to migrate periodically. The instances given may or may not be typical of the classes, but they are all common species. If as much attention were given to life-history in any of these classes it is at least possible that there would be as much indication of migration as in the fishes.

A Report on Cross Fertilization Experiments,
(Asterias x Solaster)

ROBERT CHAMBERS AND BESSIE MOSSOP

Presented by J. P. McMurrich, Ph.D., F.R.S.C.

(Read May Meeting, 1918)

During the first two weeks of August, 1917, a number of adult Solaster endeca (Forbes) were obtained by dredging over a rocky reef in the vicinity of Joe's Point near the Biological Station, St. Andrews, N.B. At this time mature *Asterias forbesii* (Desor) were to be had at St. Andrews. The extent of the breeding season of Asterias in the vicinity of St. Andrews may be estimated from the occurrence of Bipinnaria in the plankton of Passamaquoddy Bay, which is being investigated by Professor J. P. McMurrich. During 1916 the first Bipinnaria observed occurred on July 20th. They were present in all subsequent tows till August 31st. In 1917, none appeared till August 8th, after which date they appeared throughout the remainder of the month.

The Asteriidæ and the Solasteridæ are comparatively closely related families, both belonging to the order Cryptozonia in the Asteroidea. The Solaster possesses a heavily yolk-laden ovum (1 mm or over in diameter) which undergoes a somewhat incomplete metamorphosis, the free swimming larva not having a completely formed alimentary tract. The Asterias, on the other hand, undergoes complete metamorphosis, the larval form being a typical Bipinnaria.

Because of this and because of the fact that the spermatozoa of the two species are very much alike, although the ova are very dissimilar in size, the possibility suggested itself that interesting results may arise from attempts at cross-fertilizing these two species.

Among the specimens of Solaster procured, the females contained large numbers of apparently mature ova. Repeated attempts at fertilizing them with spermatozoa of their own species as well as with those of Asterias proved unsuccessful. The breeding season of Solaster, according to Gemmill,[1] is normally in March or early April, at least for those on the British Coast. This may account for our failure with the Solaster eggs so late as July and August. On the

1912, Gemmill, J. F., The Development of the Starfish, *Solaster endeca*, Forbes, Transactions Zoological Society, London, Vol. 20, p. 1.

other hand, the breeding season of Solaster may be much later at St. Andrews than in Great Britain (as is the case with a number of other forms) and the sperm may have ripened earlier than the ova, as was observed in the case of Asterias in 1917.

The Asterias sperm and ova were normal and ripe. The ova matured within 30-40 minutes after being placed in sea water. As the spermatozoa were rather sluggish, a few drops of ammonia were added to the water. Sperm thus treated became very motile, and when added to the ova of its own species induced a development of from 90 to 100 per cent.

On July 22, 1917, at least two weeks before Bipinnaria were found in the plankton, male Asterias were procured whose testes were swollen and large and had every appearance of being mature. The spermatozoa, however, when introduced into sea-water remained motionless. On adding enough ammonia to the water to raise the NH_3 concentration to 0·0055 grams in 100 c.c., the sperm became motile and capable of fertilization. A lowering of the concentration to 0·0045 grams in 100 c.c. stopped all movement. Fresh sea water was found to contain normally 0·002 per cent NH_3. Later in the season (early August) spermatozoa were active in normal sea water. It is known that increase in the hydrogen ion concentration will inhibit the movement of spermatozoa and cilia. Possibly the testis is acid owing to the presence of a relatively great amount of CO_2 produced in the active metabolism of the developing sperm. The mature sperm would thus be existing in an anæsthetized condition. The addition of ammonia neutralizes the inhibiting effect of the CO_2 and renders the mature sperm motile. In a fully ripened testis, the developing process has largely ceased and the acidity has had a chance to be dissipated. For such a testis the alkalinity of normal sea water is sufficient to activate the spermatozoa. The Solaster testes, according to this assumption, were not fully ripe, since the spermatozoa of Solaster were quite motionless in sea water and were activated only by being placed in alkaline sea water.

Solaster spermatozoa, which had been thus activated, were poured into bowls containing mature Asterias ova. In one and one half hours fertilization membranes appeared in about 20 per cent of the eggs. Their polar bodies were all *outside* the fertilization membrane. In the case of the control (Asterias sperm x Asterias ova) the polar bodies were all *inside* the fertilization membrane.

The difference in the position of the polar bodies is due the difference in time of the initiation of fertilization. In the cross-fertilized ova this is delayed well beyond an hour during which the polar bodies are extruded. When the membrane forms it lifts up from the surface of the ovum and pushes the polar bodies ahead of it. In the self-fertilized ova the membrane forms within a few minutes, the polar bodies are produced later and, therefore, come to lie within the membrane.

Development proceeded regularly in the cross-fertilized ova, but more slowly than in the self-fertilized Asterias ova. Six hours after mixing the sperm with the ova the Solaster sperm x Asterias ova had developed into the 16-cell stage while the Asterias sperm x Asterias ova had developed into the 32-cell stage and some even into later stages. Except for this delay in rate and for the very much decreased percentage of developing eggs, no difference was discernible on comparing the living self and cross-fertilized Bipinnaria.

To exclude the possibility that the alkalinized water alone might have caused the development, Asterias ova were placed in alkaline water without sperm. None developed. Also, to exclude the possibility of Asterias sperm being present with the Asterias ova before introducing the Solaster sperm, all the water used was carefully heated to boiling point and then cooled. The starfish used were thoroughly rinsed in such water before removing the gonads.

We know that fertilization involves two sharply separated processes; first, an impetus which activates the hitherto quiescent egg so that it will segment and undergo embryonic development; and second, a fusion of the male pronucleus, introduced into the egg by the spermatozoon, with the female pronucleus, a part of the original nucleus of the egg. The second process involves the inheritance, in the offspring, of the paternal and maternal characters.

The first process has been independently produced in the laboratory by a variety of so called "parthenogenetic" agents. The Asterias ova are very easily induced to this sort of development. The application of heat and mere shaking occasionally suffices to start cortical changes resulting in the throwing off of a fertilization membrane followed by segmentation. It is possible that the Solaster sperm may have acted on the Asterias eggs only in so far as to induce them to parthenogenetic development. This would explain the purely maternal appearance of the larvæ resulting from the cross. Further investigation of this problem is being conducted.

A Contribution to the Evolution and Morphology of the Human Skull, including a comparative Study of the Crania of certain Fossil Hominidæ

BY JOHN CAMERON, M.D., D.Sc., F.R.S.E.

Presented by C. GORDON HEWITT, D.Sc., F.R.S.C.

(Read May Meeting, 1918)

Huxley,[1] Flower,[2] Turner,[3] Humphry,[4] and Cleland[5] may be justly regarded as the founders of the modern British School of craniometry, for they were among the first to recognize the value of taking methodical measurements of the skull, and thus rendered yeoman service in raising this to the level of a definite science. It would, however, be somewhat derogatory to the very powerful and influential French School were one not to mention and likewise pay homage to the brilliant work also done on the human skull by such famous morphologists as Daubenton,[6] Cuvier,[7] St. Hilaire,[8] Broca,[9] de Quatrefages,[10] Topinard,[11] and many others. A tribute must also be paid to the pioneer work performed by Camper,[12] Huschke,[13] Froriep,[14] Merkel,[15] Gegenbauer,[16] Virchow[17] and Welcker,[18] and also to the more recent researches on craniometry carried out by Schwalbe[19] and Klaatsch.[20] The literature on the subject is now immense, and

[1] *Lectures on Comparative Anatomy*, London, 1865.

[2] *Catalogue of Museum of Roy. College of Surg. Museum*, London, 1879.

[3] and [22] Reports of the voyage of H.M.S. Challenger, 1880-1895, Vol. X. *Zoology*.

[4] *A Treatise on the Human Skeleton*, 1858.

[5] On the Variations of the Human Skull, *Trans. Roy. Soc. Lond.*, 1869.

[6] I have been unable to consult his work, published in 1764.

[7] *Histoire Naturelle des Animaux*, Paris, 1798-1799.

[8] *Philosophie Anatomique*, Paris, 1818-20.

[9] *Instructions Craniologiques et Craniométriques*, Paris, 1875.

[10] *Crania Ethnica*, 1873-1881.

[11] *Eléments d'Anthropologie générale.*

[12] 1722-1789. He devised a "facial angle" and a "method of projection."

[13] *Schädel, Hirn und Seele*, 1854.

[14] *Characteristik des Kopfes nach dem Entwickelungsgsetz desselben*, 1845.

[15] *Entwickelung des menschlichen Schadels*, 1882.

[16] *Elements of Compar. Anatomy* (Eng. Trans.).

[17] *Zeitschrift fur Ethnologie*, 1882.

[18] *Archiv fur Anthropologie*, vol. XVI.

[19] *Zeitschrift für Morph und Anthrop.* Vol. 1. Pt. 1. 1899.

[20] *Ergebnisse der Anat and Entwick.* (M. & B.). Vol. XII, 1903.

I have therefore merely chosen a few names representative of the various schools of thought on this subject.

Since the publication of the classical researches of Huxley[1] and Turner[2] on the cranio-facial axis, a fresh impetus to the comparative study of the human skull has been furnished by the discovery of the remains of the Java man-ape,[3] the numerous additional specimens or examples of crania of Neanderthal[4] or Mousterian[5] man, and lastly the discovery of the fossil remains of Piltdown[6] man in 1912. The latter discovery has proved the main stimulus to the production of this memoir for it impressed me with the value of making a comparative investigation of the various cranial types of fossil hominidæ, and even carrying the evolutionary idea back to the man-ape of Java (*Pithecanthropus erectus*) and the anthropoid apes. Many of the results thus obtained were found to justify the extension of the investigation along these channels. In carrying out this research it was found that the most valuable information gained from the evolutionary standpoint was secured by a study of the following indices and cranial measurements, which will be considered in their turn—

1. The fronto-parietal index.
2. The calvarial height.
3. The bregmatic angle and the cranial curvatures.
4. Other angular cranial measurements.

I. The Fronto-parietal Index

The post-frontal, or more accurately, the post-orbital constriction is a very marked feature of the skulls of the anthropoid apes, when studied from above. It is also very prominently displayed in the skull of the Java man-ape, as shown in Fig. 1 where it is indicated by the line AB. In this skull its extent is actually 35% less than that of the maximum parietal breadth, represented by the line DE. This figure has been drawn to the scale of a glabella-inion length of 100 mm. In Fig. 1, a similar outline of the well known model of the Neanderthal skull is shown, reduced to the same scale. On comparing these two, it will be observed that the maximum parietal breadth has increased only 9·5% whereas the minimum post-orbital

[1] *Jour. of Anat. and Phys.* Vol. I.

[2] *Op. cit.*

[3] *Archiv für Anthrop*, 1895. *Jour. Anat. and Phys.*, 1895, and *Smithsonian Report*, 1898.

[4] Der Neanderthalschädel, *Bonner Jahrbücher*, 1901.

[5] *Archives de Biologie.* Tome VII.

[6] *Quart. Jour. Geolog. Soc. London* Vol. LXIX, 1913.

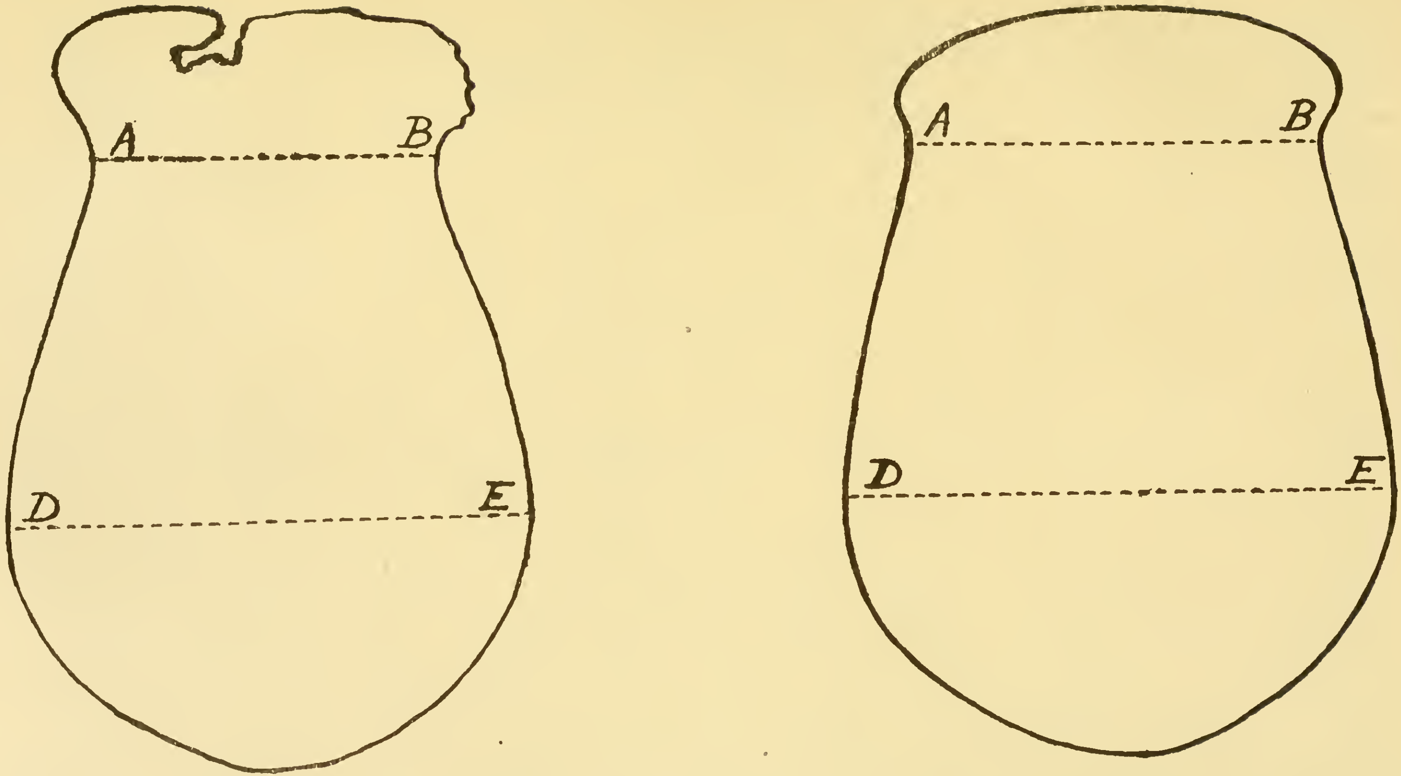

FIG. 1.—Shows the Java skull (Pithecanthropus) on the left and the Neanderthal skull on the right, both reduced to the same standard glabella-inion length and viewed from above. On comparing these two it will be noted that the maximum parietal breadth (the line D E) has increased very slightly in the Neanderthal skull, whereas the minimum post-orbital diameter (the line A B) shows a considerable increase in length.

breadth exhibits the relatively large increase of 18·6%, that is to say twice the rate of the other. It should be noted here that Neanderthal man is regarded by some biologists as a degenerative offshoot from the main evolutionary stem, but nevertheless it is instructive to make use of some of his cranial dimensions in a comparative study of the evolution of the skull. On coming now to the skull of Piltdown[1] man it will be found that decided progress has been made especially in the case of the minimum post-orbital breadth, where the increase over that of the Java skull is 22·3%. Compared with this the progress in the evolution of the maximum parietal breadth is still slow, the increase over that of the Java skull being merely 11·3%. Both these figures show of course a marked advance when compared with the Neanderthal skull. On investigating the corresponding dimensions of modern Melanesian[2] and aboriginal Australian skulls, it was ascertained that the minimum post-orbital breadth had on an average increased a mere 7·4% over that of the Java skull, while the maximum parietal breadth was actually slightly less (12·6 and 13 cm. being the respective measurements). We thus obtain the striking information that the evolution of modern Melanesian and aboriginal Australian skulls with special reference to both these dimensions was decidedly below the stage actually reached by the Piltdown skull (Fig. 2), while as regards its maximum parietal breadth it compared unfavourably even with the Java skull. Of course, it must be remembered that in all these cases the basal height ought also to be taken into account, since the evolution of the skull must necessarily take place in three dimensions. Unfortunately the Java, Piltdown and Neanderthal specimens are represented merely by the roof part of the skull, or calvaria, so that there are no possible means of studying the basal height in these cases, though one is enabled to investigate the calvarial height which, as will be shown presently, furnishes us with much valuable information regarding the evolution of the skull.

[1] Several reconstructions of the Piltdown skull are now in existence. It will therefore be necessary to confine our attention to one of these, so as to avoid unnecessary references and unavoidable confusion. The only reproduction I have been in a position to investigate is Smith Woodward's first model, prepared by Mr. F. O. Barlow. Since my departure from London I find that Smith Woodward has produced a second model of somewhat greater cranial capacity than the first; while Prof. J. H. Macgregor of Columbia University and Professor Arthur Keith of London have likewise prepared skilful and suggestive reproductions. My military duties have prevented me from going to New York to study Professor Macgregor's model. I have been able, however, to ascertain from photographs that its cranial outline accords very closely with that of Smith Woodward's model.

[2] Trans. and Proc. of the Nova Scotia Institute of Science, 1917-18.

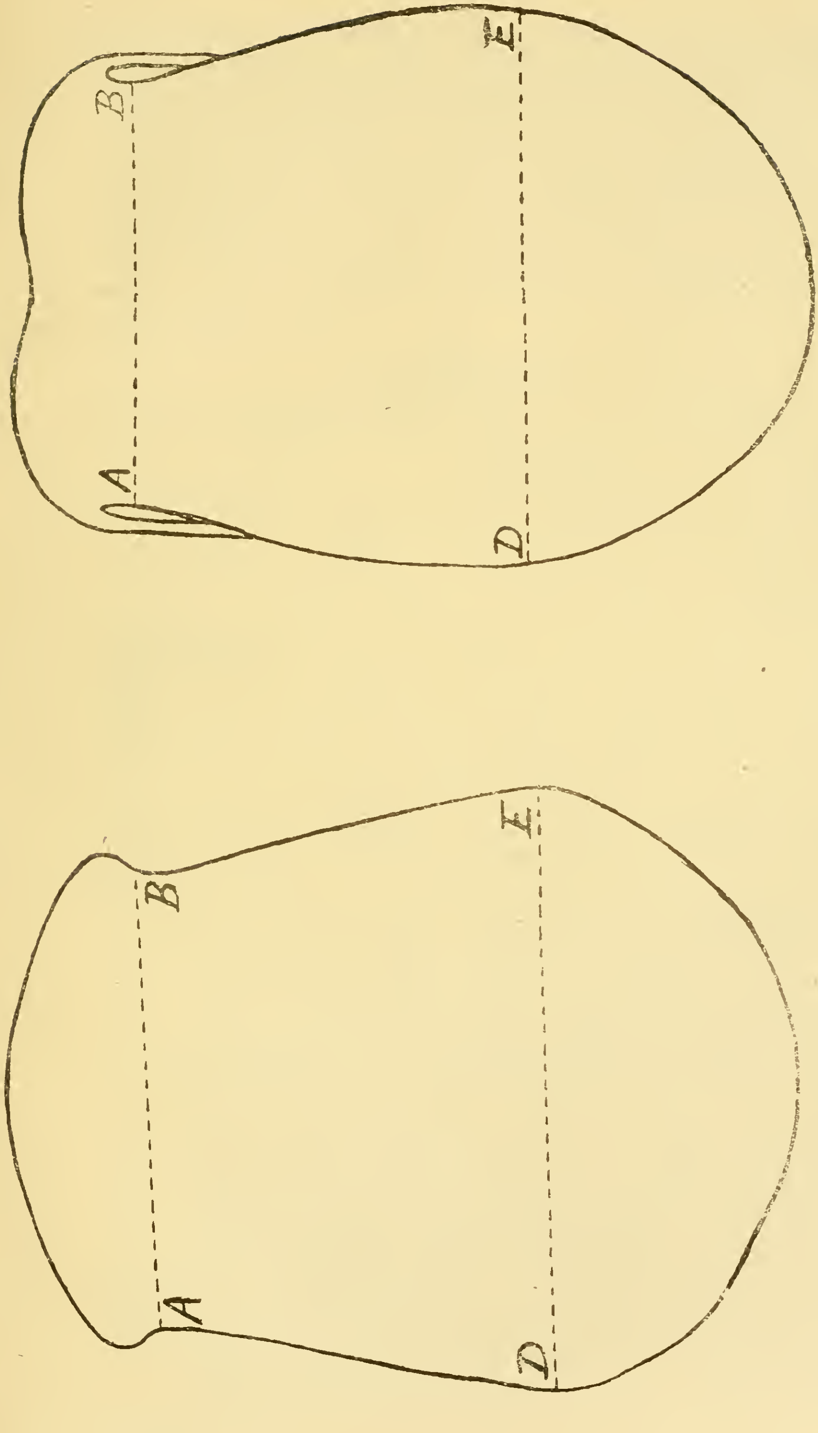

FIG. 2.—Represents the Piltdown skull on the left and a modern Melanesian skull on the right, both reduced to the same standard glabella-inion length, and viewed from above. It will be observed that the evolution of the maximum parietal breadth (D E) and the minimum post-orbital diameter (A B) exhibits more progress in the Piltdown than in the modern Melanesian skull. It will be found that the evolution of these dimensions has been practically stationary since the time of Piltdown man. Moreover, the minimum post-orbital diameter, the maximum parietal breadth and the fronto-parietal index of the Piltdown skull are all consistently within the range of variation of these in the skull of modern white races. Another significant point illustrated in Figs. 1 and 2 is the progressive attempt to obliterate the post-orbital constriction A B which is definitely manifested during the evolution of the human skull.

From the foregoing results one is enabled to glean the interesting information that the evolution of the maximum parietal breadth of the skull has been practically stationary since the period of Piltdown man, for it will be found that the dimensions of his skull in that direction are approximately the same as those of the average British skull of to-day. It may be further noted that the maximum parietal breadth of two ancient Egyptian skulls belonging to the XIIth dynasty, measured by the writer[1] was about that of the average modern Anglo-Saxon skull. After all it must be recollected that the evolution of the skull is entirely dependent upon the stage of progress made in the development and growth of the enclosed brain. Therefore one gathers from this fact that the brain must have chosen its main evolutionary paths along directions other than those indicated above. All this goes to show that the cephalic index of breadth taken by itself, is no criterion of racial superiority or the reverse. In this connection one may mention for example that the cephalic index of the Neanderthal skull[2] which is 73·9 is very slightly different from that of the modern Anglo-Saxon skull which is 76.

A very different tale, however, is unfolded when we study the progress made in the direction indicated by the line of minimum post-frontal breadth, for one can readily recognise step by step a very definite and progressive evolution of the brain and skull in this region, which in the Piltdown skull amounted to 22·3 per cent and in modern Melanesian and aboriginal Australian skulls to 7·4 per cent above that of the Java skull. This unfavourable comparison of the evolutionary progress of the modern Melanesian and aboriginal Australian skull with that of Piltdown man, who is supposed to have existed during the first half of the Pleistocene epoch, at once classes the former as a lower type of skull than could have been imagined as existing at the present day. However, such was the case; for the above figure was confirmed as a fair average for Melanesian and native Australian types of skull. In this connection I may mention that the minimum post-orbital diameter of the Piltdown skull is given by Smith Woodward as 112 mm., and I have found no modern Anglo-Saxon skull in my collection that exceeded this measurement. It is evident, then, from a study both of the minimum post-frontal breadth and the maximum parietal breadth, that the evolution of the latter dimension of the skull from the stage represented by the Java man-ape has not been particularly striking, and that the evolution of both dimensions has, moreover, been practically stationary since the time of Piltdown man. It would appear from this fact that we must

[1] Manchester University Museum Publication No. 68, 1910.

[2] Schwalbe, *op. cit.*

look in other directions for an expansion of the skull that is at all commensurate with the high degree of cerebral evolution attained in modern man. However, one of the most important facts shown so far is, that the minimum post-orbital diameter, the maximum parietal breadth, and the fronto-parietal index of the Piltdown skull are all consistently within the range of variation of these in the skull of modern white races. Another significant point illustrated in Figs. 1 and 2 is the progressive attempt to obliterate the post-orbital constriction which is definitely manifested during the evolution of the human skull.

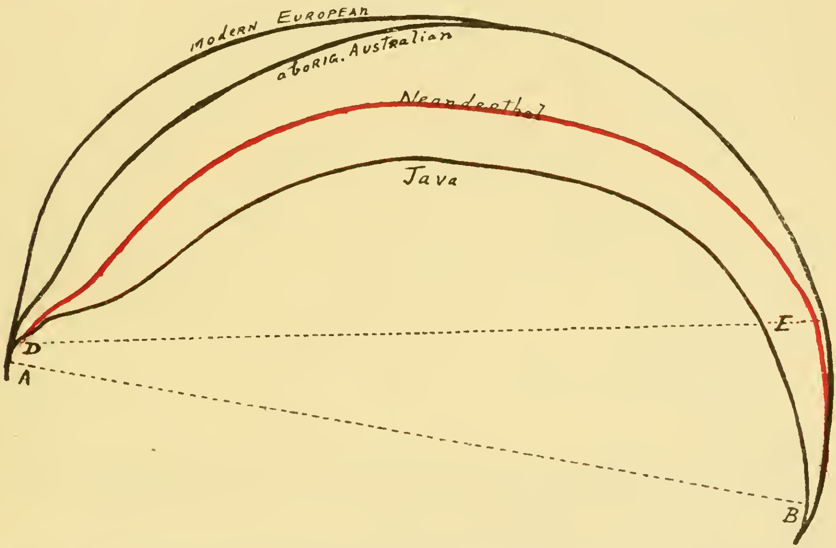

FIG. 3.—The four lines represent antero-posterior cranial outlines in the mesial plane, all drawn to scale on the same standard glabella-inion base line A B. The line D E represents approximately the horizontal plane for all four skulls. The lowest line represents the skull of the Java man-ape, the next the Neanderthal cranium, the third a modern aboriginal Australian skull and the fourth a modern European cranium. The third and fourth lines did not absolutely coincide posteriorly at all points but the fluctuation of the outlines was so slight that they have been represented there by the same line in order to avoid confusion. Fig. 3 presents a suggestive mental picture of the remarkable strides made by the developing brain, and the concomitant expansion of the skull that has taken place in order to provide accomodation for its growing cerebral contents. It may be noted that the Neanderthal cranium, though degenerate, had at any rate begun well by making remarkably uniform evolutionary progress when compared with the Java Calvaria. The fig. shows that practically all the evolutionary progress made by the modern European skull has been in the frontal region, thus suggesting that the frontal lobes of the brain are amongst the last parts of that organ to complete their phylogeny.

II. The Calvarial Height

The study of the calvarial height as a criterion of cranial evolution was found to yield rich results. At the outset it must be mentioned that the calvarial height in all the skulls examined was taken as the maximum distance between the glabella-inion line (the line AB in Fig. 3) and the cranial vault. This line of course does not lie in a horizontal plane, the latter being indicated by the line DE, which is, however, to be taken as merely approximate for all the skulls represented in Fig. 3, as its position naturally varied in the different specimens. It was obviously impossible to get one horizontal plane for all four skulls, so that an average to suit all four had to be taken. However, the distance that really matters is that between the line AB and the cranial roof. In Fig. 3 the four lines represent antero-posterior cranial outlines in the mesial plane. They were all drawn to scale on a standard glabella-inion base line. The lowest line represents the skull of the Java man-ape, the next the Neanderthal skull, the third an aboriginal Australian skull, and the fourth a modern European skull. The third and fourth outlines did not absolutely coincide posteriorly at all points but the fluctuation of the two outlines was so slight that they have been represented there by the same line in order to avoid confusion. In this relationship it is important to mention that the occipital cranial arc of the Piltdown skull was found by Smith Woodward practically to coincide with the corresponding part of the cranial arch of a more recent British skull, thus once more demonstrating the fact that the occipital cranial curve has apparently undergone very slight evolutionary changes since the stage represented by Piltdown man. The first point that strikes one about Fig. 3 is the suggestive mental picture it presents of the remarkable strides made by the developing brain, and the concomitant expansion of the skull that has taken place in order to provide accommodation for its growing cerebral contents from the stage represented by the Java man-ape up to that of the highest development as exemplified by the skull of modern white races. In preparing the outlines of the model-reproductions of the skulls of fossil hominidæ full use has been made of the data in Dubois' numerous papers[1] on the Java specimen, and in Schwalbe's memoir[2] on the Neanderthal skull in checking the results. In preparing Figs. 3, 5 & 6 the plan adopted was as follows : After each cranial tracing was completed the glabella-occipital line was drawn, and this was marked off into twenty equal parts. From these points nineteen ordinates were drawn at right angles until they reached the cranial outline. A standard glabella-occipital line of

[1] *op. cit.*

[2] *op. cit.*

200 mm. was then prepared. This was marked off into twenty equal parts each of course measuring ten millimetres.[1] The ordinates for the four cranial outlines were made proportionate to this standard base line by careful calculation (Fig. 4). On joining the free ends of these ordinates by means of a curved line an approximate outline of the skull resulted. At the frontal and occipital ends extra ordinates had to be inserted, so as to represent more accurately the rapid descent of the curve at these points. The curve for the Java specimen was first prepared, and the ordinates afterwards prolonged to the requisite amounts for each of the other three skulls in turn. Thus the glabella-

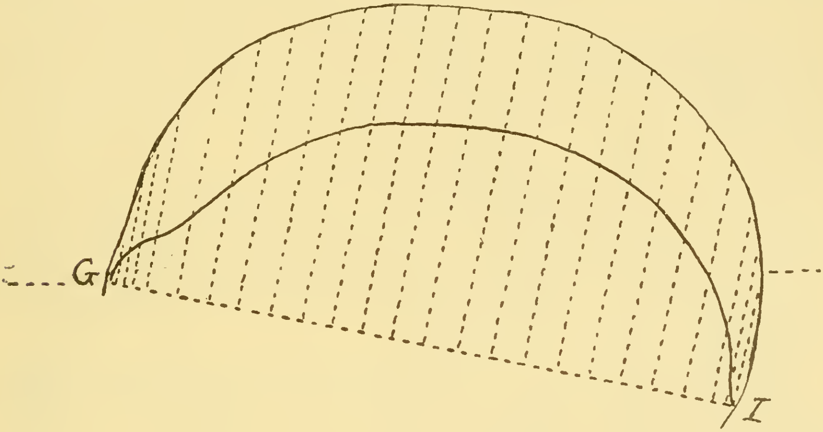

FIG. 4.—Is to illustrate the author's "ordinate method" of reconstruction, as used in Figs. 3, 5, and 6. After each cranial tracing was completed the glabella-inion line was drawn and marked off into twenty equal parts. From these points nineteen ordinates were drawn at right angles until they reached the cranial outline. A standard glabella-inion line of 200 m.m. was then prepared and marked off into twenty equal parts. The ordinates for the cranial outlines were made proportionate to this standard base line by careful calculation. On joining the free ends of these ordinates by a curved line the cranial outline resulted. At the frontal and occipital ends extra ordinates had to be inserted of course. The lowest curve was first prepared and the ordinates afterwards prolonged to the requisite amounts for each of the other skulls in turn, as the Fig. shows.

occipital base line and the twenty-four ordinates for each skull had all to be converted to one standard, an operation which entailed much labour. In fact the various conversions were so numerous that slight errors in the cranial curves have probably crept in. Every reasonable

[1] Figs. 3, 5 and 6 have of course been reduced in the reproduction.

care, however, was taken in order to secure as accurate results as possible. On studying first of all the outline of the Java skull in Fig. 3 one will note what a low grade of evolution it represents. The frontal region is particularly deficient. In fact this part of the cranial arc looks as if it has fallen in. This depression corresponds of course to the post-orbital constriction which, as noted in Section I, is so well marked a feature of the Java skull when viewed from above (Fig. 1). The maximum height of the skull cap of *Pithecanthropus erectus* is only 34·3 per cent,[1] that is to say, roughly one third of its maximum glabella-occipital length, which compares very vividly with the condition found in a recent human skull where it is usually over 50 per cent, or, in other words, at least one half. As an example I have chosen the calvarial height of an aboriginal Australian skull which was found to be 53·3. From these figures it is an easy matter to calculate that the maximum calvarial height has undergone a process of evolution to the remarkable extent of 35·7 per cent between the stages represented by the Java man-ape and the aboriginal Australian skull which exemplifies the lowest group of modern hominidæ. Of course it must be noted that this figure merely indicates the degree of heightening of the cranial roof that has taken place along one single ordinate. The same figure naturally would not be expected to apply to the other twenty-three ordinates.

The red outline in Fig. 3 represents the Neanderthal skull-cap. Its calvarial height index was calculated by Schwalbe[2] to be 40·4 On comparing this with the index of the aboriginal Australian skull mentioned in the preceding paragraph it was found that the evolutionary progress had been to the extent of 24·3 per cent. On comparing the progress between the Java man-ape and the stage of Neanderthal man it will be noted that this amounts to 15·09 per cent. It is clear from this that the progress made between the Neanderthal stage and modern man has been more than half as much again as that recorded between the Java man-ape stage and the Neanderthal stage. For this reason one is tempted to utilise Neanderthal man as an intermediate phase in cranial evolution, as his curve appears to occupy the requisite position. It will, however, be demonstrated presently, when we come to discuss Piltdown man, that this is an entirely erroneous inference.

On comparing the two lower outlines in Fig. 3 it will be observed that the evolution of the Neanderthal skull had, at any rate, begun well by making remarkably uniform progress throughout its whole

[1] As calculated by Schwalbe, *Zeitschrift fur Morph and Anth.* 1899.
[2] *op. cit.*

cranial arc when compared with the Java Calvaria. It may be particularly noted, however, that the frontal portion of the Neanderthal cranial arc still exhibits the "fallen in" appearance. The progress between the Neanderthal stage (if I may be permitted to recall him back for a moment to the main evolutionary stem) and the modern aboriginal Australian skull is very pronounced, and is again practically uniform in all directions. Note, however, that more rapid progress has been made somewhat about the centre of the cranial arc than at the frontal and occipital extremities. The "fallen in" appearance in the frontal arc is still manifest, thus imparting the prominent superciliary ridges to the aboriginal Australian skull, and constituting one of its main features.

On coming now to the final stage of all, it is of interest to note that practically all the evolutionary progress made by the modern European skull has been in the frontal region, for it was found that

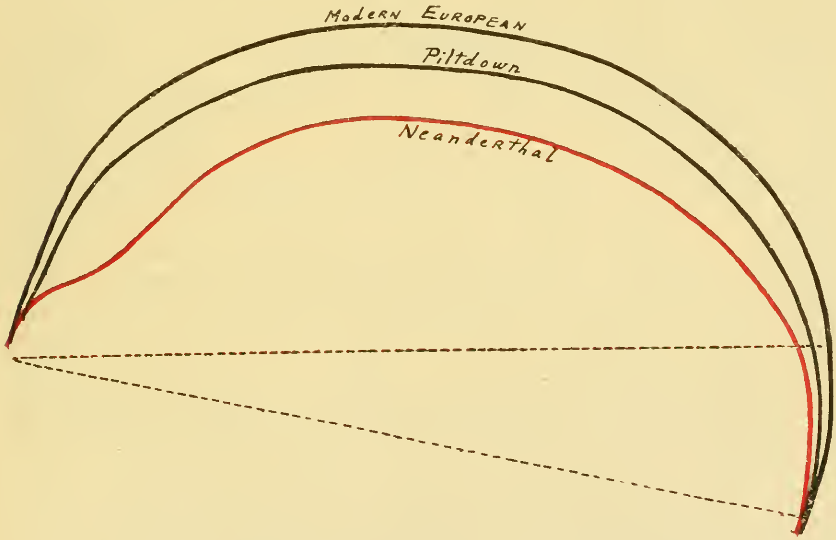

FIG. 5.—Note first of all the remarkable degree of expansion of the Piltdown skull, particularly in the frontal region, when compared with the Neanderthal calvaria. This contrast is all the more striking when it is recollected that Piltdown man existed an untold number of years before the Neanderthal type. Judging from this fact one would have gathered that the intellectual progress shown by the latter ought to have been much greater than that of Piltdown man, thus placing the curve of his cranial arc above instead of markedly below. The cranial outline of Neanderthal man is thus chronologically in the wrong place and the only feasible explanation of this remarkable fact is that he must have belonged to a degenerate species of the hominidæ which drifted away from the main evolutionary stem and probably became extinct.

the outlines of the post-parietal and occipital portions of the cranial arcs almost exactly coincided in the two specimens examined. The great result of this frontal expansion has been to wipe out almost entirely the "fallen in" appearance of the frontal arc, thus producing the typical outline of the highly evolved skull of the white races of modern mankind.

A comparative study of the Neanderthal, Piltdown and modern European skulls was found to yield several points of interest. (See Fig. 5.) As is well known there has been much controversy over the reconstruction of the Piltdown skull, so that it is advisable to again mention that in these comparative researches Smith Woodward's first model has been utilised. The external occipital protuberance of the Piltdown skull was found to form "the hindmost point of the cranium" as Smith Woodward remarks.[1] The glabella-occipital length taken to this point was 190 mm. He gives the calvarial height from this line as 90 mm. By a little calculation I found that the index of calvarial height proved to be 47·4. The skull thus indicated an advance in cranial evolution of 14·7% from the Neanderthal type of skull, so far as this index was concerned, a very substantial step indeed, as it demonstrated a general expansion of the whole cranial arc, as shown in Fig. 5. Here again the outlines of the three skulls are drawn to scale on a standard glabella-occipital base line. The great expansion of the frontal portion of the cranial arc in the Piltdown skull is particularly striking. The remarkable fact about the rate of expansion of these two skulls, however, is that Piltdown man was located by Dawson and Woodward in the first half of the pleistocene epoch. That is to say, he existed many thousands of years before Neanderthal man. Judging from this fact one would have gathered that the intellectual progress shown by Neanderthal man ought to have been greater than that of Piltdown man, thus placing the curve of his cranial arc above the latter instead of markedly below. The only feasible explanation of this remarkable fact is that Neanderthal man must have belonged to a degenerate species of the hominidæ which drifted away from the main evolutionary stream, and probably became extinct[2] as a result of the unequal struggle for existence in these strenuous ages. I have also previously pointed

[1] *op. cit.* p. 126.

[2] The literature on this subject is already vast. I would specially mention that Osborn (*Men of the Old Stone Age*, New York, 1916), Schwalbe (*Zeitsch, fur Morph und Anthropol.*, Bd. XVI.), Boule (*Ext. Ann. Pal.*, Tomes, VI, VII and VIII.) and Gregory (*Geology of To-Day*, London, 1915) hold this view; while Hrdlicka (*Report of the Smithsonian Institution*, 1913) maintains the opposite opinion. In this relationship I would also refer the student to Ex.-Pres. Theodore Roosevelt's popular and illuminating article in the *National Geographic Magazine* for Feb., 1916.

out this fact in another communication[1] where I state that "the evidence certainly seems to indicate that the Java man-ape, the Piltdown and Cro-magnon types were situated in that order from below upwards on the main stem of the ancestral tree, with the Neanderthal man as a degenerate offshoot, occurring somewhere between the positions occupied by Piltdown man and Cro-magnon man." It is evident, then, that one must not utilise the Neanderthal specimen as representing a definite step in the evolution of the skull, for his cranial outline is *chronologically in the wrong place*, but at the same time it is both instructive and interesting to compare his skull with that of other types of hominidæ.

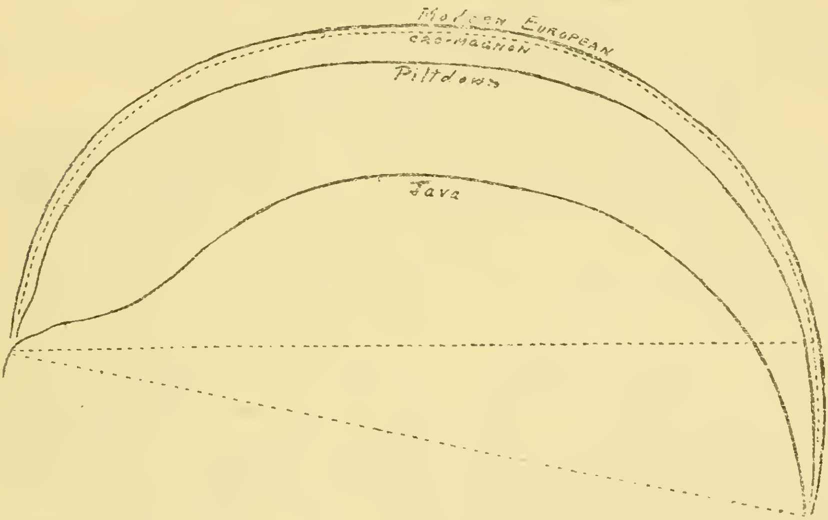

FIG. 6.—Shows that there is a vast gap between the stages represented by the Java man-ape and Piltdown man which still requires to be filled up. This is emphasised by the fact that the Piltdown and Cro-magnon outlines are close up to that of the modern skull. Thus a very important "link" in the evolution of the brain and skull is really still "missing." In fact that link in the chain connecting the Java man-ape with *Homo sapiens* has still to be forged in order to prove that Pithecanthropus is really an ancestral type for modern man.

On investigating the progress made between the stages of Piltdown man and modern man, several points of interest were elicited. The upper outline in Fig. 6 is that of a modern European skull taken at random. This was found to have a calvarial height index of fifty-five, which as a matter of fact is rather low for a skull of the white races, as it represented a progress of only 13 per cent when compared

[1] *The Canadian Magazine*, Oct., 1917.

with the Piltdown skull. It is evident, then, from Figs. 3 and 6 that if the Neanderthal or Mousterian type of skull must not be utilised as a stage in the main path of evolutionary progress, there is a vast gap between the stages represented by the Java man-ape and Piltdown man which still requires to be filled up. From this standpoint one might perhaps be bold enough to prophesy that some day a new ancestral type will be discovered to fill up this very obvious hiatus in the evolutionary history of the skull and brain. Until that is done it will be difficult indeed for some biologists to accept the view that *Pithecanthropus erectus* is really an ancestor of modern man. In fact this conclusion lends support to the assertion of certain influential members of the German school of anthropologists[1] that the Java man-ape is not to be seriously regarded as an ancestor of modern man at all. Still he appears to be situated on the main evolutionary stem, and is not a degenerate offshoot like Neanderthal man.

A striking fact brought out in Fig. 6 is the comparative slowness in the rate of expansion of the modern European skull from the Piltdown stage. This suggests to the writer that Piltdown man was qualified to be the precursor of the orthognathous higher races of mankind and not of the lower types of modern hominidæ, for his frontal arc was certainly well developed and, as already stated above, the main difference between the European and aboriginal Australian types of skull consists in the greater degree of filling out of the frontal cranial arc (Fig. 3). Another significant fact is that there are many aboriginal Australian skulls of to-day that possess a calvarial height index below that of the Piltdown skull. For example Berry and Robertson[2] record a minimum index as low as 44·9 in a collection of one hundred aboriginal Australian skulls. That is to say modern skulls are in existence with a calvarial height index as low as that of the Neanderthal Spy type (Spy No. 2 = 44·3).

The dotted outline in Fig. 6 represents the Cro-magnon skull which possessed a calvarial height index of 50. A comparative study of Figs. 3 and 6 thus provides us with one fact of very far-reaching importance, namely, that Piltdown man and Cro-magnon man, so far as their skulls are concerned, are in their correct relative positions on the main evolutionary stem, while Neanderthal man is to be definitely regarded as a degenerate offshoot from that stem. It is to be further noted that in Fig. 6 the outlines of the Piltdown and Cro-magnon skulls are close up to that of the modern European skull, a

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[1] I may specially mention Virchow, Krause and Waldeyer who at the historic discussion at the Berlin Anthropological Society in 1895 stated their conviction that the calvaria was simian. See the *Verhandl. Berl. Anthrop. Gesell.*, 1895.

[2] *Proc. Royal Soc. of Edin.* Vol. XXXIV., 1913-14.

fact which still further emphasises the extent of the great hiatus between them and the cranial outline of *Pithecanthropus erectus.*

III. The Bregmatic Angle and the Cranial Curvatures.

The bregmatic angle is an important criterion of the degree of evolution of the frontal region of the skull. This angle was found by Schwalbe[1] to be forty-four in the Neanderthal skull. It may rise as high as sixty-six in modern European types of skulls according to Duckworth.[2] The range of difference is thus extraordinarily great.

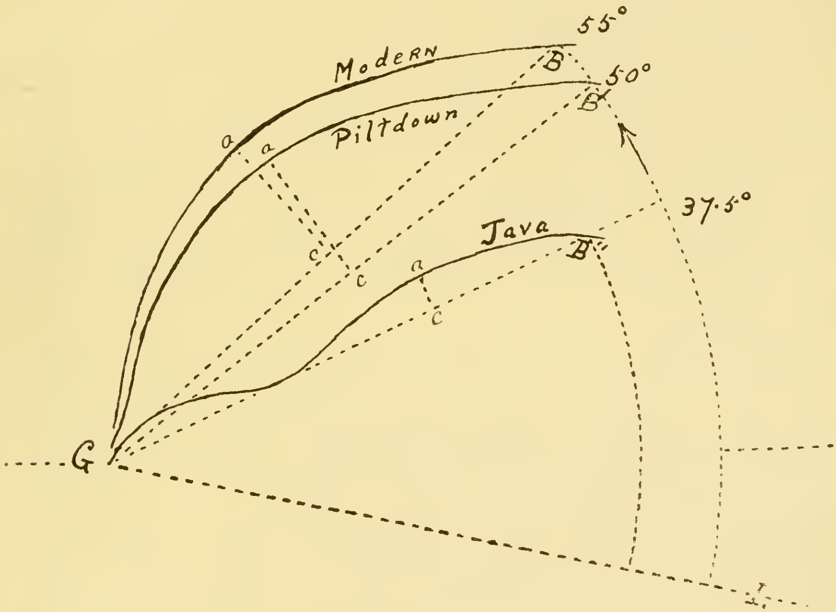

Fig. 7.—Has been designed to illustrate the gradual expansion of the bregmatic angle from the stage of Java man to that of the modern European type. It will be noted that if the Piltdown cranial arc were to be swung upwards by increasing the size of the bregmatic angle to 55, the area GaB[1] would almost exactly coincide with the area GaB of the modern skull, showing that the evolution of the frontal cranial arc as such, has remained practically stationary since the time of Piltdown man.

Smith Woodward[3] calculated the bregmatic angle to be fifty in his first reconstruction of the Piltdown skull, which is larger than the angle found in many aboriginal Australian crania at the present day.

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[1] *op. cit.*

[2] *Morphology and Anthropology,* 1904.

[3] *op. cit.*

For instance Berry and Robertson[1] found that it reached a minimum of forty-nine in a series of one hundred of these. The angle in a Melanesian skull investigated by the writer[2] was ascertained to be fifty-five which represents an evolutionary advance of only 9% above the Piltdown type. The angle in a modern European cranium taken at random from the writer's collection was found to be sixty-two which represents evolutionary progress to the extent of 19·4% above the Piltdown type. This certainly is a very substantial gain, and is another indication of the decided evolutionary activity that has been shown to be taking place towards the frontal end of the cranium, not only upwards and forwards, but also in a transverse direction as previously discussed in Section I. Fig. 7 has been designed to show the relative extent of the bregmatic angle in the Java skull (B″), the Piltdown skull (B′), and a modern European type of skull (B″). This figure demonstrates the gradual swinging upwards and forwards of the line BG, opening up as it were like a lid, with the glabella as the position of the hinge. It will be noted from the figure what a relatively large addition to the cranial capacity is secured by even a very slight degree of swing movement. One is thereby enabled to appreciate how valuable is the index of cranial superiority furnished by a study of the bregmatic angle.

The expansion of the frontal cranial arc is the striking feature of the skull of white races, therefore the higher up the scale one goes, one finds a gradual increase in the maximum distance between the arc and the glabella-bregma chord, which I found to be about 25 mm. as the average of twelve Canadian crania. A study of Fig. 7 thus shows that there are two great factors in operation during the evolution of the frontal region of the skull. The first is a gradual increase in the size of the bregmatic angle, while the second is superadded to this in the form of a concomitant bulging outwards and forwards of the frontal cranial arc, rather after the fashion of the way in which an archer bends his strongbow. It is necessary to pay attention first of all to the glabella-bregma chord which, to carry the previous analogy further, might be termed the string of the bow. I calculated this to be 9·4 cm. long in Dubois' reconstruction of the Java skull, whereas it proved to have an average length of about 11 cm. in the modern Canadian cranium. This represents an increase of 14·5%, and its vast effect in increasing the capacity of the frontal end of the skull can be best appreciated by studying Fig. 7, where it will be observed to add the strip of territory between the two curved dotted lines to the cranial capacity—a very substantial addition indeed, it may be

[1] *op. cit.*

[2] *Trans. and Proc. of the Nova Scotia Institute of Science*, 1917-18.

noted. I found 11 cm. to be the average length of the glabella-bregma chord recorded by Büchner[1] for modern European skulls (the same as my Canadian average), and I was much interested to find that on measuring it in Smith Woodward's first reproduction of the Piltdown cranium the chord was found to be 11·3 cm.[2] It is evident, then, that this chord has remained almost stationary in length since the time of Piltdown man. Moreover it is interesting to note that the chord length in such an ancient type as Cro-magnon man reached the high total of 12·3 cm. according to the measurements of Schwalbe[3] and Klaatsch,[4] which was thus decidedly better than the average of modern white races. It will be noted from a study of Fig. 7 that there is a profound difference between the curvature of the frontal cranial arc in the Java skull, and those of the Piltdown and modern skulls. In *Pithecanthropus* the curvature is shown to be divided up very definitely by the chord into two parts, termed by Schwalbe[5] the glabellar and cerebral portions, the extent of the latter being more than twice that of the former. The maximum distance of the cerebral portion of the arc from the chord in the Java skull was estimated by Klaatsch[4] as 7 mm. (the line AC). In the Piltdown and modern crania the glabellar part has become merged into the cerebral portion to a marked degree, the maximum distance between the arc and the chord *in both the Piltdown and the modern skull* (the lines AC) having increased to 25 mm. that is to say three and one half times the distance. When one considers the concomitant expansion that has been taking place on each side of the mesial plane, it will be recognized that the result is a very considerable further addition to the capacity of the frontal region of the cranium. It is moreover interesting to compare the above maximum distances with those that were found by the writer[6] in two Melanesian skulls where the measurements were 13·5 and 14 mm., which it may be noted are little more than half of those in the Piltdown and modern crania. Contrast these results still further with 18·8 and 19·6 mm. which were the

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[1] Proc. Royal Soc. Edin. Vol. XXXIV, 1913-14.

[2] The measurements of the various chords of the Piltdown model will have to be accepted as approximate owing to the difficulty in determining the exact positions of the Bregma and Lambda. Fortunately, however, this drawback does not detract from the main conclusions, that all the cranial curvatures and chords of the Piltdown skull were found without exception to be within the range of vaiiation of these for the modern European type of skull.

[3] *Zeitschrift für Morph, und Anthrop.*, May, 1906.

[4] *Ergebrisse der Anat. und Entwick.* (M. & B.). Vol. XII, 1903.

[5] *Der Neanderthalschädel,* Bonner Jahrbücher, 1901.

[6] *op. cit.*

figures found by Büchner[1] in aboriginal Australian and Tasmanian skulls. From these varying distances one can readily appreciate step by step the evolution of the frontal cranial arc from the lowest types of both modern and fossil hominidæ. In constructing Fig. 7, I was fortunate enough to secure a modern European type of skull with practically the same length of glabella-bregma chord (11·5 and 11·3 cm.) and the same maximum distance between the frontal cranial arc and the chord (25 mm.) as those of the Piltdown cranium, but with a bregmatic angle of 55° (as against 50°). It will be noticed in this figure that if the Piltdown cranial arc were to be swung upwards by increasing the size of the bregmatic angle to 55°, the area GaB′ would almost exactly coincide with the area GaB of the modern skull except in the region of the superciliary ridges. That is to say, if the bregmatic angle of the Piltdown skull had been a little greater the slope of the forehead would have almost exactly corresponded to that of the average modern European type. This is quite a remarkable fact when considered in conjunction with the admittedly great antiquity of Piltdown man, and shows evidently that the evolution of the frontal cranial arc as such has remained practically stationary since his time; the extra amount of uplifting necessary to produce the modern orthognathous type of forehead being effected by increasing the size of the bregmatic angle. It should of course be noted that the description of this expansion has so far had reference entirely to the mesial plane of the cranium, but it may be noted in passing that the front view of the reconstructed Piltdown frontal bone[2] is quite within the range of variation of this bone in the modern European type of skull, this statement applying with equal force to the configuration imparted by the modeller to the supraorbital arches. It is unfortunate that the forehead of the Piltdown cranium is mostly reconstruction with the exception of portions near the right and left margins, for it is certainly difficult to accept the view that a skull with an amount of frontal development far above that of many modern races could lay claim to the low type of jaw accredited to it. The writer is therefore inclined to support the recent opinion of Miller[3] who states that the characters of the Piltdown jaw are such that it could not have belonged to the skull but to a new species of anthropoid ape named by him *Pan vetus*. It was particularly unfortunate that no traces of the Piltdown superior maxillæ were found, as their configuration would have cleared up many difficult problems, especially those

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[1] *op. cit:*

[2] *op. cit.*, Pl. XVIII. 2.

[3] Smithsonian Institution, Washington, Nov., 1915.

associated with the exact type of modelling of the lower jaw, and the relation of the upper and lower dental arches to one another.

On measuring the bregma-lambda chord in the Piltdown skull I found it to be 11·3 cm., which is practically the same as that of modern white races (See Fig. 8). I calculated the maximum distance of this from the parietal arc to be 22 mm. which in its turn closely corresponds to the measurement in modern European skulls. Both arc and chord exhibited greater lengths than those found by Büchner[1] in aboriginal Australian and Tasmanian crania.

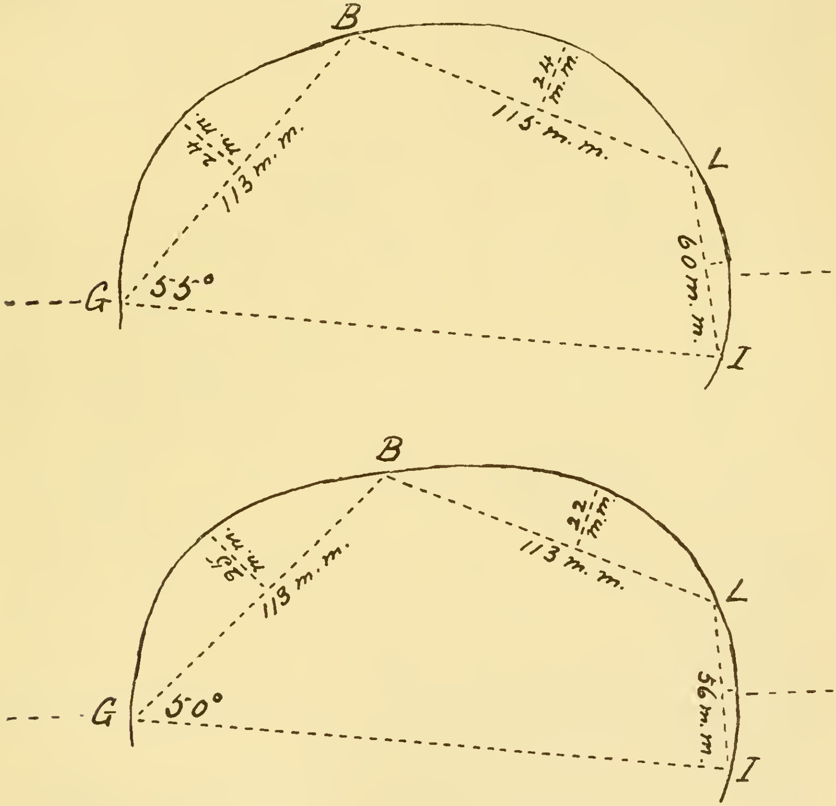

FIG. 8.—Shows *below* the Piltdown outline and *above* a modern European cranial outline, both drawn to scale on the same length of glabella-inion line. It would be difficult to distinguish them, apart from the size of the bregmatic angle. This Fig. shows that the frontal cranial arc and chord, the parietal cranial arc and chord and the lambda-inion curvature and chord are not only within the range of variation but are practically the same as those of the modern European type of skull.

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[1] *op. cit.*

The examination of the Piltdown lambda-inion curvature and chord displayed a similar result. The chord, I calculated to be about 56 mm. and its maximum distance from the lambda-inion arc to be 7 mm., both of which are well within the range of variation for the crania of the higher races of modern mankind. Fig. 8 has been devised to render this point more convincing, and at the same time represent it in a graphic manner. A modern Canadian skull of the same glabella-inion length as the Piltdown specimen, namely 190 mm., was chosen in order to render the comparison more striking. On examining this figure it is indeed almost impossible to determine which of the two outlines represents the modern skull. The only essential difference between the two is that the bregmatic angle in the modern cranium is a little greater, namely fifty-five. Otherwise the configuration of the two is wonderfully alike. Note that the frontal, parietal and occipital arcs and chords very closely correspond to one another.

Much valuable information regarding the evolution of the frontal cranial arc was found to be gained from a comparative study of it in the highest and lowest races of modern hominidæ, as illustrated in Fig. 9. I chose a Melanesian skull as it represented one of the lowest types I have ever had the privilege of examining.[1] Its bregmatic angle was fifty-five, and I chose for comparison with it a European type of cranium possessing the same size of angle, and the same length of glabella-bregma chord so as to render the effect more striking. In the latter the maximum distance of the glabella-bregma arc from the chord at approximately its centre was 24 mm. In the case of the Melanesian skull the maximum distance was only 14 mm. which was found to be at a point about two-thirds of the way from the glabella to the bregma. These two curves make a rather effective contrast in Fig. 9. It will be noted that the area included between the Melanesian arc and chord is only about one-half of that included between these in the European specimen. In other words the Melanesian frontal arc is only half "filled out," and it may be further observed that the filling out process has so far mainly affected the upper half of the frontal arc. Another significant fact demonstrated in Fig. 9, is that the forcing outwards of the frontal arc by the phylogenetic frontal lobes of the brain apparently begins at the bregmatic end and descends in a sort of undulatory wave-like movement towards the glabellar end which is last involved. I may state, however, that I found a Melanesian skull in which the main bulging was about the centre of the frontal arc. Still the chief effect appears to commence from above; for most of the skulls that I have examined certainly conveyed that

[1] *op. cit.*

impression. This brings out an important fact often lost sight of by craniologists and it is this, that the growth of the brain must always be considered along with that of the cranium; for the two go hand in hand, and cannot be divorced from one another. Thus the growth and expansion of the skull, as recorded above, both tell us that the frontal lobes of the brain are amongst the last parts of that organ to complete their evolutionary history.

It is evident, then, that even the races of modern hominidæ can furnish us with useful information regarding the evolution of the frontal cranial arc. One can go further and say that a comparative study of the highest and lowest types of modern man yields more

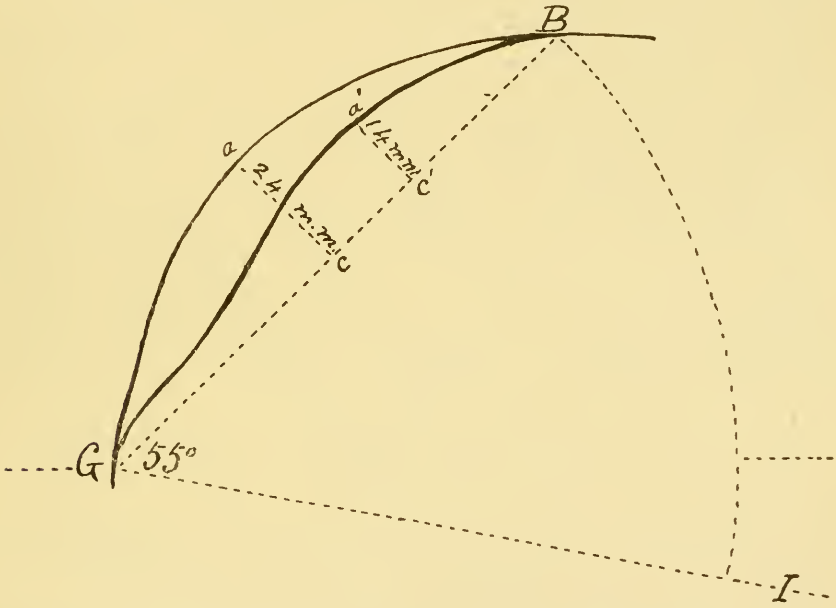

FIG. 9.—Is a comparative study of a Melanesian and a European frontal cranial arc. It will be noted that the area included between the Melanesian chord and arc is only about one half of that included between these in the European specimen. This Fig. seems to suggest that the forcing outwards of the frontal arc by the phylogenetic frontal lobes of the brain apparently begins at the bregmatic end and descends in a sort of undulatory wave-like movement towards the glabellar end which is last involved.

valuable knowledge regarding the evolution of the cranial roof than the Piltdown specimen, more particularly with reference to the main direction in which the evolutionary paths of both the brain and skull have chosen to go. A study of the bregmatic angle, the frontal, parietal and occipital chords and arcs further proves to us that the evolution of these has been practically stationary since the time of Piltdown man, who thus must have been the ancestral type for the higher races of mankind, as previously mentioned in Section II, for it has just been shown that many races of modern man still exist, where all these cranial measurements are without exception found to compare unfavourably (in the frontal segment particularly) with the stage of evolutionary progress attained by him.

Some interesting facts can be elicited by making a comparative study of the Cro-magnon and Piltdown crania. In the first place the Cro-magnon skull belonged to a very tall man, while the Piltdown specimen is believed to have been that of a female. Therefore the various cranial curvatures and chords and the bregmatic angle are a little larger in the former, as would be expected. Nevertheless the slope of the frontal region corresponds very closely in the two instances, and that is a point of very far reaching importance. Indeed it would be easy to convince oneself that the two outlines as shown in Fig. 6 might perhaps have belonged to the same race, for they would be within the range of cranial variation. Now it is fortunate that the facial portion of the Cro-magnon skull and the mandible were so well preserved, for they exhibit a markedly orthognathous modern type, as was to be expected in a specimen showing such a highly evolved frontal cranial arc. It is therefore obvious that this fact still further increases our difficulty in accepting the view that the Piltdown jaw belongs to the Piltdown cranium.

IV. The Evolution of the Jaws and the Facial Portion of the Skull

The dental index takes cognisance only of the space occupied by the molar and premolar teeth in the alveolar arch. It should be noted however, that as recent researches have shown, the area allotted to the incisors and canines is of the greatest morphological and evolutionary importance. Smith Woodward[1] has fully impressed us with this fact in the case of the fragmentary Piltdown jaw, for he points out very significantly that the relatively large space apparently allocated to the canines and incisors in that specimen was probably associated with an unusually large canine tooth, which as a consequence would partake of the characters of that of an ape, and thus project above the level of its fellows in the dental arch. This hypothesis was confirmed by the discovery a short time afterwards[2] of an ape-like canine tooth in the gravel near where the jaw was discovered. It is quite evident

[1] *op. cit.*

[2] *Quart. Jour. Geolog. Soc.*, London, 1914.

that this increased extent of the dental arch would have the important effect of making the upper and lower jaws very prominent, thus producing a marked degree of prognathism, and consequently a low type of skull. This is a very significant and indeed fundamental fact, for the great feature of the more highly evolved forms of the human skull is the relatively greater degree of development of its cranial portion when compared with the facial portion. In lower animals on the other hand the jaws are thrust forward in a prominent manner, the result being that the facial portion dominates the cranial portion to a marked degree. On elaborating this idea a little further it becomes evident that the shrinkage of the dental arcades has been of the utmost importance, has in fact been one of the great factors in producing the human type of skull. What proof have we that this shrinkage is going on? The reply is that there are two. In the first place the segment of the dental arch occupied by the canines and incisors is relatively much greater in the jaw of the ape, where there are, in addition, distinct gaps especially on each side of the canines. These spaces have become greatly reduced in the modern human skull when compared even with prehistoric skulls such as for example the Piltdown type. In the latter Smith Woodward[1] calculated the length of the alveolar arch in front of the molars to be 60 mm., as compared with an extent of 30 or 40 mm. in the modern human jaw, representing a diminution in the case of the latter to the remarkable extent of one-third or even one-half. Moreover, the extent of the canine-incisor segment is less in the higher types of modern hominidæ than in those more lowly. This crowding together of the teeth has been one of the strongest influences in guiding and controlling the evolution of the chin, as illustrated in Fig. 10, for it is obvious what the effect of the contraction of the dental arch would be if the lower border of the jaw were to remain relatively very slightly altered in length. The result would naturally be to cause a retraction of the alveolar border of the jaw, causing the teeth to become closely huddled together, and indeed tend to crowd out the molar series. Now the latter effect is just exactly what is happening at the present day; for it is granted on all sides that the third molars are gradually undergoing a process of devolution, and it has been prophesied that in future generations it will have vanished utterly. Three signs of this suppression are already in evidence. Firstly, a reduction in its size in the higher races of modern hominidæ when compared with the lower races, secondly, the very frequent reduction in the number of its cusps, and thirdly, the not uncommon fact that it may fail to develop or erupt altogether, even in the lowest races of modern mankind. In fact I recently

[1] *op. cit.*

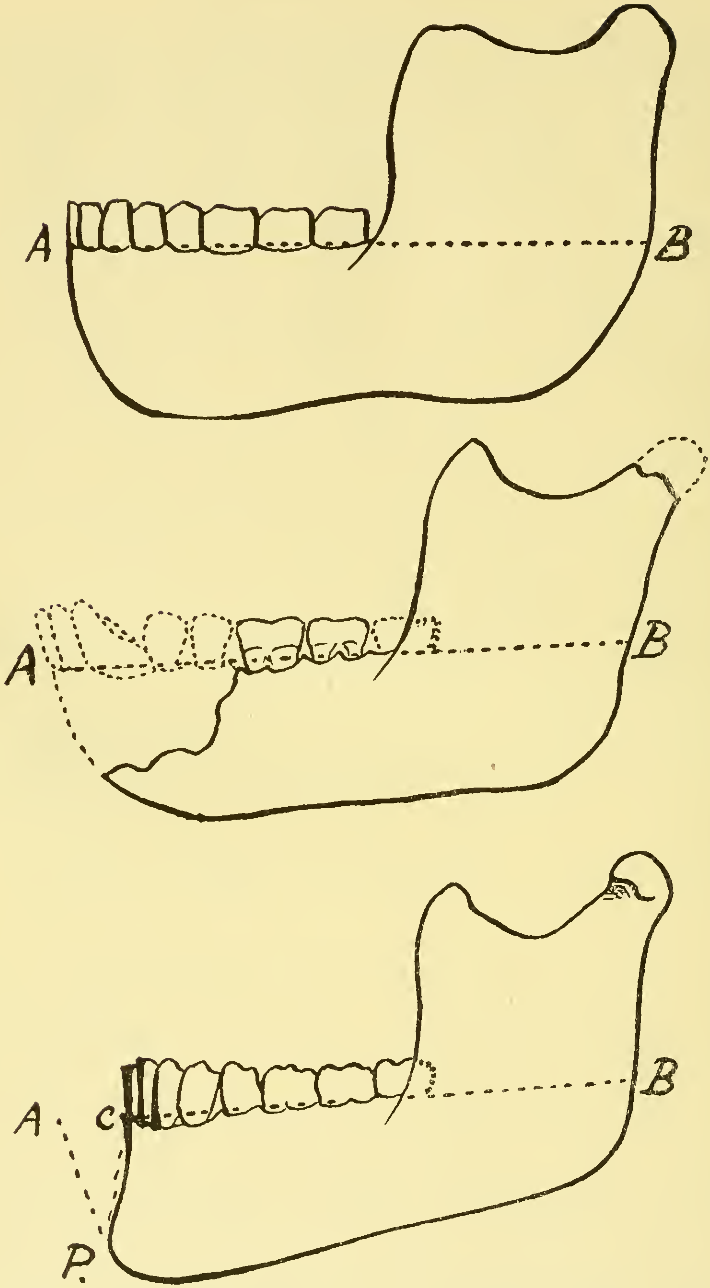

Fig. 10 —Shows the Heidelberg jaw (above), the Piltdown jaw (in the middle) and a modern jaw (below), all reduced to the same extent in size for purposes of comparison. The distance A B will be found to be exactly the same in the Heidelberg and Piltdown specimens. In the modern jaw this distance has become shrunken to the extent of the gap A C or the angle A P C, P being the Pogonion. It will be noticed that the distance along the line A B occupied by the teeth is exactly the same in the Heidelberg jaw and the modern jaw, whereas this distance is nearly half as much again in the Piltdown specimen.

recorded a Melanesian skull[1] in which the third molars of both the upper and lower jaws had utterly failed to develop. Moreover the dental index is instructive in this relationship for it demonstrates to us that even in the case of the molar-premolar series the space occupied by these teeth is likewise decidedly less in the higher races of modern mankind when compared with the lowest types—the aboriginal Australian, for example. The second great factor in producing the shrinkage of the dental arcade has been the reduction in the size of the individual teeth which has been going on progressively and consistently from the anthropoid stage, throughout the fossil hominidæ and the lowest types of modern hominidæ right up to the white races, where they reach their minimum size.

Fig. 10 has been devised to render these above points more effective. It shows the Heidelberg jaw,[2] the Piltdown jaw and a modern jaw, all reduced to two thirds their normal size. The line AB has been drawn along the alveolar margin in each case. I found on measuring this distance in the Heidelberg and Piltdown specimens that it was *exactly the same in both.* In the modern jaw, on the other hand, I ascertained that this distance had become shrunken to the extent of the gap AC which is 11 per cent of the distance AB, and this, it may be noted, is a very considerable amount indeed. One might measure the amount of this contraction by the angle APC (P being the pogonion) which was found to be 30·5 degrees, thus representing a substantial degree of movement backwards of the point C. Another instructive fact gleaned from Fig. 10 was that the distance along the line AB occupied by the teeth was exactly the same in the Heidelberg jaw and the modern jaw, whereas this distance was found to be nearly half as much again in the Piltdown specimen. Of course in measuring this space one would have to make allowance to a considerable extent for the inward curvature of the mesial portion of the alveolar border. Apart from this drawback the figure yields some striking points of comparison.

Some evolutionists have laid stress on the fact that the evolution of the chin in man has been intimately associated with the conferring of the gift of speech. Certainly some support is given to this statement by the well known fact that in some types of microcephalic idiot where the chin is very feebly developed (see Fig. 14), these unfortunate individuals are frequently incapable of the power of articulation. However, the explanations of this defect have not always been very definite or convincing. It has been suggested by other authorities that it may be due to some interference with the proper

[1] *op. cit.*

[2] See the elaborate memoir by Schötensack, published at Leipzig, 1908.

attachment or even some defect of the geniohyoglossus muscles. Smith Woodward[1] has, however, pointed out that Piltdown man who was a chinless individual probably had these muscles well developed. It would appear then that the growth and evolution or rather devolution of the teeth provide us with the most convincing evidence at present regarding the exact way in which the chin has been evolved. The effect which a well developed and shapely chin has upon the general configuration, the expression and the character of the human face is of course admitted on all sides.

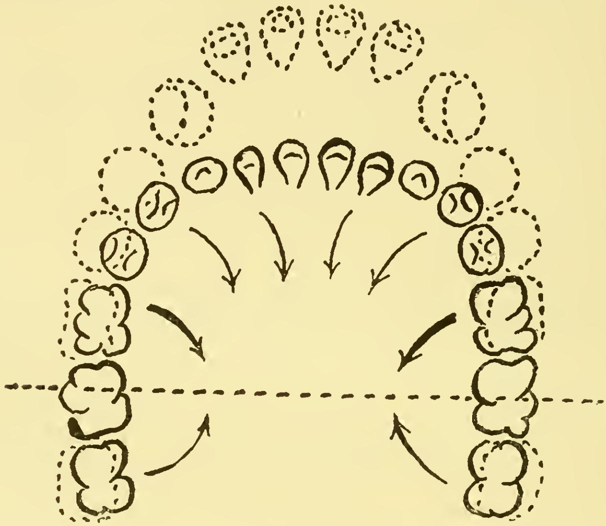

FIG. 11.—Shows a modern dental arch from the lower jaw superimposed upon the Piltdown dental arcade (shown dotted). It was first of all found that the average modern dental arch had to be slightly magnified so as to get any of the teeth to coincide. It was then ascertained that the second molars were the only ones that would thus coincide. The second molars thus appear to represent the fixed points from which the alteration in the curve of the dental arch has proceeded. The direction of displacement of the teeth in order to form the modern dental arch is indicated by the arrows.

It is interesting and also instructive to compare the lower dental arch of a modern European type of cranium with that of the Piltdown jaw. Fig. 11 has been devised for the purpose of representing this comparison in a more vivid manner. It will be noted that the dental arch of modern white races forms a parabola-like curve while the Piltdown specimen, shown in dotted outline, forms a curve which is decidedly U shaped, the latter being likewise the type of arch met with in the lowest races of modern hominidæ—for example the aboriginal

[1] *op. cit.*

Australian. In designing Fig. 11, it was first of all found that the average modern dental arch required to be slightly enlarged so as to get any of the teeth to coincide. It was then ascertained that the second molars were the only ones that would thus coincide with one another, all the other teeth being placed at gradually increasing distances from one another. The second molars thus appear to represent the fixed points from which the alteration in the curve of the dental arch has proceeded. All the teeth in front of these have been deliberately forced backwards and inwards, the amount of this movement becoming gradually greater as one proceeds in a forward direction, until it reaches its maximum in the case of the central incisors. The third molars even must have been very slightly forced inwards in this evolution process, as the figure indicates, though this does not occur in every case. The general effect of this movement of course has been to crowd the front teeth very closely together, but even then they could not have been accommodated in the restricted space left at their disposal unless there had been some concomitant reduction in their size. Now this has been definitely proved in the case of the canine tooth of the Piltdown jaw by Woodward and Dawson[1] who were fortunate enough after immense labour to discover a specimen of this a short time after the skull was unearthed. These observers have shown definitely that the canine tooth of the Piltdown jaw was decidedly larger than that of modern man, and was indeed quite ape-like, as mentioned above. Probably the incisors and premolars of the Piltdown jaw would have had to become reduced in size in a proportional manner, as Fig. 11 suggests. This fact must, however, be left for the future to prove, since a complete dental arch for the Piltdown type has yet to be discovered.

The preceding paragraph has dealt entirely with the effects of the teeth upon the evolution of the lower jaw. It is of course obvious that the dental arches of both the upper and lower jaws must undergo the same evolutionary process simultaneously, so that the "bite" of the individual may always remain the same at all stages. The same statement must apply with equal force, and in the same measure to the evolution of the jaws themselves.

The sphenomaxillary angle has proved a most useful angular measurement to illustrate the progress that has been made in the evolution of the orthognathous type of skull from the prognathous. This angle it may be mentioned is included between lines joining the Prosphenion to the Basion and the Prosthion.[2] In the orang-utan it

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[1] *op. cit.* This tooth proved to be the upper left canine.

[2] I have adopted Duckworth's (*op. cit.*) method of measuring this angle as I consider it preferable to that of Huxley.

was calculated to be 146 by Duckworth,[1] while in the gorilla, man's nearest relation amongst the anthropoid apes, the angle has become reduced to 125 as found by the same observer. In two Melanesian skulls recently described by the writer[2] it was calculated to be ninety-five and ninety-seven, while in white races it is about seventy-five, that is to say it has become reduced practically one half when compared with the skull of the orang, and about one fifth when compared with the low Melanesian type. Thus one is even able to record a very decided difference between the size of this angle in the higher and the lower races of modern mankind. This angular measurement appears to yield more satisfactory and more constant results than the Frankfort angle and also the angles devised by Camper, Welcker and others. A comparative study of Figs. 12 and 13 shows the effect of the reduction of this angle upon the configuration of the facial portion of the skull. It will be observed that both limbs of the angle have partaken in this approximation, though of course the prosphenion-prosthion line has been affected to a more marked degree. For example in the chimpanzee cranium the prosphenion-basion line is practically horizontal, while in modern man it is very definitely directed downwards and backwards. The most feasible explanation of this profound alteration that suggests itself to the writer is, that the cerebellum, pons and medulla have been as it were forced bodily downwards into the posterior cranial fossa evidently by the backward growth of the occipital lobes of the cerebrum. One important proof of this downward thrust is that in lower animals the plane of attachment of the tentorium cerebelli is very oblique, while in man it is practically horizontal. This appears to indicate that though the main direction of growth of the phylogenetic brain has been upwards, still there are evidences such as this which show that there has been some development in a downward direction as well, resulting of course in the formation of the middle and posterior cranial fossæ which are such marked features of the human cranium. The spheno-ethmoidal angle has been devised[3] to show this sinking of the middle and posterior cranial fossæ during the evolution of the human skull, and has been found to yield very interesting and consistent as well as progressive results (see Figs. 12 and 13). For example, the whole of the skull base in front of the foramen magnum is almost in the same plane in some of the apes, e.g., the chimpanzee and the orang, whereas in the higher hominidæ the angle has sunk from 180 down to 140 degrees or even less. Duck-

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[1] *op. cit.*

[2] *op. cit.*

[3] Huxley apparently first introduced this angle. See the *Jour. of Anat. and Phys.* Vol. I.

Explanation of Plate.

Figs. 12 and 13.—Have been designed to show how important an index of prognathism is represented by the size of the spheno-maxillary angle. In Fig. 12 are shown tracings from mesial sections of the skulls of the orang (above) and the gorilla (below). In the former this angle (B Pr P) was found to be 150°, whereas in the gorilla it measured 123°, thus considerably reducing the degree of prognathism. The anterior limb of the angle (Pr P) gives one the impression of a pendulum which is gradually swinging backwards. The dotted line inside the crania indicates the approximate position of the tentorium cerebelli. Note that in the skull of the orang the cranial base lies in one continuous horizontal plane.

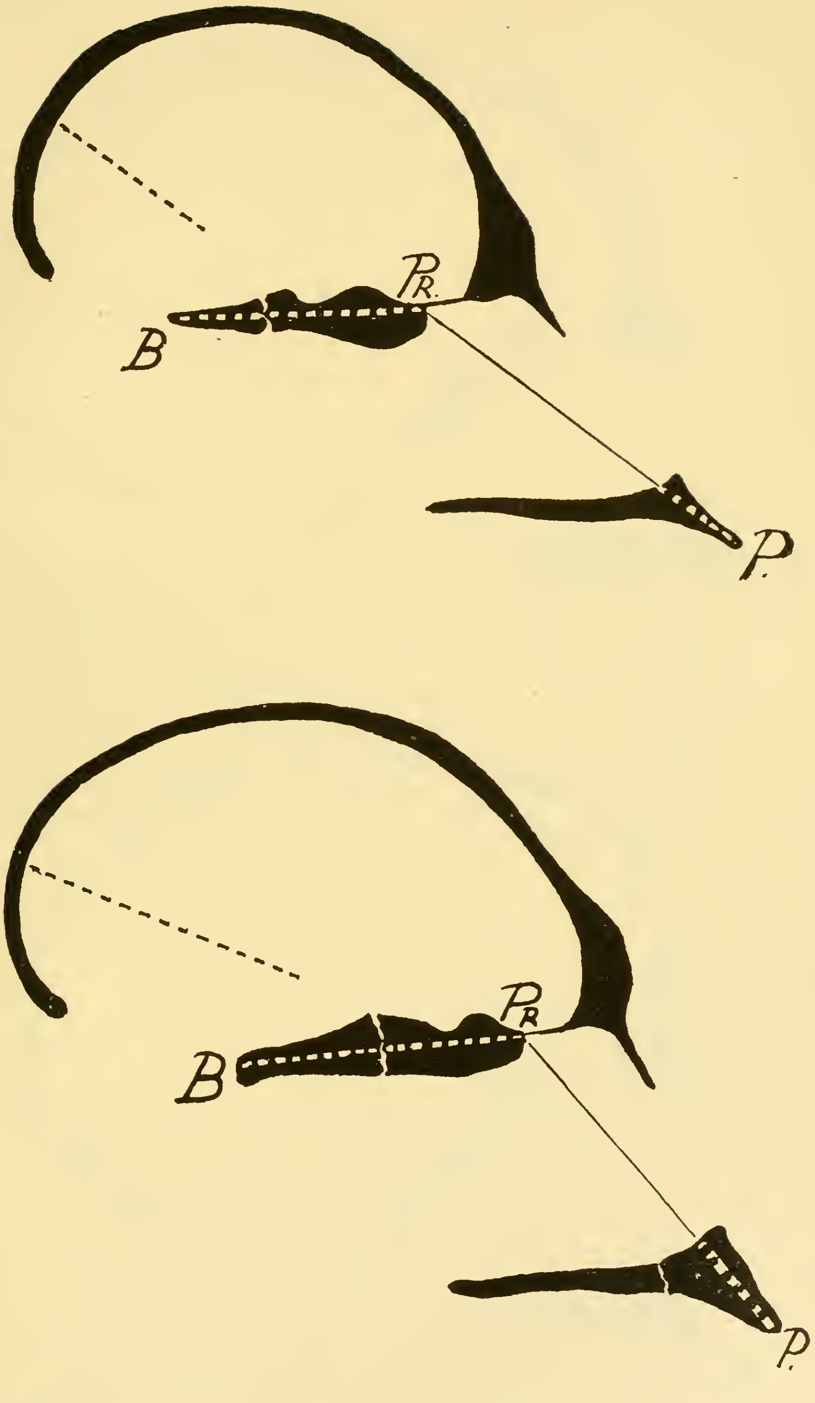

FIGURE 12.

Sec. IV, Sig. 13

Explanation of Plate.

Fig. 13.—Shows tracings of mesial sections of an aboriginal Australian skull (above) and a modern European skull (below), in order to demonstrate how much the spheno-maxillary angle has become reduced in size in order to produce the orthognathous type of skull. In the Australian skull this angle was found to be 93°, and in the modern European type 76°, the former thus representing a half way stage, so far as this angle was concerned, between the anthropoids and the white races of modern mankind. Note that both limbs of the angle have been affected, and that the anterior limb shows a further swing backwards of the pendulum (see Fig. 12). The spheno-ethmoidal angle is indicated by N Pr. B. Note how it also becomes reduced in size in the white races.

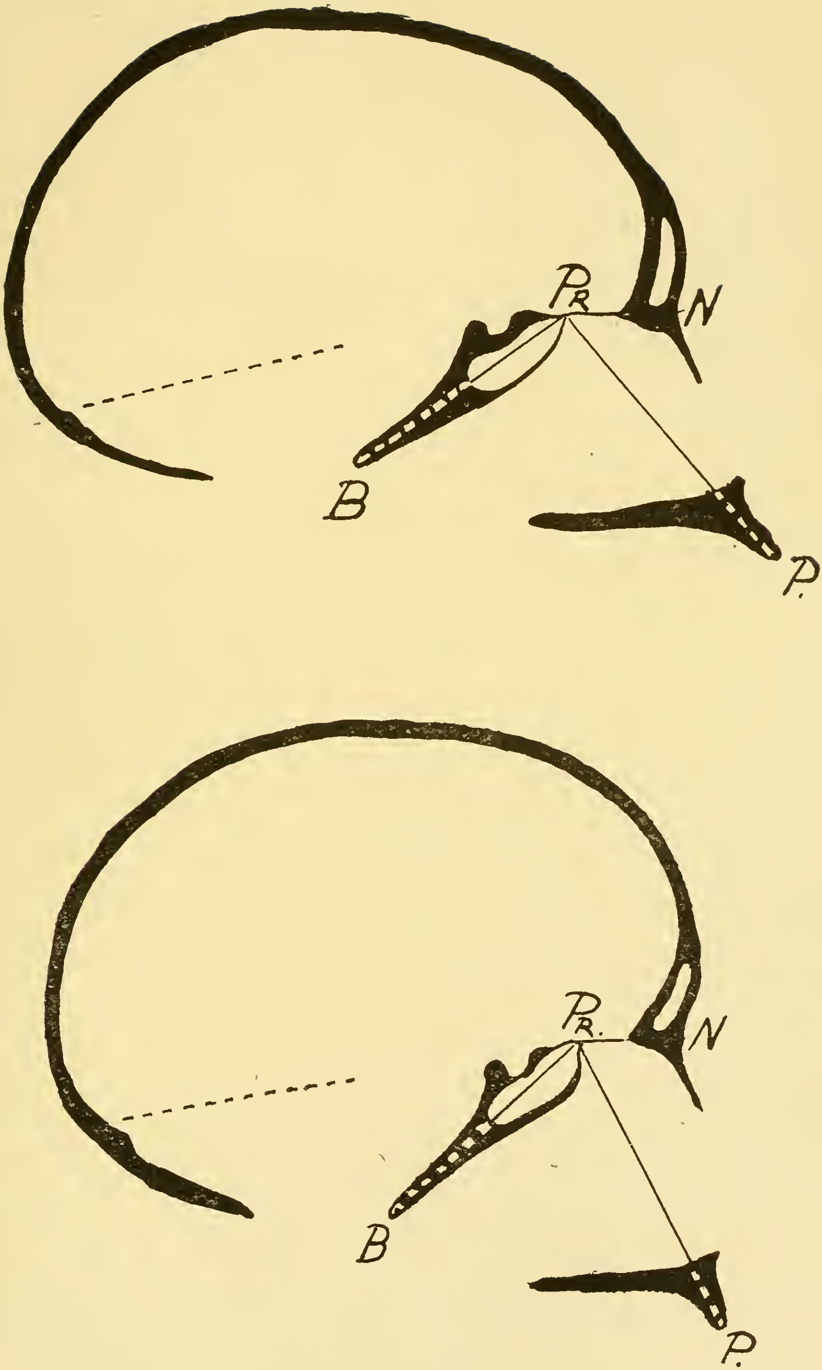

FIGURE 13.

FIG. 14 is a photograph of a model of the head of a microcephalic idiot (reduced $\frac{1}{3}$). Note that the upper and lower portions of the face markedly converge towards the tip of the prominent beak-like nose, thus imparting a characteristic bird-like appearance to the countenance. Observe also the malformed ear and how far back on the side of the head it is situated. The striking feature is, however, the excessive degree of retraction of the jaws and chin due to the defective dentition. For this condition I have proposed the use of the term "retrognathism."

worth[1] records 138 as the average in two European skulls examined by him. The writer[2] recently reported 151 as the measurement of this angle in two New Hebridean crania, which might thus be said to represent the intermediate evolutionary phase between the anthropoids and the white races of modern mankind.

V. Microcephaly

The evolution theory possesses one very effective means of support in the shape of the doctrine of reversion. That is to say, if man has a definite ancestral tree, one ought to be able to prove the existence of this ancestry by occasional reversions or "throwbacks" to one or other of the evolutionary stages situated lower down the stem. In this connection, the writer has been for many years interested in the extraordinary condition termed microcephaly.[3] Now there are two diametrically opposed theories in existence regarding the causation of this phenomenon. One of these is that it is due to premature synostosis of the sutures of the skull, which accordingly imprisons the growing brain, thus preventing any further expansion in the size of that organ. The other theory is that the fault lies entirely with the brain, which simply ceases to develop beyond a certain evolutionary stage. The protective skull has then to follow suit, and consequently becomes synostosed. After a careful study of all the facts relative to these theories, and they are too many to recount in this brief space, the writer is convinced that the second theory is the correct one. Thus one fact already strongly emphasised by the writer in Section III is again brought into prominence and it is this, that one cannot study the evolution of the skull and the brain apart from one another. After all, the cranium is merely the protective capsule round the brain exactly in the same way that all other viscera throughout the body possess their investing sheaths. As a result it is reasonable to expect that if the contents expand, then the capsule must accommodate itself to this expansion accordingly. Thus the main support to the second theory, which proves its accuracy, is that it is founded on sound evolutionary and embryological principles. Moreover, Sollier[4] has clinched the matter by demonstrating that the brain in microcephaly exhibits a very primitive arrangement of its sulci and convolutions. Therefore, microcephaly is not a pathological condition. It is a normal occurrence, one of the occasional hints in fact,

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[1] *op. cit.*

[2] *op. cit.*

[3] See *The Canadian Magazine*, Oct., 1917.

[4] *Twentieth Century Practice of Medicine.* Vol. XII, p. 275.

which evolutionists tell us to expect now and then, as reminders of our early ancestry.

The writer was fortunate enough to secure a model of the head of a microcephalic idiot taken immediately after death. This is represented in Fig. 14. There are a few preliminary observations about this which arrest the attention. Note first of all that the upper and lower portions of the face markedly converge towards the tip of the prominent beak-like nose, thus imparting a characteristic bird-like appearance to the countenance. It is important to notice how feebly developed the chin is. In a previous paper[1] I have already referred to the significance of this in association with the gift of speech, for most of these microcephalic idiots are devoid of the power of articulation.

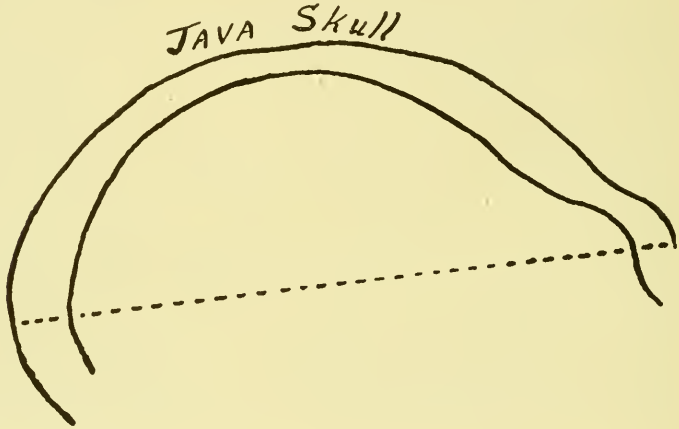

FIG. 15. Shows the comparison between the outline of the microcephalic head illustrated in Fig. 14 and the outline of the Java skull. The two are drawn to the same scale, the reduction being to the extent of one half in each case. Note that the outline of the microcephalic head very intimately corresponds to, though it is very decidedly less than that of the Java calvaria. This Fig. shows that there can actually be found to exist at the present day reversions of the skull of man back to the stage of the Java man-ape, and not only that, but even comparing unfavourably both in dimensions and capacity with his cranium. This fact would suggest that *Pithecanthropus* is an ancestral stage in the evolution of man.

Note finally that the ear is markedly malformed, and is situated relatively far back on the side of the head. The most striking fact, however, is the extraordinary lack of frontal development. To render this point even more emphatic I devised Fig. 15 which shows the comparison between the outline of this head and the outline of the Java

[1] *Canadian Magazine*, Oct., 1917.

skull. The two are drawn to the same scale, the reduction being to the extent of one half in each case. Note in the figure that the outline of the microcephalic head very intimately corresponds to, though it is very decidedly less than, that of the Java calvaria, so that it actually fits inside the latter, being almost equidistant from it at nearly every point. The maximum lengths were 18·1 cm. and 14·65 cm. It should be noted moreover that at least 5 mm. would have to be taken off the measurement of the model in front and behind in order to allow for the thinkness of the scalp, and thus procure the approximate glabella-inion length of the microcephalic skull which would then work out at about 13·65 cm. It would therefore appear from the foregoing facts that there can actually be found to exist at the present day reversions of the modern human skull back to the stage of the Java man-ape, and not only that, but even comparing unfavourably both in dimensions and in capacity with his cranium. According to the Darwinian theory this fact would contribute its testimony in definitely fixing *Pithecanthropus erectus* as an ancestral stage in the evolution of man, and would thus assist in settling the great controversy over the exact status of Java man, which has raged since the discovery of his fossil remains twenty-five years ago. It is of interest to compare other measurements in these two specimens. For instance the maximum breadth of the microcephalic head was 11·2 cm. which in its turn compared unfavourably with the maximum parietal breadth of the Java calvaria, the latter being 13·3 c.m. The minimum post-orbital breadth of the microcephalic head was 9·4 cm., but if due allowance were to be made for the thickness of the overlying soft parts, the minimum post-orbital breadth of the skull itself must also have been rather less than that of the Java calvaria which was 8·7 cm.

A study of the jaws and the dentition in microcephaly will be found to yield most valuable information regarding their evolution. The teeth in this condition often present the most primitive characters, so much so indeed in many cases that it is difficult to recognise the different kinds and thus ascertain the dental formula. Moreover, in many of these individuals some of the teeth never develop at all. The effect of this defective dentition is reflected in the correspondingly feeble degree of development of the jaws, which are consequently both contracted and retracted, thus imparting the progressive backward slope of the face from the nose downwards towards the chin, and at the same time rendering the malar bones unduly prominent. I should have liked to have studied the spheno-maxillary angle in the specimen represented in Fig. 14. It could not have been more than 60°, an excessively low figure indeed.

One will now be able to appreciate what these facts all signify. They indicate very emphatically that the dentition is the chief factor in determining the configuration and the modelling of the jaws. Thus it comes to pass that in lower animals and in the lower races of modern mankind who possess a macrodont dentition the jaws are markedly prognathous. Further, in the white races who possess, on the other hand, a microdont dentition, the jaws become retracted and orthognathous, the anterior limb of the spheno-maxillary angle (see Figs. 12 and 13) meanwhile having been swinging steadily backwards pendulum-like from a measurement of 150° or so in certain of the anthropoid apes to 75°, a reduction of exactly one half. A further swing backwards is found in microcephaly with its associated deficiency of the dentition, thus still further retracting the jaws and reducing the size of the spheno-maxillary angle. For this latter condition I propose to coin a new word namely, "retrognathism" which is legitimate as it accords, and falls into line, with the two previous terms. I cannot find any reference to the existence of this word in the American Illustrated Medical Dictionary, and must therefore offer some apology for inflicting one more word on the English language.

Critics may ask, "If the skull in microcephaly represents a reversion to the stage of Java-man, why do not the jaws also consistently exhibit a 'throwback' to the same type by becoming prognathous, as his jaws probably were?" The most satisfactory answer to that is secured by again studying the question of cause and effect. In the case of the microcephalic skull the brain was the primary *cause* of the condition, the *effect* being shown by a concomitant stoppage in the growth of the investing cranial wall. The same principle holds good in the case of the jaws in microcephaly. The superior and inferior maxillæ, in the early stages of their ossification, it may be recollected, are fragile bony shells enclosing the dental germs. For example, the lower jaw at birth is simply a thin trough of bone enclosing the developing teeth. The *cause* in this case is a deficiency or actual total failure of development of the dental germs, the *effect* being that the investing jaws likewise fail to execute their normal growth and evolution.

VI. Summary and Main Conclusions.

1. The minimum post-frontal diameter of the cranium of modern white races shows on the average an increase of about 23%, while the maximum parietal breadth exhibits an increase of merely 11% above the corresponding dimensions of the skull of the Java man-ape.

2. The evolution of the minimum post-frontal diameter and the maximum parietal breadth has been practically stationary since the

time of Piltdown man. It would therefore appear that one must look in other directions for an expansion of the skull that is at all commensurate with the high degree of cerebral evolution attained in the higher races of modern mankind.

3. The minimum post-orbital diameter, the maximum parietal breadth and the fronto-parietal index of the Piltdown cranium are all consistently within the range of variation of these in the modern European type of skull.

4. In studying the various cranial outlines in this investigation it was found most convenient to reduce them all to the same standard glabella-inion line. For this purpose the writer has devised what he terms the "ordinate method" of reconstruction. A study of the standardised cranial outlines thus obtained was found to yield very instructive results.

5. On comparing the outline of the Piltdown skull with that of the Neanderthal specimen on the same standardised glabella-inion line, it was found that the latter outline was situated very much below the other. Now the geological strata in which the Piltdown remains were found indicated that they were much more ancient than the Neanderthal. Therefore it is clear that the cranial outline of Neanderthal man is chronologically in the wrong position, a fact which helps to prove that he was a degenerate off-shoot from the main evolutionary stem, and probably became extinct.

6. If the Neanderthal or Mousterian type of skull must not be utilised as a stage in the main path of evolutionary progress, it is apparent that there is a vast gap between the stages represented by the Java man-ape and Piltdown man which still requires to be filled up. Thus a very important "link," in the evolution of the brain and skull is really still "missing." In fact that link in the chain connecting the Java man-ape with *Homo sapiens* has still to be forged, in order to prove that *Pithecanthropus erectus* is really an ancestral type for modern man.

7. Piltdown man and Cro-magnon man, so far as their skulls are concerned, are (in striking contrast to Neanderthal man) in their correct relative positions on the main evolutionary stem, but their cranial outlines are close up to that of the modern European type of skull, a fact which still further emphasises the extent of the great hiatus between them and the cranial outline of *Pithecanthropus erectus*.

8. The evolution of the frontal cranial arc, as such, has remained practically stationary since the time of Piltdown man; the extra amount of uplifting necessary to produce the modern orthognathous

type of forehead having been effected by increasing the size of the bregmatic angle.

9. The frontal cranial arc and chord, the parietal cranial arc and chord and the lambda-inion curvature and chord of the Piltdown cranium are not only within the range of variation, but are practically the same as those of the modern European type of skull. In fact all the linear and angular measurements of the Piltdown cranium are practically the same as those of the modern European skull with the exception of the bregmatic angle; and I consider that Smith Woodward has underestimated the size of this as well as the cranial capacity in his first reconstruction.

10. It is evident, then, that Piltdown man must have been the ancestral type for the higher races of mankind, because there are existing races of modern man in whom all the cranial measurements, both linear and angular, are without exception found to compare unfavourably (in the frontal segment particularly) with the stage of evolutionary progress attained by him.

11. A comparative study of the highest and lowest types of modern man will be found to yield more valuable knowledge regarding the evolution of the cranial roof than the Piltdown specimen, more particularly with reference to the main direction in which the evolutionary paths of both the brain and skull have chosen to go.

12. It is difficult to accept the view that the Piltdown skull which possesses an amount of frontal development far above that of many modern races could lay claim to the low type of jaw accredited to it. The writer is therefore inclined to support the recent opinion of Miller who states that the characters of the jaw are such that it could not have belonged to the skull but to a new species of anthropoid ape named by him *Pan vetus*.

13. The shrinkage of the dental arcades and the reduction in the size of the individual teeth have been the great factors in modelling the facial portion of the human skull.

14. In superimposing an average modern European type of lower dental arch on the Piltdown dental arch it was found that the former had in the first place to be enlarged in order to get any of the teeth to coincide. It was then ascertained that the second molars were the only ones that would thus coincide, all the other teeth being placed at gradually increasing distances from one another. The second molars thus appear to represent the fixed points from which the alteration in the curve of the dental arch has proceeded.

15. The teeth in microcephaly often present the most primitive characters, so much so indeed in many cases that it is difficult to

recognise the dental formula. The effect of this defective dentition is reflected in the correspondingly feeble degree of development of the jaws which are consequently both contracted and retracted. For this condition the writer has suggested the term "retrognathism."

16. The cranial outline in microcephaly sometimes shows a reversion back to the stage of the Java man-ape, and not only that, but may even compare unfavourably both in dimensions and capacity with his cranium. According to the Darwinian theory this fact would contribute its testimony in fixing *Pithecanthropus erectus* as an ancestral stage in the evolution of man,

17. As this research progressed it became increasingly evident that the present paper would have to be regarded as a preliminary communication. It is therefore intended to treat each of the five sections separately, and more exhaustively in subsequent memoirs in order to be able to deal effectively with the subjects and do anything like full justice to the vast issues that are involved.

On Ferrierite, a New Zeolitic Mineral, from British Columbia; with Notes on some other Canadian Minerals

By R. P. D. GRAHAM

Presented by Frank D. Adams, D.Sc., F.R.S.C.

(Read May Meeting, 1918)

FERRIERITE, A NEW ZEOLITIC MINERAL FROM THE NORTH SHORE OF KAMLOOPS LAKE, BRITISH COLUMBIA

During the summer of 1917, Dr. W. F. Ferrier collected some specimens of a soft white mineral, in the form of spherical aggregates of radiated blades, and having much the appearance and associations of a zeolite. The mineral, however, presents certain features which led Dr. Ferrier to believe that it might be a new species, but being at that time engaged in field work for the Munition Resources Commission, he was, through lack of facilities, unable to proceed further with its identification. Specimens were accordingly sent to the University of Alberta, and a determination of the blow-pipe characters by Dr. J. A. Allan, together with a partial analysis made by Mr. Kelso, only tended to confirm Dr. Ferrier's surmise. More and better specimens were subsequently obtained, and, early in the present year, Dr. Ferrier, with the permission of the Commission, placed this material in the hands of the writer for examination. This examination has now been completed, and the result, detailed below, definitely establishes the mineral as a new species. The writer has great pleasure in naming the mineral *ferrierite*, in honour of Dr. Ferrier, the well known mineralogist and mining engineer, formerly of the Canadian Geological Survey.

PLACE AND MODE OF OCCURRENCE

The specimens were collected in a cut along the Canadian Northern Railway, about half a mile west of Mile Post 17, on the north shore of Kamloops Lake, British Columbia. The north shore of the lake is here underlain by rocks of the Kamloops Volcanic Group (lower Miocene), which have a widespread distribution throughout this district. This volcanic group consists mainly of surface lava flows, tuff beds, and agglomerate accumulations, but as a result of erosion, it is now represented chiefly by the lava flows, which are predominantly basaltic. The basalt passes transitionally into vesicular and amygdaloidal types, the amygdules being in many places well banded but pale coloured chalcedony. Zeolites, a green chloritic mineral, quartz, and calcite (the latter intergrown with chalcedony) also fill vesicles.[1]

In the railway cut where the ferrierite was found, the rock is a massive olivine-basalt. Where fresh, this rock is nearly black in colour, and fine grained, but with a distinctly porphyritic structure. A thin section of a very fresh specimen was examined and showed well developed phenocrysts of plagioclase feldspar, pale brownish-green pyroxene, and colourless olivine, the latter only very slightly altered to serpentine. A fair number of grains of magnetite are present, and all these minerals are distributed through a finely crystalline ground-mass, with no apparent tendency towards a fluidal arrangement.

Fractures traversing the basalt are filled with seams, or veins, of pale coloured, translucent chalcedony, and in the vicinity of these the rock is very much decomposed, soft, and crumbling. The seams vary from mere films to veins several inches in width, but they are usually quite narrow. The ferrierite occurs within the chalcedony, which completely or partially encloses the spherical aggregates of the mineral. Subsequently to the formation of the chalcedony and ferrierite, white coarsely crystalline calcite has been deposited in the veins. Many of the ferrierite aggregates are thus partially enclosed in calcite, and by dissolving the latter in dilute acid, their surfaces may be freed, when the outer ends of the crystals are found to exhibit terminal faces. In the best specimens collected, the spheres have a radius of three-eighths of an inch, but for the most part they are smaller than this.

In addition to the new mineral, Dr. Ferrier reports the occurrence at this locality of agate, and also chalcedony geodes lined with crystals of amethyst, as well as with ordinary quartz. Finely developed flat rhombohedral crystals of calcite are, in some cases, implanted on the quartz, and in one specimen crystals of the latter mineral are coated with tufts of minute rutile crystals. These geodes are sometimes over six inches in diameter. Some of the smaller ones, measuring two or three inches in diameter, are completely filled with coarsely crystalline calcite, with a comparatively narrow marginal zone of banded pale chalcedony, between which and the calcite there may be some quartz.

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[1] See Summary Report, Geological Survey, 1912, p. 142: Geology of the Thompson River Valley below Kamloops Lake, B.C., by Chas. W. Drysdale.

Radiated groups of ferrierite crystals are sometimes seen on the outer surface of such specimens, embedded in the chalcedony.

Crystallography and General Physical Properties

Individual crystals of ferrierite have the form of very thin blades, which are rectangular in outline, but isolated crystals of this type are seldom seen. In the specimens, these blades are stacked upon one another in nearly parallel position, after the manner of the leaves in a closed fan; a large number of such piles of slightly divergent blades radiate from a common centre, and give rise to the spherical aggregates. The true form of the latter, and the manner in which they are built up, becomes very evident when the spheres have a covering of calcite, and this is removed by solution in acid. It is then seen that the ferrierite does not, as a rule, form a continuous, solid sphere, but that spaces have been left between the variously inclined piles of blades, and have been filled by the subsequent deposition of calcite. The structure is no doubt similar when chalcedony forms the enclosing material. Here, cross sections of the spheres usually appear as complete circles of radiated ferrierite blades, but on closer examination white streaks of the silica may usually be seen between the blades, especially towards the circumference of the circle.

The optical study of the mineral proves it to be orthorhombic, and if the crystals are oriented as tabular parallel to $a(100)$, with elongation along the c-axis, the forms exhibited are the pinacoids, a (100) and b (010), and the macro-prism or dome $d(101)$. The angle 100 : 010 is 90° 00′. The dome faces form the terminal planes of the blades, but, although they are often of fair size, they are always imperfect, and yield multiple reflections as a result of the parallel growth already referred to. Only two or three very thin blades were found, on which the dome face yielded a single, but faint, image, and the mean of the measurements made on these gave the angle $ad = 67° 47'$, from which $dd' = 44° 26'$. No twin crystals were observed, nor did the optical examination reveal any evidence of twinning.

The mineral has a perfect cleavage parallel to $a(100)$, and on this face the lustre is pearly; the lustre on $b(010)$ is bright vitreous, but on the dome faces it is duller, doubtless owing to their imperfect nature. Individual blades or thin cleavage plates are perfectly colourless and transparent, but in the crystal aggregates the mineral appears white; in some weathered specimens, it is stained reddish by iron oxide. The outer ends of the blades, near their contact with the enclosing chalcedony, are quite generally translucent and milky, while thin white streaks of chalcedony penetrate for a short distance between the blades; also, a narrow zone of the chalcedony, immediately bordering the spheres, is clouded and bluish as compared with that further distant. There seems to have been some reaction between the chalcedony and the ferrierite, and it is possible that at the time the crystals of the latter mineral were forming, the surrounding silica had not yet assumed the solid state, but was still in the gelatinous condition.

The mineral has a hardness of 3 to $3\frac{1}{2}$, and the specific gravity is 2·150.

Optical Characters

The blades show straight extinction when lying flat, on *a*(100), and also when they rest on *b*(010) and on *c*(001); in each case compensation takes place when the quartz wedge is inserted normal to the length, whence it appears that the *a*-axis $=\alpha$, *b*-axis $=\beta$, *c*-axis $=\gamma$, and the axial plane lies in the direction of elongation of the blades. In convergent light it is seen that the obtuse bisectrix is normal to the blades, or coincides with the *a*-axis and therefore $=\alpha$, and the birefringence, which is weak, is thus positive.

The refractive indices β and γ were determined by total reflection from *a*(100), the crystal being immersed in methylene iodide, and the obtuse optic axial angle was measured in the same medium. The angle $2V$ calculated from the latter measurement, the indices β and γ, and the index α calculated from these values, are as follows:—

$$2V=50°25'; \ \alpha=1\cdot478, \ \beta=1\cdot479, \ \gamma=1\cdot482, \ \gamma-\alpha=0\cdot004.$$

It was necessary to employ very small plates for the determination of the refractive indices, because in the larger blades, the face *a*(100) is never a perfect plane. It is believed, however, that the values given above are approximately correct.

Chemical Composition

Heated in the flame of a bunsen burner, the mineral whitens, and thin splinters fuse to a blebby glass. Fusibility $3-3\frac{1}{2}$. The flame is yellow, and observed with the hand spectroscope it shows only the sodium line. Heated in a closed tube, the mineral whitens and gives off much water, which is slightly acid. Insoluble, or only very slightly soluble, in hydrochloric acid.

In view of the danger of contamination with chalcedony, especial care was taken in selecting the material for analysis, and colourless and perfectly transparent blades only were used. The fusion was very pale bluish-green, indicating the presence of a trace of manganese. The analysis gave the following result:—

		Molecular	ratio.
SiO_2	69·13	1·152	10·28
Al_2O_3	11·44	·112	1·00
CaO	None		
MgO	2·92	·073	0·65
Na_2O	3·97	·064	0·61
K_2O	0·36	·004	
H_2O	13·05	·725	6·47
	100·87		

The water was fractionated as follows, heating at each temperature being continued for two hours:—

At	102°	130°	150°	175°	205°	260°	275°	Ignition
Loss %	1·85	1·55	0·50	1·00	1·60	0·68	0·16	5·71

The mineral commences to lose water at, or below, 100°, and continues to do so at a fairly uniform rate until a temperature of 205° is reached, when 6·5 per cent., or almost exactly one-half, of the water has been driven off. At 275° the additional loss has been less than 1 per cent., and the 5·71 per cent. of water still retained by the mineral corresponds to 0·317 molecules, or 2·83 molecules on the basis $Al_2O_3 = 1 \cdot 00$.

Ferrierite thus has all the general characters of a zeolite; but it differs from all known zeolites in containing MgO in place of CaO, which is entirely absent from the mineral. In composition it is very closely related to mordenite and ptilolite, both of which have been shown by Clarke[1] to be simply representable by the general formula $Al_2(Si_2O_5)_5R'_4 + n$Aq., where $R'_2 = Ca$, Na_2, K_2, H_2 and $n = 6$ or 3.

In ferrierite, the molecular ratio $Al_2O_3 : SiO_2 = 1 : 10$, as required by this formula; the molecular ratio Al_2O_3 : MgO is approximately $1 : \frac{2}{3}$, and the ratio $Al_2O_3 : (Na, K)_2O$ approaches the same value. For exact correspondence with Clarke's formula, it would be necessary to assume that 1·35 per cent. of the water contained in the mineral is basic. Ferrierite might then be given the formula $Al_2(Si_2O_5)_5R'_4 + 6H_2O$, where $R'_2 = Mg : Na_2 : H_2 = 1 : 1 : 1$; the theoretical percentage composition calculated for this formula is as follows:—

[1] *Am. Jour. Sci.*, 3rd Series, vol. 44, 1892, p. 101.

SiO_2	67·42	10
Al_2O_3	11·46	1
MgO	2·99	$\frac{2}{3}$
Na_2O	4·65	$\frac{2}{3}$
H_2O {	1·35	$\frac{2}{3}$
	12·13	6
	100·00	

It is true that, in arriving at the above formula for ferrierite, an entirely arbitrary assumption has been made with regard to the water content of the mineral; but, in general, the same criticism might be levelled at the formulae which have been assigned to practically all the zeolites. These minerals without exception commence to lose water at a relatively low temperature, and the percentage loss increases at a fairly uniform rate as the temperature is raised to 300°. Determinations which have been made of the loss of water at definite temperatures seldom go beyond this point, at which the minerals still retain several per cent of water. Moreover, with many zeolites, as for example chabazite, scolecite, thomsonite, brewsterite, etc., it has been found that after heating at this temperature the material regains its original weight when exposed for some time to a moist atmosphere. It is very probable that all these minerals continue to lose water at the same gradual and uniform rate at temperatures considerably higher than 300°, and that much of the water still retained by them at the latter temperature is water of crystallization. Levynite, for example, remains hygroscopic even after heating at 360°.

There is thus no reason for supposing that the whole of the 5·71 per cent of water which ferrierite retains at 275° is constitutional, or basic; on the other hand, a consideration of certain other related zeolites indicates that some portion of it may well be present in the mineral as water of constitution, and in the formula here suggested for ferrierite, 1·35 per cent of water is assumed to be so combined.

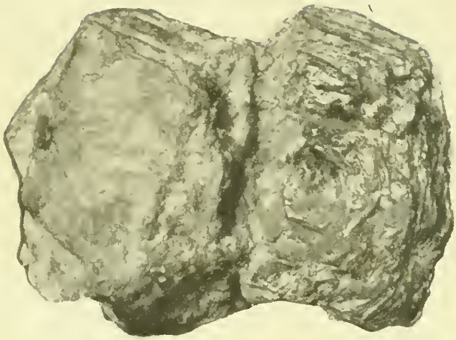
In the case of the ptilolite from Silver Cliff (Custer County, Colorado), Cross and Eakins[1] found that 3·10 per cent of the water were stable at 300°. In the theoretical composition assigned to this mineral by Clarke, a trifle less than two per cent of the water is basic, but this discrepancy is not considered an insuperable objection to the formula proposed.

Ferrierite is apparently not isomorphous with mordenite, which is monoclinic. Ptilolite has only been observed in capillary needles; these have parallel extinction, and a negative optical character[2].

[1]*Amer. Jour. Sci.*, 3rd. Series, Vol. 44, 1892, p. 96.

[2] Cross and Eakins, *op. cit.*

Figure 1.



On left, Bismuthinite; on right, Molybdenite.

On Phenacite, and a Pseudomorph of Bismuthinite after Molybdenite, from Northern Quebec

Location and Mode of Occurrence of the specimens

The specimens described below came from the Height of Land Mining Company's property, on the west bank of Kewagama river, in the extreme north of Preissac township, northern Quebec. The locality is about fifteen miles south of the Trans-continental Railway (which here, for a short distance, follows the Height of Land), and fifty-two miles east of the Quebec-Ontario provincial boundary.

The property of the Height of Land Mining Company is situated on the western margin of an extensive granite (Laurentian) batholith. The peripheral zone of this mass, where it crosses the Kewagama river, is unusually pegmatitic in character, and the rock is traversed by a great number of quartz veins; these, as well as tongues of pegmatite, also appear cutting the neighbouring Keewatin schists. The quartz veins are themselves undoubtedly pegmatitic, and represent the last and most acid intrusions of the same magma which gave rise to the granite. Molybdenite and bismuthinite occur in the pegmatitic and aplitic facies of the granite, and, more especially, in the quartz veins. Both minerals are very erratic in their distribution, and bismuthinite is relatively much the less common. The bismuthinite usually occurs along fracture planes within the veins and filling cracks in other minerals, such as pyrite, and in some places it surrounds and encloses minute crystals of molybdenite. It thus appears to have been introduced later than the latter mineral, and this view receives support from the occurrence here of a pseudomorph of bismuthinite after molybdenite, which is described below.

Other minerals which have been met with in these quartz veins include the following:—beryl, fairly abundant in some of the veins, in greenish sub-translucent prismatic crystals, which may attain a diameter of three or four inches; phenacite, only observed in specimens from one vein and described below; fluorite, of a deep purple colour; pyrite, chalcopyrite, and sphalerite. Some of the veins show low values in gold.

Pseudomorph of Bismuthinite after Molybdenite

This interesting specimen was collected in 1907 by Mr. J. A. Dresser, who later presented it to the McGill University Mineral Collection. It is shown in Plate I, figure 1, which is reproduced from a photograph, and is about natural size.

As may be seen, the specimen consists of two apparently hexagonal crystals, about equal in size, of similar shape, and attached in parallel position; one of these, however, (that on the right in the figure), is molybdenite, while the other is composed of bismuthinite. Neither individual has a very sharp crystal outline, but each presents the appearance of a hexagonal bi-pyramid with its apices deeply truncated by faces of the basal pinacoid, so that the habit is somewhat tabular.

In the molybdenite crystal, the pyramid faces are, as is usual, heavily striated parallel to the base; it would be more correct to say that the pyramid is formed by the free outer edges of superposed thin plates of molybdenite, which, being of continually decreasing diameter, give rise to the tapering above and below. Approximate measurement of the angles with the hand goniometer indicates that the pyramid is the form $o(10\bar{1}1)$. Instead of a flat basal plane, the upper surface of the crystal exhibits a concave rosette form, due to the manner in which the hexagonal plates, of smaller and variable size, overlap here, and also in part to a curvature of the plates. The crystal is coated in places with a little earthy yellow molybdite, but in general this is inconspicuous or absent.

The other individual (on the left in Fig. 1) shows the same combination of pyramid and basal pinacoid, and has similar angles; but in this case the base is an approximately flat surface. It is composed of very fine-granular bismuthinite, through which occasional specks of native bismuth, isolated or in small nests, are dispersed. Here and there, also, traces of the original molybdenite may be seen. The surface is largely coated with a thin deposit of greyish-white or yellowish-white material, which is, in part at least, bismuth carbonate.

The manner in which the replacement of the molybdenite by bismuthinite has progressed may be observed better on the under side of the specimen. Attached to the large molybdenite crystal are several smaller crystals of similar habit, which also are quite fresh and unaltered, Below the pseudomorphous individual, on the other hand, are some crystals which show partial alteration to bismuthinite. One of these has been broken across and shows in cross-section the curvilaminar structure resulting from the superposition of curved flakes. At one end of this crystal the molybdenite has been entirely replaced by bismuthinite, but the original structure is still very evident. The fine granular bismuthinite retains the form of the curved plates, and in some cases these are easily separable, owing to the presence of a thin film of oxide, or of molybdenite, between them. Even where the material is more compact, the original curvilaminar structure is plainly indicated by a streaky appearance, largely caused by the presence of narrow streaks of earthy grey oxidation products, in part bismuth carbonate. Another portion of the same crystal is still composed almost entirely of unaltered molybdenite, with only an occasional layer replaced by the granular bismuthinite.

It can hardly be doubted that the whole specimen consisted originally of molybdenite alone, of which mineral two large crystals had grown in parallel position, united by a pyramid face, as shown diagrammatically in Plate I, figure 2, with several smaller crystals grouped irregularly upon them.

Although the association of bismuthinite with molybdenite is by no means uncommon, pseudomorphs of the one after the other have not hitherto been recorded. In the present occurrence, a study of the veins has shown that the bismuthinite was deposited later than the molybdenite, and it would seem that, where the exhalations or solutions carrying the former have encountered crystals of the latter, they have, under certain conditions, been able to effect a replacement of the molybdenite by bismuthinite.

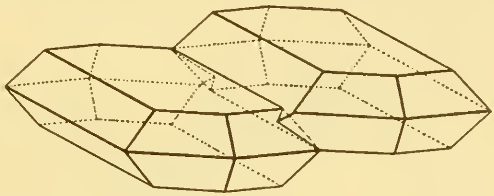


FIGURE 2.

In the particular case of the specimen described above, there remains the difficulty of accounting for the fact that only one half of it has been so affected, while the other half has undergone no change. It might be suggested that the individual plates of molybdenite, whose aggregation has built up the larger crystals, were less closely compacted in one case than in the other; or that the surroundings of the specimen within the vein were of such a character that, while one portion of it was freely exposed to the ascending bismuthinous fluids, the other was entirely protected from their influence.

The only other minerals present on the specimen are quartz and muscovite, both in small amount.

Phenacite

A specimen collected in 1910 by Dr. J. A. Bancroft from a pegmatitic quartz vein, near the northern end of the Height of Land Mining Company's property, proved on examination by the writer to be composed partly of phenacite. The quartz of the vein is of the usual milky white variety, through which, in addition to the minerals mentioned above as generally occurring in these veins, there are distributed patches of dark green, massive or fine-granular chlorite.

The phenacite, in the specimen collected, is intimately associated with the latter mineral. For the most part it is massive, or exhibits an ill-defined prismatic habit. In appearance it closely resembles the quartz, than which, however, it is rather more colourless and transparent. The similarity to quartz is further increased by the hexagonal form and optically positive character, but the birefringence and high refractive index proved conclusively that the mineral could not be quartz. A few imperfectly terminated crystals were found, and from the measurement of these, the mineral was identified as phenacite. The following forms were observed on the crystals:—

$a(11\bar{2}0)$, $m(10\bar{1}0)$, $k(5\bar{1}\bar{4}0)$, $r(10\bar{1}1)$, $p(11\bar{2}3)$, $p_1(2\bar{1}\bar{1}3)$, $d(01\bar{1}2)$.

On one crystal, of which figure 3 is a drawing, there is, in addition to the above forms, a well-defined face lying betwen $r(10\bar{1}1)$ and

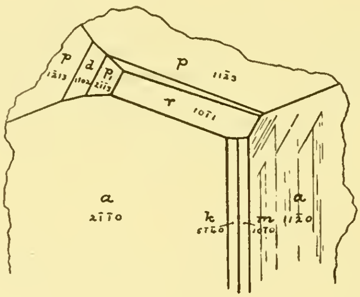


FIGURE 3.

$p(11\bar{2}3)$, but not quite in zone with them. This is vicinal, but very nearly coincident with $v(21\bar{3}4)$, as may be seen from a comparison of the measured and calculated angles:—

Angle	Measured	Calculated
$11\bar{2}0 : 21\bar{3}4 = a_1 : v$	64° 13′	63° 44′
$2\bar{1}\bar{1}0 : 21\bar{3}4 = a : v$	71° 47′	72° 50′
$10\bar{1}1 : 21\bar{3}4 = r : v$	13° 41′	14° 32′

The prism is striated vertically, while on the face $a(11\bar{2}0)$ there are also striæ parallel to the edge *ar*.

The crystals have a diameter of about 2 mm., and only about the same length of prism, bearing the terminating forms, stands out freely from the massive matrix. The latter is itself largely phenacite, often showing an ill-defined, longitudinally striated prismatic form, and also a fair prismatic cleavage, parallel to the predominant prism $a(11\bar{2}0)$. The free ends of the crystals are colourless and transparent, but the more massive material appears white, or is filled with inclusions of dark green chlorite.

The specific gravity, as determined in methylene iodide, is 2·944. The refractive indices, using the minimum deviation method and sodium light, were measured as

$$\epsilon = 1{\cdot}673, \quad \omega = 1{\cdot}656, \quad \epsilon - \omega = +0{\cdot}017,$$

but the images obtained being somewhat faint, these values are only approximate.

Especial interest attaches to the phenacite from the fact that this is the first record of the occurrence of the mineral in Canada.

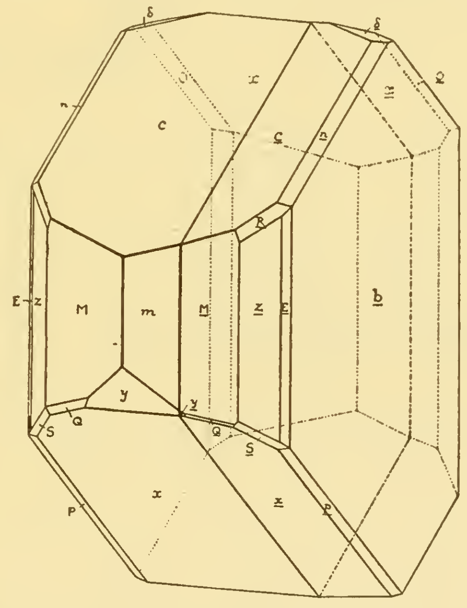


FIGURE 4.

NEW FORMS ON A CRYSTAL OF ALBITE FROM THE ASCOT MINE, SHERBROOKE COUNTY, QUEBEC

A crystal of albite occurring on a specimen collected by Dr. Ferrier at the Ascot Mine, Sherbrooke County, Quebec, exhibits several forms which appear to be new for this mineral. The crystal, shown in Plate II, figure 4, has the usual prismatic albite habit, and is composed of two individuals twinned according to the *albite law*. The most prominent of the new forms occurs in the prism zone, where there is a well-defined face between $b(0\bar{1}0)$ and z$(1\bar{3}0)$, and inclined at nearly two degrees to the latter. This is lettered E in the figure, and has the symbol $(4\cdot\overline{13}\cdot 0)$. The calculated angle z:E is 1° 57½′, and measurement gave 1° 42′ and 1° 57′. The form $R(3\bar{9}1)$, truncating the edge between z$(1\bar{3}0)$ and $c(001)$, is also present as faces of appreciable width which give fair reflections. The measured and calculated angles are as follows:—

z : R.........	measured	10° 07′.......	calculated 10° 22′
c : R.........	"	70° 05′.......	" 69° 49′

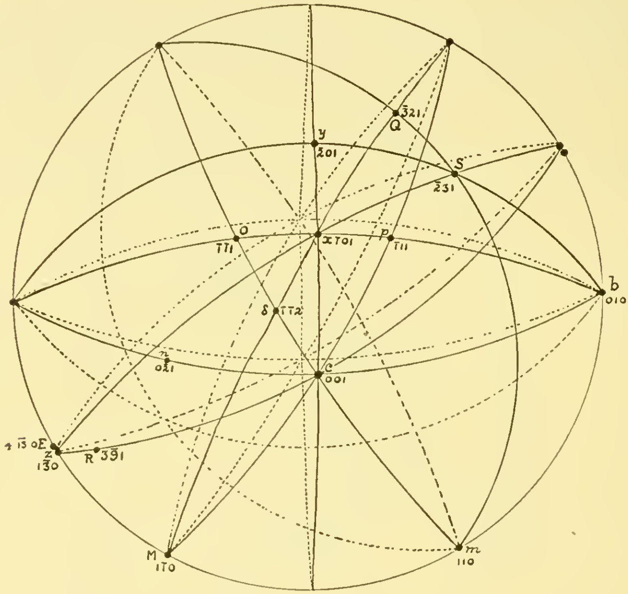


FIGURE 5.

Two other new forms, $Q(3\bar{2}\bar{1})$ and $S(2\bar{3}\bar{1})$ appear as very narrow facets truncating the edges $x(10\bar{1})$: $M(1\bar{1}0)$ and x $(10\bar{1})$: z $(1\bar{3}0)$ respectively. The angles for these faces are:

M : Q.......	measured	19° 52′........	calculated 20° 29′
b : S.......	"	45° 50′........	" 45° 30′
y : S.......	"	41° 53′........	" 42° 10′

Owing to the small size of the faces, the readings for these two forms were obtained by maximum illumination only, but the angles agree fairly closely with the calculated values. Moreover, as shown in the spherical projection (figure 5), the face S was found to lie accurately in the two zones [bSy] and [zSx], and the face Q is similarly common to the zones [*MQx*] and [*mQS*], so that the symbols of these two forms are definitely fixed by the zone law.

The crystal on which the new forms were observed is colourless and transparent, and rather more than one-eighth of an inch in length. The other forms present are shown in the figure, which gives the approximate relative dimensions of all the forms occurring on the crystal. All the new forms appear on both halves of the twin.

The specific gravity, as determined by immersion in methylene iodide, is 2·605; this is the value found by Day for pure artificial albite, and it would indicate that the crystal is relatively free from lime.

The albite is associated with very pale brown dolomite, in simple rhombohedra. The specimen came from the Harvey vein of the Ascot Mine, Range VIII, Lot 8 (West half), Ascot Township, Sherbrooke County, Quebec.

Thaumasite from the Corporation Quarry, Montreal

Some time ago the writer collected, at the Corporation Quarry, a specimen of crystalline limestone which was coated along a joint plane with a thin deposit of a soft white mineral, and a preliminary examination indicated that this was thaumasite. During a recent visit to the quarry, several larger specimens of better material were obtained, and it was possible to confirm the identification and make an analysis of the mineral.

The Corporation Quarry is situated immediately below the northwestern shoulder of Mount Royal, and it affords excellent exposures of the intrusive contact between the nepheline syenite, of which this side of the mountain is largely composed, and the Trenton limestone. The latter has been altered to a crystalline limestone, and both it and the nepheline syenite are traversed by a number of dykes, while all these rocks are intersected by joint planes.

The thaumasite occurs near one of these contacts, usually as a thin coating on narrow joint planes, which may be continuous through the syenite, limestone, and one or more dykes; but so far as observed, the mineral is mainly coating joint planes within the limestone. The thaumasite is white, with a dull silky lustre, and forms crusts made up of fibres with a feathery or somewhat radial arrangement; beneath this there may be a thin layer of more compact material, also thaumasite, which rests directly on the limestone or other rock. In one case a joint plane traversing the nepheline syenite had been first coated with crystals of calcite and upon these the thaumasite rests as loosely compacted, and more or less freely developed, capillary crystals up to 1/16 of an inch in length.

The best specimens were obtained from a fissure about 3 inches in width, which was completely filled with thaumasite in the form of mealy masses, somewhat loose in texture. These also are built up of capillary crystals, aggregated together with a tendency towards a feathery arrangement, and the specimens show a somewhat fibrous structure when broken. The material for analysis was selected from these specimens, and it was found to be remarkably pure, only 0·3 per cent. remaining undissolved in cold dilute hydrochloric acid. The analysis yielded the following result:—

	Theoretical composition	Corporation Quarry	Molecular ratio		
SiO_2	9·64	9·38	·156	0·96	1
SO_3	12·86	13·07	·163	1·01	1
CO_2	7·08	6·71	·153	0·95	1
CaO	27·01	27·32	·488	3·02	3
H_2O	43·41	43·69	2·427	15·00	15
	100·00	100·17			

The ratios agree fairly closely with the established formula, $3CaO. SiO_2. SO_3. CO_2. 15H_2O$. Both the silica and the carbon dioxide are a little low. Three determinations of the carbon dioxide gave 6·66, 6·71, and 6·71 per cent. The water was determined by the Penfield direct method.

The specific gravity was determined as 1·877 by the pycnometer method, and 1·879 using Thoulet solution. This agrees with the value usually assigned to thaumasite, but is higher than that found by Schaller for the Utah material (Sp. G. =1·84). The remaining physical properties, and the optical characters, so far as they could be determined, are as usual for thaumasite, and call for no comment.

Thaumasite has not previously been recorded from Canada; indeed, this peculiarly constituted mineral appears to be of somewhat rare occurrence, having been noted only at one or two localities in Sweden and the United States. It was first described in 1878 by Baron von Nordenskiöld,[1] from the copper mines of Areskuta, Jemtland, Sweden, and it has since been found at two other neighbouring localities in that country. In the United States, the occurrence of the mineral at Berger's Quarry, West Paterson, New Jersey, was described

[1]Compt. Rend., vol. 87, 1878, p. 313.

by S. L. Penfield and J. H. Pratt[1] in 1896, and E. T. Wherry[2] states that it occurs in considerable amount also at another quarry (Francisco Bros.) at Great Notch, 3 miles southwest of Paterson. More recently, W. T. Schaller[3] has described thaumasite from a second locality in the United States, Beaver County, Utah.

Saponite from the Canadian Northern Railway Tunnel, Montreal

When first collected, this substance is somewhat translucent, soft, and quite plastic, with very much the consistency and appearance of candle grease. If kept immersed in water, the material retains its original character for some time, but gradually it becomes more opaque and rather harder. After long exposure to the air, also, it turns white and opaque, and ultimately crumbles to powder, apparently through loss of moisture. This dry material is soft, has a somewhat soapy feel when rubbed between the fingers, and does not adhere to the tongue. Moistened with water, it forms a clay-like paste.

Some of this material, which had been exposed to the atmosphere for about a year, was analysed, with the following result:—

Clarke's Formula		C.N.R. Tunnel Montreal	Molecular ratio			
47·24	SiO_2	46·45	·774			1·00
	Al_2O_3	3·32	·032	·035 × 3 = ·105	·763	0·99
	Fe_2O_3	0·42	·003			
	FeO	0·72	·010	·658		
31·50	MgO	25·91	·648			
14·17	H_2O-100	14·48	·805			1·04
7·09	H_2O+100	8·13	·452			0·58
100·00		99·43				

The water is, in part at least, very loosely held. After heating to 40° C, there was a loss in weight of 8·5 per cent, and thereafter there was a gradually increasing loss at higher temperatures, until at 100° it amounted to 14·48%. Above this temperature, the mineral still continued to lose weight at a fairly regular rate, as follows:—

Temperature............	120°	140°	160°	180°	205°
Total loss %............	15·03	15·46	16·07	16·53	16·89

[1] *Am. Jour. Sci.*, 4th ser., vol. 1, 1896, p. 229.

[2] Quoted by Schaller, *op. cit.*

[3] Mineralogical Notes, Series 2, U.S. Geol. Survey, Bulletin 509, 1912, p. 110.

There was no change in the appearance of the material after it had been heated to this temperature. It was placed, together with a dish containing water, under a bell jar, and allowed to remain for a day, when it was found to have regained very nearly its original weight (all but 0·3 per cent.). This material was then ignited; almost immediately it began to darken in colour, and soon the entire mass appeared nearly black, but with further heating the mineral became white again, and remained so on cooling. The total loss in weight was 22·61 per cent. From the change in colour it is evident that this loss is not entirely due to the water expelled, but the cause of the blackening was not determined; it is apparently a characteristic feature of all saponite. A direct determination of the water by the Penfield method gave 20·42 per cent., but this is probably low, for the last traces of water appear to be very tenaceously held, and by the ignition method it is only after very prolonged heating that a constant weight is attained. After complete dehydration in this way, the substance does not re-absorb water when exposed to a moist atmosphere.

The mineral is essentially a hydrous silicate of magnesium, containing also aluminium, and although the analysis shows rather less of the latter constituent than is usual in the recorded analyses of saponite, the mineral is best referred to this species, which it further closely resembles in its general physical and blowpipe characters.

The recorded analyses of saponite vary between very wide limits for all the principal constituents, and this is no doubt to be explained, in part at least, on the assumption that the material analysed has in most cases been impure, or has consisted of a mixture of two or more substances. However, the analyses without exception show alumina to be present, and in most cases ferric oxide also, these two sesquioxides averaging more than 10 per cent., and even amounting to as much as 20 per cent. on occasion. Generally speaking, the sesquioxide and magnesia contents vary more or less inversely. The mineral appears, in every case, to lose about two-thirds of its water content at 100°C.

It may be doubted whether saponite, considered as a hydrous silicate of magnesium and aluminium, should be regarded as a definite species. Many analyses would approximate very closely to mixtures in varying proportions of, say, deweylite and kaolin. Clarke[1] suggests that "saponite is perhaps normally $H_4(MgOH)_2Si_2O_7$, although the analyses all show admixtures of some aluminous compound." The percentage composition calculated for Clarke's formula is given in the first column of the table above. It is perhaps a curious chance that the Montreal material gives almost exactly the ratios required by this

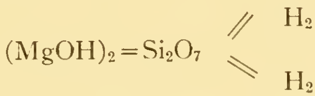
[1] The constitution of the Natural Silicates, U. S. Geological Survey, Bulletin 588, 1914, p. 109.

formula, assuming Al_2O_3 equivalent to 3MgO, i.e., that the substance is a mixture of the compound $6MgO \cdot 6SiO_2 \cdot 9H_2O$ with a small amount of the corresponding compound $2Al_2O_3 \cdot 6SiO_2 \cdot 9H_2O$.

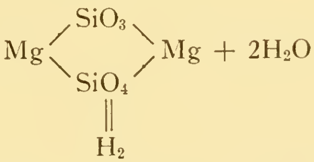
If Clarke's formula really expresses the true composition of saponite, it would seem better to write it in the form $(MgOH)_2 Si_2O_5 + 2H_2O$, or $H_2Mg_2Si_2O_7 + 2H_2O$, seeing that two-thirds of the water, representing two molecules, are given off at a temperature below 100°C, and moreover are again absorbed by the material when it is exposed to a moist atmosphere at the ordinary temperature.

According to this view, saponite would be comparable with picrosmine, $H_2Mg_2Si_2O_7$, differing from it only in containing two additional molecules of water, which are held very loosely.

Little is known concerning the actual constitution of saponite. Clarke favours the view that the mineral is best represented by the orthodisilicate formula



To indicate that two molecules of water are very loosely held, the formula might still be written as an orthodisilicate, $H_2Mg_2Si_2O_7 \cdot 2H_2O$; or it might be represented as



which is the constitution ascribed by Clarke to picrosmine. Other constitutional formulæ, as for example the metadisilicate $(MgOH)_2 Si_2O_5 + 2H_2O$, might of course be suggested for saponite, but in the present state of our knowledge concerning the genesis of the mineral, and especially in view of the existing uncertainty even of its correct empirical formula, it is not possible to confidently assign any particular one of these to the mineral.

The saponite described above was collected by Dr. J. A. Bancroft near the western end of the Canadian Northern Railway tunnel, immediately beneath the Corporation Quarry. This tunnel, which has been recently completed, passes from east to west under Mount Royal, and below the quarry it traverses the intrusive contact between the nepheline syenite and Trenton limestone. It is here that the saponite occurs, as a deposit on corroded crystals of calcite which coat fissures and cavities in the rock.

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Rosette forming Organism, x 1000.

A Rosette Forming Organism

By F. C. Harrison, D.Sc., F.R.S.C.

(Read May Meeting, 1918)

This organism was found in a sample of ropy or slimy milk, its presence being discovered when making a microscopic examination of the affected milk, and it was subsequently isolated by successive platings.

The organism is peculiar owing to its forming rosette-shaped masses. Singly, it is slightly curved, resembling the bent rods of the tubercle bacillus, but usually somewhat thicker; it is Gram positive, grows well on ordinary media, has an optimum temperature of 25°–27°C., thermal death point of 63°C. for ten minutes, and gives a peculiar and characteristic odour to milk, whey and other liquids.

The peculiar interest of this organism is not, however, in its cultural features but in the formation of the rosettes, or clusters of the bacillus, all the rods radiating from a common centre forming a whorl which may be compared to the petals of a daisy. The number of individuals in a rosette or cluster varies from two or three to fifty or sixty, or more, appearing when examined in hanging drop as a burr, but when on the slide giving a daisy or aster-like appearance. The rosettes are formed on both solid and liquid media. Involution forms in old cultures are frequent, and the changes in shape vary,—short stunted rods, crescent shape with the middle thicker than the ends, lemon shape, club shape, and occasionally threads; in fact, the diversity in shape was so marked that at first it was thought that other organisms were present, but this idea was found incorrect.

The formation of the clusters was observed under the microscope in hanging drops in Böttcher's cells, and whilst there was considerable difficulty in observing the development of a single organism owing to its motility, the process could be followed fairly well.

An organism lengthens and divides and then seems to swing apart until an acute angle forms. This is a gradual movement, and not the so-called "snapping" movement described by Hill. These two organisms again divide and the swing apart again takes place from the ends in contact; if both divide at the same time a rosette of four cells results. Often one rod divides before the other, and a three-rayed cluster forms. When this operation goes on for some time a large rosette is the result. Two organisms lying close to one another will both divide and at once form a cluster of four. When one side of a cluster grows more quickly than the other an irregular rosette develops.

After a cell forms a dividing wall it does not always swing apart, but may remain attached, thus lengthening, as it were, the individual rays of the cluster.

All these phases of growth may be observed in the accompanying microphotographs, which should be examined with a magnifying glass. The clear space in the centre of the rosette, comparable to the eye of the daisy or aster, varies in size, the larger the cluster the larger is the central clear area.

Free organisms swimming in the hanging drop will often become attached to a cluster and grow with it, although as often they will move away.

In milk and whey rosettes develop freely, on whey gelatine they are less numerous.

Staining. The organism stains fairly well with the ordinary stains, but accepts the colour better after immersion in weak acetic acid. It is Gram positive.

Appearance of the Organism and Occurrence of Rosettes in Various Media. The bacilli are motile, but in the rosette stage the motility is lost, except at times a slight swaying motion of the free ends. The organism is peritrichous. The flagella stained by Van Ermegem's methods vary in number, usually from five to seven.

On unhopped wort, whey, yeast water and beef peptone gelatine rosette formation occurs. Single organisms in liquid cultures of sweet wort are of peculiar shapes, lemon and crescent shaped forms are common, and the individual elements of the rosettes are often slightly club shaped. In hopped wort the rosettes are smaller.

In yeast water, milk, and the usual sugar media rosette formation occurs freely. After two or three days' growth the organisms composing the clump become more uneven or club-shaped.

Cultures. On beef peptone and whey gelatine the colonies are punctiform. Surface colonies are slightly larger, averaging about 1·5 mm. in diameter, and cause a very slight depression in the gelatine which, however, cannot be definitely ascribed to liquefaction. When grown with the viscous milk organism the gelatine is liquefied, a result which neither organism can accomplish when growing separately.

The deep colonies are very regular, the edge sharply defined when examined with low power objective. The surface colony is not so spherical, the margin is more irregular. The agar colonies are very similar.

In stick cultures in gelatine (beef peptone, whey and yeast water) the growth is filiform, on the surface the growth extends slightly as a thin dry film. There is no liquefaction, but a slight depression on the surface after five days' growth.

In sugar media (glucose, saccharose and lactose) there is good growth, no gas and no acid, a slight film most pronounced near the wall of the tube forms, the body of the tube is turbid, and there is a slight deposit. The odour is peculiar, somewhat resembling mustard.

In milk there is no apparent change in consistency or color, the medium smells strongly of boiled cabbage, or cabbage refuse water.

The organism grows well in hopped and sweet wort, and yeast water, but there is no growth in wine must.

Temperature Relations. There is no growth at 38°C., very scanty growth at 35°, excellent growth at 25°-28°, and growth at 12°C.

Thermal death point 62°C. for ten minutes.

The only description of rosette formation in bacteria that I have been able to find is that described by Mary Hefferan[1] in *Bacillus rosaceus metalloidea* (Tataroff). This organism is a pseudomonas, it forms rosettes in liquid media, and also on the surface of agar.

Miss Hefferan thinks that the phenomenon of rosette formation is not due to agglomeration by some agglutinating substance, but must be closely connected with the vital processes,—a deduction which seems equally true of the organism here described.

[1] Hefferan, Mary. "*An Unusual Bacterial Grouping.*" Centr. f. Bakt., 11:8:69, 1912.

Exuviation and Variation of Plankton Copepods with special reference to Calanus finmarchicus.

BY MARY E. CURRIE, B.A., MCGILL UNIVERSITY.

Presented by J. P. McMurrich, Ph.D., F.R.S.C.

(Read May Meeting, 1918)

In the life history of *Calanus finmarchicus* it has been observed that twelve stages intervene between the laying of the egg and the attainment of maturity. The first six of these are the nauplius or larval stages; the others are the copepodite or postlarval stages. Successive stages are separated from one another by an exuviation and, contrary to what occurs among higher crustacea, the copepods undergo no further exuviation after sexual maturity has been reached. All copepod exuviations are, therefore, developmental and not merely the result of continuous growth.

The changes in external form which *Calanus* undergoes in passing from one stage to the next have been described recently by Marie Lebour ("Stages in the Life History of Calanus finmarchicus," Journ. Mar. Biol. Ass. Plymouth, XI, March, 1916), whose paper is not concerned with questions of variation in growth and consequently does not anticipate the results contained in the present report. In his "Notes biologiques sur les Copepodes de la mer Norvégienne" (C.P. I.E.M. Pub. Circ. 22, Copenhagen 1905) D. Damas defined the copepodite stages of *C. finmarchicus* and stated that the five phases of metamorphosis leading up to the adult form probably correspond to as many successive exuviations. The extraordinary variation in length met with in stage IV., together with the character of the coxal teeth or denticulations on the inner margin of the basal joint of the fifth pair of swimming feet, to which neither Marie Lebour nor D. Damas makes any reference, might lead to the supposition that an additional moult would be intercalated within the period occupied by this stage, but this is not so. There remains the possibility which can only be substantiated by experimental rearing, that there is more than one race of *C. finmarchicus* in the material examined. The stages which were studied at the Atlantic Biological Station, St. Andrews, N.B., during the months of June, July and early part of August 1916, were III, IV, V, and VI., the last including the adult male and female. Besides *C. finmarchicus*, observations were made upon *Eurytemora*, *Tortanus*, *Acartia*, *Pseudocalanus* and *Metridia*, which will be detailed in their turn.

A. Calanus finmarchicus.

Stage III. In this stage there are five free thoracic segments in the forebody, two segments in the urosome, four pairs of swimming feet and the fifth pair (p.5)[1] rudimentary.

Only twenty-three specimens of this stage were examined, all being from "Prince" Sta. No. 3, June 28th, 1916, 10 fathom tow.

Length Variation. The length varied from 1·5 mm. to 1·8 mm. with an average of 1·615 mm. The variation is continuous without any abrupt deviations which might be taken to indicate the existence of two races at this stage.

Exuviation. During the stages intervening between its successive moults, a copepod is continually growing and acquiring the characteristics of the following stage within its cuticle, which becomes stretched to its limit of elasticity. The cuticle of the next stage, owing to its larger surface, is wrinkled and crowded within the old one. When it is ready to exuviate, the copepod first withdraws its eating and swimming appendages and the caudal furca, beginning from the inner lobes of the eating appendages, the inner rami of the swimming feet, and the two rami of the caudal furca; the antennæ are the last which it withdraws. The new setæ loosen themselves from the exuvia by withdrawing within the body of the appendages as if they were being turned inside out from the bases. This turning inside out process is never completed for when the setæ have been pressed in until their tips are on a level with their bases the pressure created stretches the internal cuticle until the exuvia reaches its limit of elasticity and breaks on the top of the head and along the back. As soon as the exuvia is broken the pressure is reversed. The setæ are again stretched out, in so doing pushing the exuvia away from the copepod. The setæ of the eating and swimming appendages are forced out by their contents swelling and exerting pressure at the tips (Fig. I), whereas those of the caudal furca are pushed out by the contents of the rami swelling and exerting such pressure around the setæ that the bases of the setæ are pushed out as cylinders about their protruding tips (Fig. 2). These cylinders lengthen and as they lengthen the setæ are brought farther out from the body until they are quite stretched out

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[1] List of abbreviations used in the text.

p 5, Fifth swimming foot or feet; *Li I*, First inner lobe; *Re* Outer ramus or branch of an appendage; *Ri*, Inner ramus; *Bi*, First coxal or basal joint; *Se*, Outer marginal setæ; *St*, Terminal setæ.

For explanation of figures see end of report.

and the cylinders disappear (Fig. 3). The pressure is greatest at the tips of the rami as is shown by the different lengths of the cylinders formed by the unfolding setæ; those of the middle termina setæ being longer than the other terminal ones which in their turn are longer than the one of the outer seta (Fig. 2).

During this energy consuming process of exuviation the stored supply of oil within the copepod, which is comparatively large at the beginning of exuviation, gradually diminishes as it is being used for food. The copepod does not dart about in the water, but remains apparently motionless except for an occasional quiver as it frees itself from its appendages.

After the setæ are quite unfolded the pressure exerted by the tissues is so great that it forces the tips of the rami into the setæ, thus forming an inner cylinder at the base of each seta (Figs. 2-3). These inner cylinders are also of definite lengths, those of the two middle terminal setæ being twice as long as the other two, and four times as long as the outer one. If any seta of the caudal furca, except the inner one, is pulled off, it slips off this inner cylinder formed by the ramus at its base and leaves it exposed (Fig. 2).

If the copepod is in a healthy active condition, initial attempts to regenerate lost setæ of the caudal rami are made and usually an irregularly shaped, sometimes even bifurcated seta protrudes from the rim of the cylinder (Fig. 4). When the setæ do not wholly break away from their bases but are injured or broken, regeneration is also attempted (Fig. 27).

Among all the individuals of *C. finmarchicus* III examined, none was found exuviating to stage IV., but an excellent example of *C. hyperboreus* III. in this condition (Fig. 5) was obtained in a vertical haul from "Prince" Sta. 3 on May 24th. This species differs from *finmarchicus* in certain morphological features, but the two are so closely related that the exuviation of both of them from one stage to another takes place in a similar manner.

Stage IV. In this stage there are five free thoracic segments in the forebody, each with a pair of swimming feet, and three abdominal segments in the urosome. The ramus externus (Re) and ramus internus (Ri) of the fifth feet (p5), each consists of one joint. On the proximal joint (Bi) of the stem of the fifth foot there are coxal teeth like those of the adult but with a different distribution and varying in number.

Length variation. One hundred and forty eight specimens of stage IV., taken in several hauls from "Prince" Sta. 3, were examined. As shown by graph. I, instead of there being a continuous variation in length, as appears to be the case in stage III, about a single mean, there are two averages, one large and the other small. The occurrence of these two size-classes gave rise to the supposition that there might be an ecdysis intercalated within this stage. Of twenty-seven examples examined from a vertical haul made on May 24th the averages were 2·5 mm. and 3·2 mm.; of 116 examples from a 10 fathom tow on June 28th, the averages were 2·1 mm. and 3·1 mm. Both in the haul and in the tow there were a great many more of the smaller individuals, 23 of the 27 from the vertical haul and 87 of the 116 from the tow, belonging to the small size class. If there were an exuviation during this stage such a large variation in the numbers of the individuals of the two sizes would not be expected, but if there were two races of *C. finmarchicus*, this variation could be easily explained by one race being more numerous than the other.

The coxal teeth of the fifth feet in stage IV, besides varying in number, seem to have no regularity in their distribution. Usually they are more or less scattered, although sometimes, on one or both of the feet, they may be in a distinct transverse or marginal row, or they may be in a row and scattered as well. They are arranged in two principal ways, which correspond to the two leading size classes, as is shown by the similarity of the graphs 1 and 2.

In the one class, containing small individuals, the teeth are generally few in number, from three to ten, and of a certain size, but they may be more numerous and smaller, the numerical and substantive variation in this regard showing no regularity. In the other class containing large individuals, generally there are from eleven to eighteen teeth of a large size. Graph 3 shows the correlation between the lengths and the teeth. As a general rule, the shorter the individual the fewer are the coxal teeth. The few-teeth-small-size-class includes those with lengths from 1·8 mm. to 2·7 mm., and teeth from three to eleven in number. The many-teeth-large-size-class includes those with lengths from 2·7 mm. to 3·2 mm. and teeth from eleven to eighteen in number. Since one class contains many more individuals than the other, one might be led to believe that the supposition that there are two races of *C. finmarchicus* is correct, though not definitely recognizable in later stages.

Although in both these classes there is no regularity in the distribution of the coxal teeth, yet each has a characteristic appearance. A typical example of the teeth of the small size is given in Fig. 6, and of the large size class in Fig. 18. The small size class may have large or small teeth. As a general rule when the teeth are large they are not so numerous as when they are small. Some specimens occurred with comparatively large and few teeth (Figs. 8, 11), while others had small and many teeth (Figs. 9, 10, 12); and there were quite a number with both large and small teeth together (Figs. 13, 14, 15) suggesting that new teeth may be intercalated. This idea was strengthened by the observation that the nuclei below the small teeth were usually very large and closely appressed to the cuticle, as if indicating active metabolism. One specimen occurred with supernumerary teeth (Fig. 7), five needle-shaped teeth at the proximal end of the left basal joint, while the other teeth on this joint were large and numerous. Another specimen with a normal row of ten teeth on the left B I was abnormal in having but one tooth on the right B I but had a normal internal row of the teeth of stage V. This is not only a proof that the few-teeth-small-size-class exuviates directly to stage V, but that an abnormality occurring in one stage may disappear in the next. The large size class may have large teeth (Figs. 16, 18, 19) or small teeth (Fig. 17). As a rule, in this class, the teeth are large and crowded in an irregular marginal row.

These two quite distinct tooth classes seemed to indicate that there is an ecdysis during stage IV. It would be expected, if this were true, that the numbers of individuals belonging to each class would be about equal. This is not the case as mentioned before and illustrated by the graphs.

Exuviation. The most convincing proof of ecdysis during stage IV would be to find a copepod of the few-teeth-small-size class exuviating to the many-teeth-large-size-class. Instead of this, it was found that the copepods of both classes exuviate directly to stage V, as shown in the following table, in which the features peculiar to stage V of each individual were easily recognized through the exuvia *i.e.*, internal teeth, segmentation and number of setæ (Fig. 20, 22).

TABLE I.
COPEPODS OF STAGE IV IN EXUVIATION TO STAGE V.

	Date of Collection	Station	Tow	Class	Length in mm.	Coxal Teeth on Bl of p5 of exuvia		Coxal Teeth on Bl. of p5 of Stage V	
						right	left	right	left
1	June 28	"Prince" 3	10 fathom	small size	2·38	6	6	31	31
2	July 14	Wilson's Beach	surface tow	"	2·4	2	3	x	x
3	May 24	"Prince" 3	vertical haul	"	2·56	1	10	x	x
4	"	"	"	"	2·66	1	4	21	21
5	"	"	"	large	3·2	9	17	x	x
6	August 2	culture flask	"	"	3·2	9	9	36	36

Stage V. At this stage there are five free thoracic segments in the forebody and four segments in the urosome. The antennæ, mandibles, maxillæ, anterior maxilliped and four pairs of swimming feet are like the adult. The posterior maxilliped has not the full number of setæ and the last swimming foot (p5), although it has the full number of setæ, has only two segments in each ramus.

Length variation. Upwards of two hundred specimens were measured and the coxal teeth counted. The total length from the front of the head to the end of the caudal rami varied from 2·5 mm. to 4·68 mm., the average being 3·2 mm. Although there was such a variation in length, yet there were no abrupt changes as in stage IV. There is the one average of 3·2 mm. about which the lengths fluctuate. If there had been two races of *C. finmarchicus*, as our observations of stage IV seemed to indicate, we would have expected to find them represented in stage V.

Coxal teeth. The denticulations on p5 at stage V are arranged like those of the adult in a regular row, usually with a slight sigmoid bend in the middle of the row, along the inner margin of BI. The number of teeth varies from twenty-four to forty-four, the average being thirty-two. The right BI has rarely the same number of teeth as the left, but there is no regularity in this variation. Occasionally a specimen will be found with many more teeth on one side than on the other. When this is the case, the teeth that are more numerous are correspondingly smaller in size. One individual had exceptionally few large teeth; eighteen on the right, ten on the left (Fig. 23). This variation from the average number and size of the teeth is so great, that it may be classed as an abnormality. Very often, in addition to the long regular row of teeth, there are a few supernumerary teeth either at the proximal end of the series or at the distal end. The number of teeth at this stage makes no difference in the number of teeth in the succeeding stage VI, as the teeth of stage VI are formed quite independently of those of stage V. (Figs. 24, 25).

Setæ. In the *Account of the Crustacea of Norway*, (Vol. IV, Calanoida I and II, Plates II and III) G. O. Sars figures the p5 of *C. finmarchicus* female with one external seta on the Ri and that of the male with two external setæ (se) on the inner ramus. Marie Lebour (op. cit.) describes stage V as having "swimming feet like adult except the fifth pair which has the full number of bristles, but only two segments to the endopodite and exopodite." If this were the case it would be expected that the copepods of stage V destined to be females would have one Se on Ri of p. 5, and that those destined to be males would have two Se on Ri. According to the general law of nature we would also be justified in expecting that there would be just as many prospective males as prospective females and that, although there is but one average length for stage V, the largest specimens would be famales, since in the adult stage the female averages larger than the male.

In the 184 specimens of stage V examined, 140 of them had two Se on Ri, only 38 had one Se on Ri, and 6 had one Se on the Ri of one swimming foot (p5) and two on the other. The occurrence of six, out of 184, with one Se on one foot and two on the other is peculiar in that the percentage is too large for them to be classed as mere abnormalities. *C. finmarchicus V* can evidently be divided into three classes as regards the setæ on the internal ramus of p5, and these classes do not appear to have any relation to the size of the copepods or to the prospective sex of the adult stage.

Exuviation. It is unknown whether in stage V of *C. finmarchicus* there are certain characteristics which indicate what sex it is to be when it exuviates to stage VI. Microscopic examination of the gonads might throw light on this point. Although copepodite exuviation is continually occurring, yet during ecdysis the vitality of the copepods is so low that they sink towards the bottom of the water. Perhaps this is why it is so rare to find a copepod in the actual process, and it is rarer still to find that the exuviation has progressed far enough to distinguish, within the exuvia of Stage V, the sex of stage VI. In a few specimens Numbers 1-9, Table II, the commencement of exuviation was only apparent in the eating and swimming appendages and in the caudal furca, especially in p5 where the coxal teeth of stage VI could be seen through the cuticle. Others, numbers 10-18 Table II, were in ecdysis when examined, and the exuviation had progressed to such a degree that the sex could easily be ascertained. These were obtained from Dr. Willey's copepod cultures.

Table II.

Copepods of Stage V in Exuviation to Stage VI.

No.	Length in mm.	Coxal teeth on Bl of p5 of Stage V		Coxal teeth on Bl of p5 of Stage VI		Se on Ri of p5		Sex of Stage VI.
		right	left	right	left	right	left	
1	3·16	30	26	x	x	1	1	—
2	3·5	32	32	x	x	2	2	♂
3	4·1	32	32	29	33	2	2	♀
4	4·45	35	35	29	29	2	1	—
5	3·78	39	35	x	x	2	2	—
6	2·75	27	25	x	x	1	1	—
7	3·1	33	38	x	x	1	1	—
8	3·	32	36	22	23	2	2	♀
9	—	35	36	x	x	1	1	—
10	—	32	32	x	x	—	—	♀
11	—	—	—	—	—	1	1	♀
12	—	—	—	—	—	1	1	♀
13	—	—	—	—	—	—	—	♀
14	—	—	—	—	—	—	—	♀
15	—	39	39	35	35	2	2	♀
16	—	—	—	—	—	—	—	♀
17	—	—	—	—	—	2	2	♂
18	4·2	29	29	33	33	—	—	—

The freshly gathered plankton was brought from the outside to the laboratory in quart thermos flasks. The material was then decanted into a glass jar, active copepods picked out with a glass tube and transferred to a litre flask containing filtered sea-water sterilized by heating to 70°C. The most successful experiment was started on July 14th from material conveyed to the laboratory in a thermos flask on the previous day. The air temperature in the laboratory at 9 a.m. was 19°C. The half-filled litre flask was loosely corked and placed in an ice-house near the laboratory, with a fairly constant temperature of 10°C. The Copepods remained active, without addition to diatom food, until August 28th, when the experiment was discontinued. See Table II.

Number 15, table II, proves that those copepods of Stage V with 2 Se on the Ri do not always exuviate to males (Fig. 28). Those that were undoubtedly exuviating to females as shown by the segmentation and the enlagrement of the first segment, of the urosome, (Figs. 1, 2, 25) and the large number of teeth on BI of p5, showed no peculiarities which might distinguish their sex in stage V, nor did those exuviating to males as shown by the segmentation of the urosome and large sized but few teeth on BI of p5 (Fig. 29). From the observations of the specimens of Table II it appears that there is no constant external feature which will serve to distinguish the sexes in stage V.

Exceptional Cases. One specimen, number 13, was peculiar in that the withdrawn parts of the setæ in the rami were wrinkled, Fig. 26. This was probably due to the pressure of the crowded tissues, but it is worth mentioning that the wrinkling in the two rami was practically identical. Number 17 was exceptional in that the distal point of the external ramus Re of the left p5 was obpyriform in shape (Fig. 32) while that of the right p5 was like those of the other swimming feet (Fig. 33). Another *Calanus* stage V obtained from "Prince" Sta. 3 on May 24th, showed an abnormality in the external rami of p5. Instead of the usual three Se on the distal joint, there were only two Se. (Fig. 35).

Stage VI. This is the adult stage which terminates the series of ecdyses and, although feeding continues, the main energy of the copepod is used in reproduction.

Length at stage VI. Of twenty-seven females examined, the lengths ranged from 2.92 mm. to 5.1mm., the average length being 3.6 mm. As in stages III and V, only one average length could be distinguished.

Coxal Teeth of female at stage VI. The first basal joint of p5 is denticulate along the inner margin. The teeth are in a long regular row, usually with a sigmoid bend in the middle of the row, extending the whole length of the joint. The average number of teeth is 34; 34·1 for the right p5 and 34·17 for the left. This average is greater than that for stage V.

Setæ. In the typical condition, as figured by G. O. Sars, there is one Se on both Ri of p5 in the female. Out of 59 specimens examined, 43 were typical, 15 had two Se, one had 2 Se on one Ri and one on the other. The two Se when present, are slender, as in stage V.

Length of male. Of 29 specimens examined, the length varied from 3 mm. to 5 mm., the average being 3·5 mm.

Coxal teeth of male. The denticulations on the basal joint of p5 are much larger and fewer in number than those of the female. Usually the distal end of the row is terminated by a large jointed tooth. The average number of teeth is 22; 23·4 for the right and 22·5 for the left.

Setæ of male fifth foot. In the typical condition, figured by Sars, there are two Se on the Ri of p5 in the male. These setæ are much stouter than those of stage V. All those examined conformed to the type except one that had one Se on the right Ri and two on the left.

The position of the one seta was opposite the middle of the distance between the two distal internal setæ, while the two Se were each opposite an internal seta. This suggests that two Se had been replaced by one Se, and we would expect to find the one Se double the normal size, but this was not the case.

B. Calanus hyperboreus

This species was not very abundant in the tows, only twenty individuals being obtained from a vertical haul taken at "Prince" Sta. 3, May 24th, 1916. There is a regular row of large coxal teeth on p5 in Stages V and VI, but unlike *C. finmarchicus*, there are no coxal teeth in stage IV. The teeth are larger and fewer in number than in *C. finmarchicus* and the row does not reach the distal end of the joint. Like *C. finmarchicus* there may be two Se on each Ri of p5, or only one. Of three females examined, two of them had one Se on each Ri; the other had one Se on the right and two on the left. The occurrence of similar variations in the two species is a point of interest.

Final Exuviation of Eurytemora and Tortanus

Eurytemora herdmani, Thompson and Scott, was the most abundant copepod in the tows taken from the wharf of the Biological Station during the latter part of June and first part of July. Unlike *Calanus* which has no exuviation after it has reached the female ♀ 1 stage, *Eurytemora* exuviates from an immature stage of the female (Fig. 36) to the mature female ♀ 2 (Fig. 37). In ♀ 1 the postero-lateral angles of the forebody are produced as soft points, each with a single subapical spinule, and are not expanded into the characteristic winglike structures of ♀ 2 (Fig. 37). It is further distinguished from ♀ 2 by the structure of the fifth swimming feet (Figs. 38, 39). In ♀ 1 the undivided rami of p5 have each a smooth claw-process directed obliquely inwards and distal, not bent so as to lie parallel with the distal part of the ramus which is not articulated in this stage; there is no external seta on the second basal joint, nor is there a cilium proximal to the first external seta of the ramus as in the adult.

One measuring 1·2 mm. in length was kept alive three days in filtered sea water in a Syracuse watchglass covered by another. On the third day (June 14th), although still alive, it had ceased darting about and on close examination was discovered to be in a process of ecdysis to ♀ 2. Its appendages were moving and heart beating intermittently. At 9 a.m. on June 15th, the heart had stopped beating, but there was still an occasional quiver of the appendages and a slight peristaltic movement of the intestines; the exuvia had partly separated from the new cuticle. The copepod was transferred to a slide and a coverslip supported by a strip of paper was put over it. This slight pressure caused the exuvia to break away from parts of the body. The new postero-lateral angles of the forebody were freed and showed that they were more expanded and winglike than those of the exuvia. (Fig. 40). The caudal rami, which are 4½ times as long as they are wide, had partly withdrawn. The p5 of ♀ 2 could be clearly distinguished within the old cuticle, especially the spines of the claw process of the proximal joint of the ramus and the articulation of the terminal joint (Fig. 41).

In an oblique haul taken from the wharf on June 12, there were many mature females with their ovisacs attached, darting about in the water. One specimen had not less than fifty eggs in its ovisac, each ·082 mm. in diameter, and on examination it was found that there were many more eggs in the oviduct. It was estimated that there were enough eggs within the copepod to fill three successive ovisacs. In another specimen the eggs within the ovisac were much farther advanced and were nearly ready for hatching. In fact the ovisac had broken and a few of the nauplii had already escaped. In the same haul were a few males easily distinguished by the naked eye from the females and the other copepods by the scarlet tumefied portion of the right antenna. The right ramus of p5 had a roughened ridge at the end of the terminal joint, but no plumose seta (Fig. 42).

Tortanus discaudatus, Thompson and Scott, was usually found in the tows taken from the wharf at the Biological Station in June and July. Although it was not nearly as abundant as *Eurytemora* yet it could be picked out from the other copepods by its slightly bluish tinge. This colour was due to small dark blue spots at the base of the appendages. Towards the end of June and during July females were obtained with spermatophores attached.

As in *Eurytemora* there is an exuviation within the female stage. *Tortanus* ♀ 1 is 1·52 mm. in length. There are three segments in the urosome and the rami of the caudal furca are nearly alike (Fig. 43). The p5 are 3-jointed, with a plumose seta on the distal basal joint and four delicate spines on the ramus (Fig. 44). *Tortanus* ♀ 2 is about 2·25 mm. in length, with unequal caudal rami and a clump of stiff cilia on the right side of the second segment of the urosome. The large right caudal ramus has an area of pubescence on the outer surface, and a row of cilia on the inner surface; and the basal portion of the outer seta is enlarged to form a conspicuous process (Figs. 45 and 46). The p5 differs from that of ♀ 1 by having the ramus smooth and without any spines (Fig. 47). Eggs were seen in the ovaries of ♀ 1 as well as in ♀ 2, but in ♀ 1 they were in a single row while those of ♀ 2 were in two or three rows. In *Tortanus*, *Eurytemora* and many others the sexes can be separated by the character of p5 in earlier stages.

Species of Acartia

During the latter part of July and the first week in August, a species of *Acartia* was very abundant in the tows taken at the mouth of the St. Croix River opposite the Biological Station. On July 21st, a foggy rainy day, a tow of five minutes was taken off Kitty's Cove when the tide was on the ebb. The copepods were numerous and nearly a pure culture of *Acartia* of all stages from the nauplius to the adult. The general appearance and specific characters of the adult resembled more closely than any other the description of *A. clausi* Giesbrecht. The female ranged from 1·08 to 1·13 mm. in length, without any trace of rostral filaments. Some specimens had the lateral lobes of the last segment of the forebody beset with from four to six cilia. These cilia were not present in all the copepods examined. Some had them only on the right lobe while others had no trace of them. On the dorsal surface of the first segment of the urosome were a few cilia, but the posterior edges of the first two segments were not clothed dorsally with a transverse row of denticles as in the Norwegian material described by Sars. The urosome of the females was half as long as the forebody; the first segment measured ·124 mm., the second ·072 mm., the third ·04 mm., and the caudal furca ·072 mm. The anterior antennæ scarcely exceeded the length of the forebody, the fifth articulation having a distinct denticle in front. The length of the apical spine of the outer ramus in the second to fourth pairs of legs scarcely exceeded that of the ramus. The p5 were similar to the figure given by Sars. A specimen was obtained holding a spermatophore with the terminal joints of p5 (Fig. 48).

The male of *A. clausi* ranged in size from ·92 to 1·04 mm. The caudal rami were shorter than those of the female, being about as long as the anal segment. The p5 (Fig. 49) resembled Sars' figure except that the third joint of the left leg had two clumps of cilia on its posterior surface and the terminal joint was more spoon-shaped with the concavity filled with long slender cilia in addition to stout marginal cilia (Fig. 50). The terminal joint of the right p5 had two minute tufts of cilia on its posterior surface (Fig. 51).

In a tow taken at "Prince" Sta. 1 on July 23rd, 1916, three specimens of *Acartia longiremis*, two adult females and one adult male, occurred. This is the first record of this species at St. Andrews. It can be distinguished from *A. clausi* by the lateral lobes of the last segment of the forebody, which are rounded at the tip, each carrying dorsally a conspicuous spinule. The terminal joint of p5 of the female is much longer and slenderer than that of *A. clausi*, as it equals in length the long plumose seta of the second joint. (Fig. 52).

Rudimentary p5 in Pseudocalanus

Pseudocalanus elongatus was the most abundant copepod taken in the tows during June, July and first part of August. The majority of these were females with no fifth swimming legs, but on June 28th, in a ten fathom haul taken at "Prince" Sta. 3, two females were noted with rudimentary p5 (Fig. 53). This rare anomaly has been signalized by A. Bœck (1864) and A. Mrazek (1902). Mrazek's figures are reproduced by P. J. van Breemen in *Nordishches Plankton*, Bd. LV., 1908, p. 25. These rudimentary p5 are small, three-jointed appendages with the terminal joint blunt, not tipped with a spinule. No females of stage V were found with any trace of p5. All the males in stage V have immature p5 which are four-jointed, tipped with a spinule, and much larger than the rudimentary p5 of the adult female (Fig. 54). The peculiar asymmetry of the p5 of the adult male is not evident in Stage V, except that the left leg is slightly larger and longer than the right.

Immature p5 of Metridia

Two species of *Metridia* occurred occasionally in the tows. *M. lucens* and *M. longa*. Even in the immature copepodite stages, not only the species, but the sex may be determined. From a vertical haul made at "Prince" Sta. 3 on June 28, 1916, a number of *Metridia* at different stages were obtained. There were three specimens of *M. lucens* stage IV; one female and two males. Both female and males were 1·4 mm. in length and had three joints in the p5. The terminal joints of the p5 of the female are about equal in length to each of the other joints and carry at their tips two slender setæ (Fig. 55).

The terminal joints of the male are two and a half times as long as each of the other joints, and each carried three short external setæ, one terminal seta, and two internal setæ (Fig. 56).

There were seven specimens of *M. lucens*, stage V two females and five males. One female was 2·1 mm. in length, the other measured 2 mm. and was exuviating to stage VI. Three of the males were 1·9 mm. in length, the other two being 1·8 mm., and 1·3 mm. respectively. The fifth swimming legs of the female were similar to those of the adult except that one female had an outer seta on each of the second joints. This seta was not present on the other specimen which was exuviating to stage VI, nor is it figured by Sars.

Three specimens of *M. longa* stage V occurred; two females and one male, 3·5, 3, and 3 mm. The p5 of both sexes were much larger than those of *M. lucens*, and four jointed, the first three joints similar in appearance and size. The third joint of the female carried distally a short slender outer seta; the terminal joint was about equal in length to the third and carried three long slender setæ (Fig. 57). The third joint of the male carried distally a very small outer seta; the terminal joint was nearly 4½ times as long as the third joint, with two small outer setæ, two terminal setæ and four small inner setæ (Fig. 58).

In conclusion I wish to acknowledge the kindness and assistance which I received from my professor, Dr. Willey.

Explanation of the Figures

Fig. 1. *C. finmarchicus* V exuviating to VI. Part of outer ramus of fifth foot, showing terminal and external setæ withdrawn into seta sacs.

Fig. 2. Same. Caudal ramus with inner cylinders of terminal setæ of exuvia exposed, cylinders and seta sacs formed by everting setæ.

Fig. 2.[1] Same. Seta of exuvia slipping off inner cylinder.
Fig. 3. Same. Terminal setæ of caudal ramus unfolding.
Fig. 3.[1] Same. The new third terminal seta of the right caudal ramus with inner cylinder formed at base.
Fig. 4. *C. finmarchicus* V. Urosome showing regeneration of lost setæ.
Fig. 5. *C. hyperboreus* III-IV.
Fig. 5.[1] Mandible; inner lobe (molar process) withdrawing.
Fig. 5.[2] Maxilla; first inner lobe (Li I) withdrawing.
Figs. 6 to 19. *C. finmarchicus* IV. Variations of coxal teeth on the fifth feet. The lengths in millimetres were (6) 2·017; (7) 2·00; (8) 2·00; (9) 2·10; (10) 2·06; (11) 2·13; (12) 2·12; (13) 2·18; (14) 2·26; (15) 2·60; (16) 2·80; (17) 3·06; (18) 3·08; (19) 2·84.
Fig. 20. *C. finmarchicus* IV–V. Fifth foot showing internal coxal teeth of stage IV; also internal segmentation of Re and Ri.
Fig. 21. *C. finmarchicus* IV–V. Coxal teeth of p5, external and internal.
Fig. 22. *C. finmarchicus* IV–V. A caudal ramus.
Fig. 23. *C. finmarchicus* V. Bl of p5, aberrant.
Fig. 24. *C. finmarchicus* V–VI. Bl of p5 showing external and internal coxal teeth.
Fig. 25. *C. finmarchicus* V–VI. Bl of p5 showing external and internal coxal teeth.
Fig. 26. *C. finmarchicus* V–VI. Caudal ramus showing wrinkled bases of seta sacs.
Fig. 27 A. *C. finmarchicus* V–VI. Urosome.
Fig. 27 B. *C. finmarchicus*. Outer aspect of new caudal ramus.
Fig. 28. *C. finmarchicus* V–VI. External and internal coxal teeth.
Fig. 29. *C. finmarchicus* V-VI. External and internal coxal teeth.
Fig. 30. *C. finmarchicus* V–VI. Exuviation of urosome.

Fig. 31. *C. finmarchicus* V–VI. Exuviation of urosome.
Fig. 32. Same. Distal joint of Re of left p5, showing the internal obpyriform joint of stage VI.
Fig. 33. Same. Distal joint of Re of right p5.
Fig. 35. *C. finmarchicus* V. Distal joint of Re of p5 showing only two Se.
Fig. 36. *Eurytemora herdmani.* First (immature) form of female showing one of the postero-lateral angles of the forebody and the urosome.
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Fig. 38. *Eurytemora herdmani.* 1. Fifth feet.
Fig. 39. *Eurytemora herdmani.* 2. Fifth feet.
Fig. 40. *Eurytemora herdmani.* I–II. Exuviation of the right postero-lateral angle of forebody.
Fig. 41. *Eurytemora herdmani* I–II. Exuviation of p5. The serrated claw of 2 is seen within the smooth claw of 1.
Fig. 42. *Eurytemora herdmani.* Terminal joint of right of p5, showing a distal ridge instead of a plumose seta.
Fig. 43. *Tortanus discaudatus* I. Posterior part of forebody and urosome from above.
Fig. 44. Same. Fifth foot showing spinules on the ramus.
Fig. 45. *Tortanus discaudatus.* 2. Urosome in side view showing clump of cilia on the right side of the second segment and an area of pubescence on the right caudal ramus.
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Fig. 47. *Tortanus discaudatus.* 2. Fifth foot showing absence of spinules on the ramus.
Fig. 48. *Acartia clausi.* Genital segment, showing spermatophore held by p5.
Fig. 49. *Acartia clausi.* Fifth feet.
Fig. 50. Same. Part of left p5, showing slender and stout cilia on terminal spoon-shaped point; two clumps of cilia on third joint.
Fig. 51. Same. Distal joint of right p5, showing two distal clumps of setæ.
Fig. 52. *Acartia longiremis.* Fifth feet and postero-lateral spines.
Fig. 53. *Pseudocalanis elongatus.* Rudimentary p5.
Fig. 54. *Pseudocalanus elongatus* V. Immature p5.
Fig. 55. *Metridia lucens* IV. Immature p5.
Fig. 56. *Metridia lucens* IV. Immature p5.
Fig. 57. *Metridia longa* V. Immature p5. Distal setæ omitted from right leg in the figure.
Fig. 58. *Metridia longa.* V. Immature p5.

Legends for Graphs

Graph I. *C. finmarchicus IV.*

Bimodal curve showing length variations of 116 individuals from "Prince" Sta. 3, June 28th, 1916, 10 fathom tow.

Graph 2. *C. finmarchicus IV.*

Curve showing variation in number of coxal teeth in the 116 individuals employed in graph I.

Graph 3. *C. finmarchicus IV.*

Curve showing correlation between length and coxal teeth in the series employed in graphs 1 and 2.

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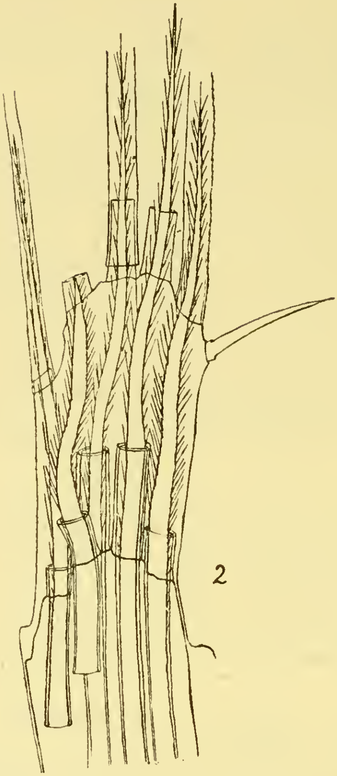

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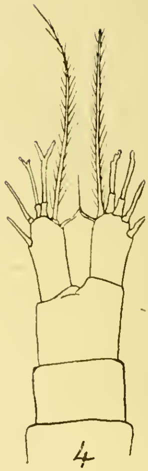

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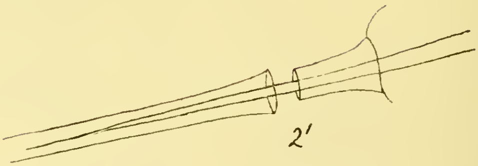

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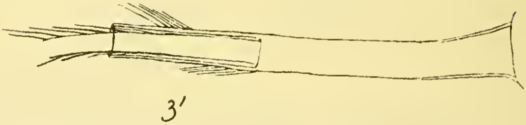

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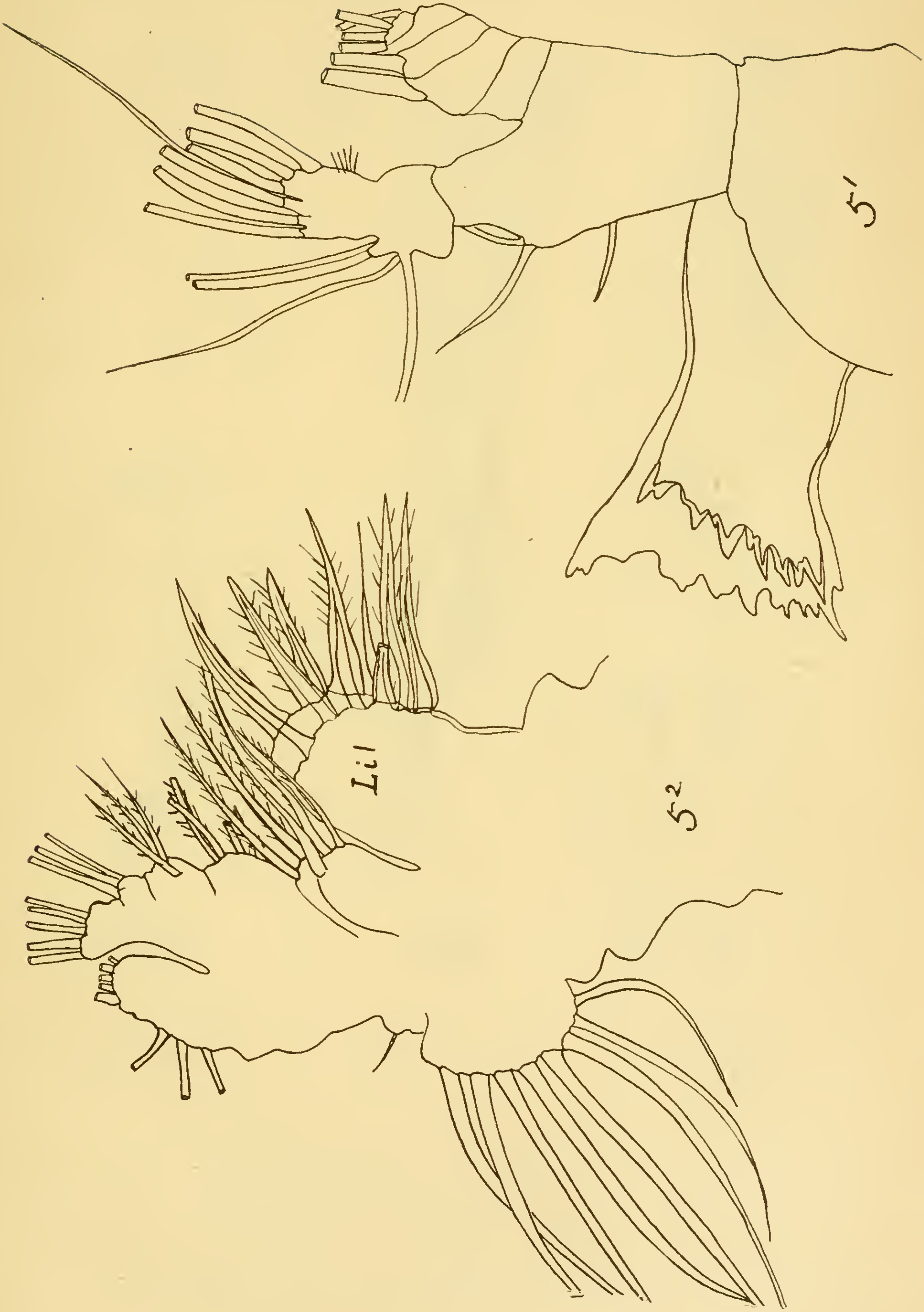


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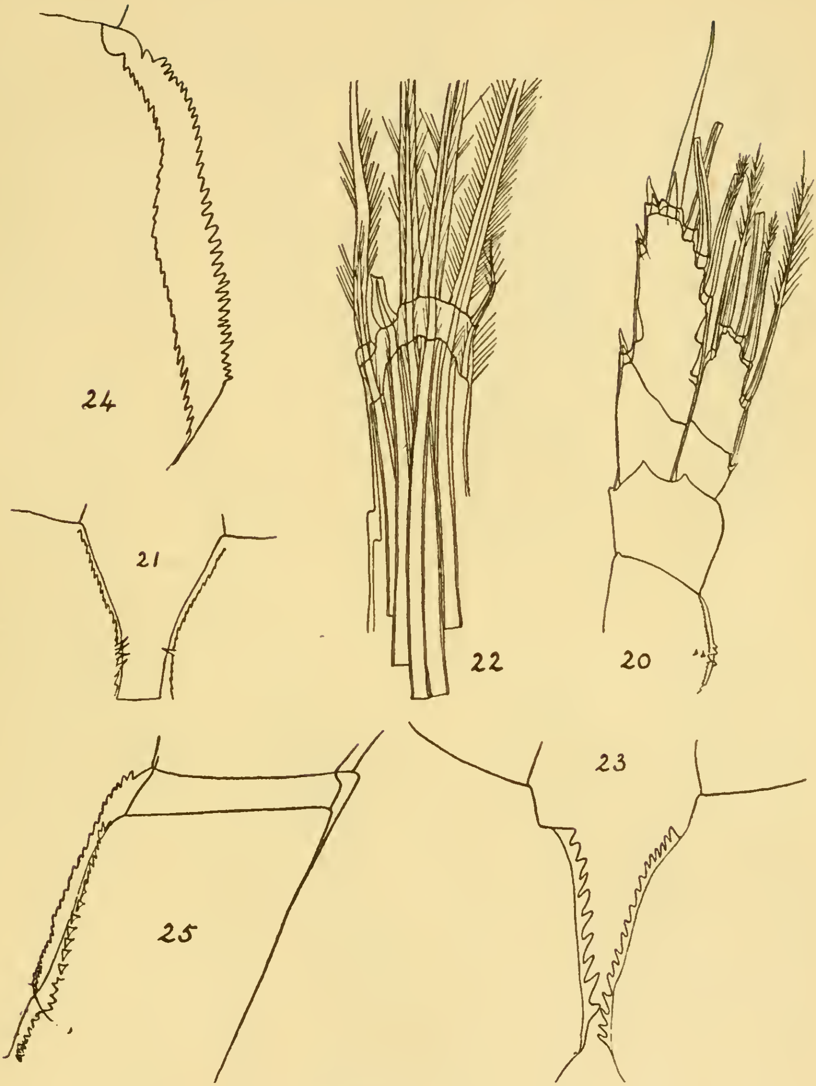
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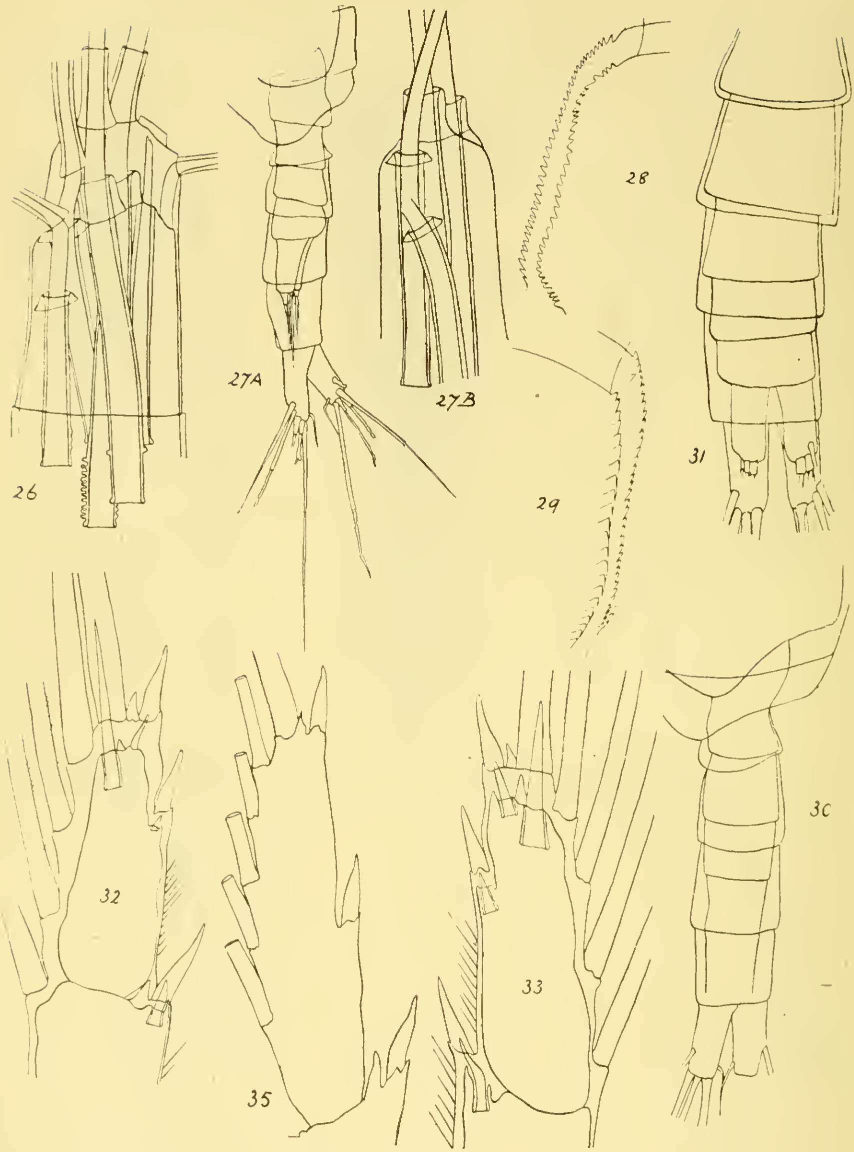

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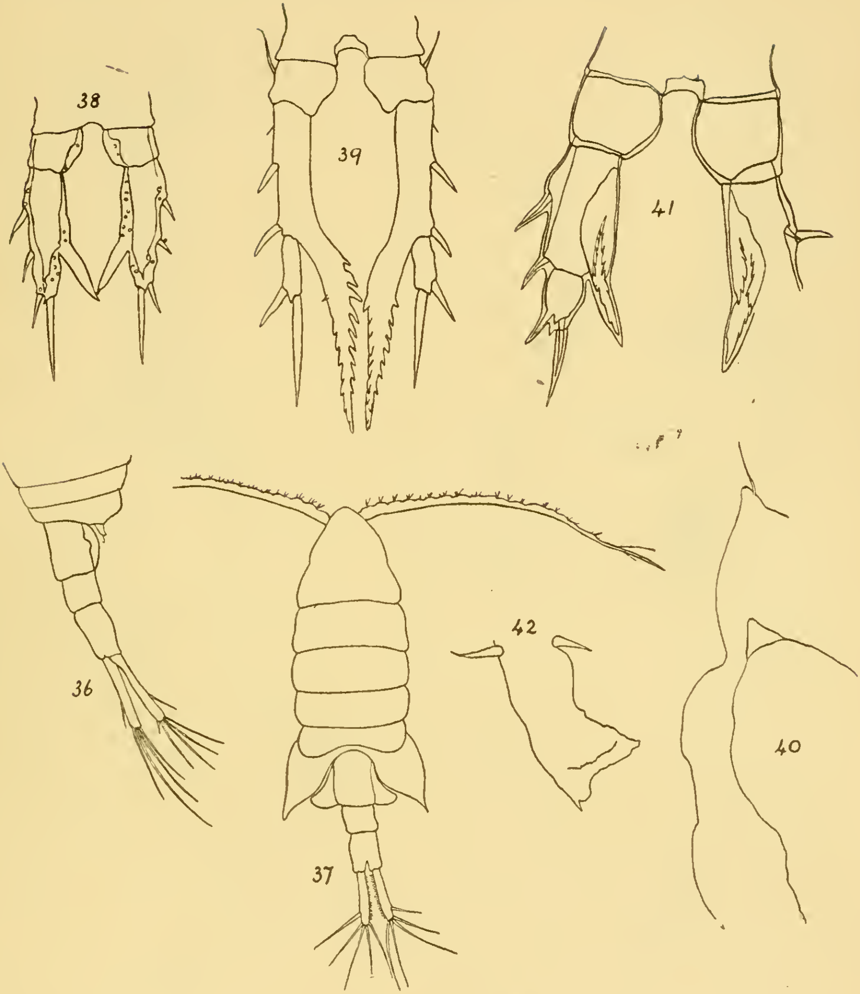
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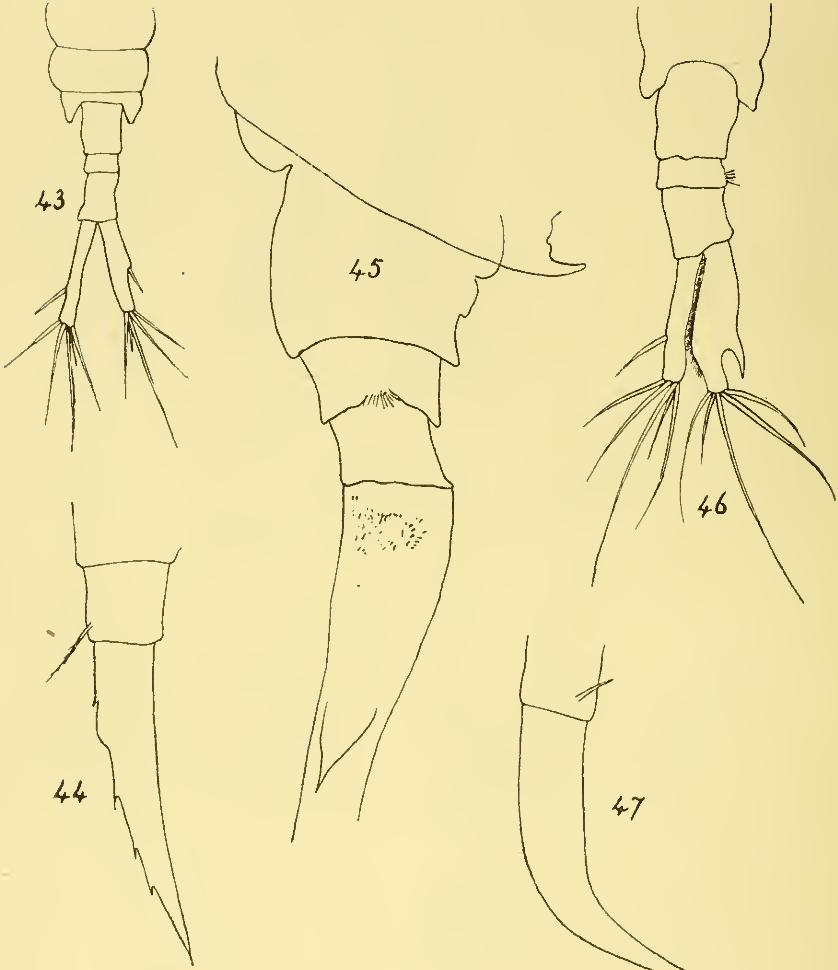
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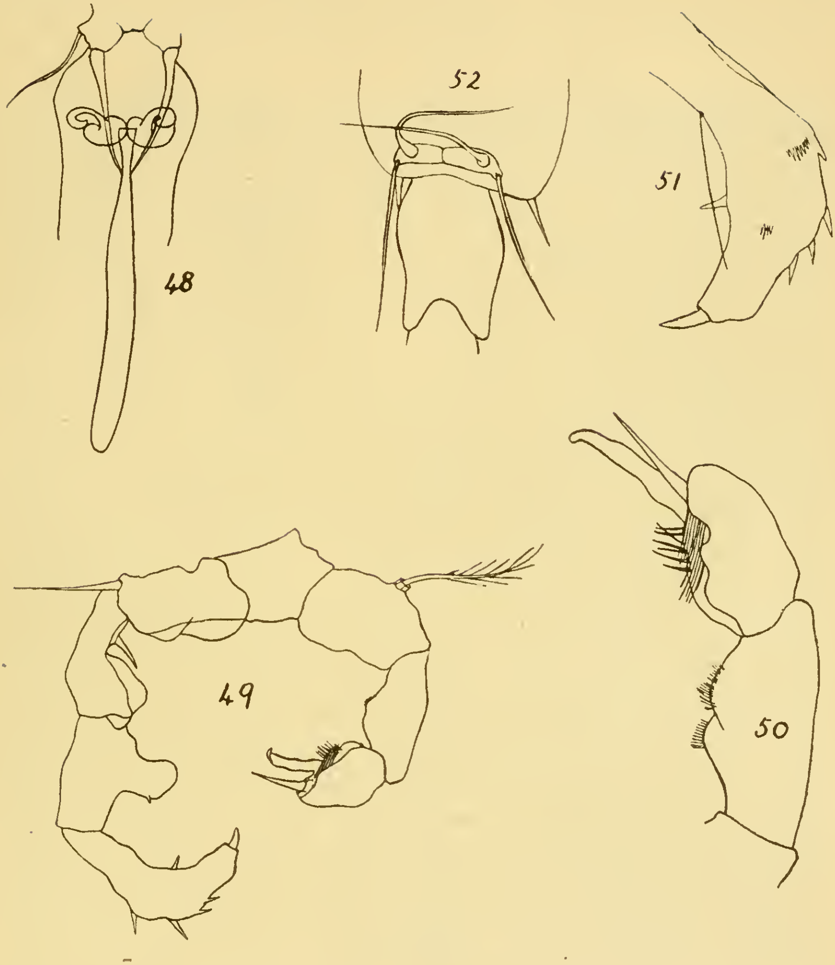
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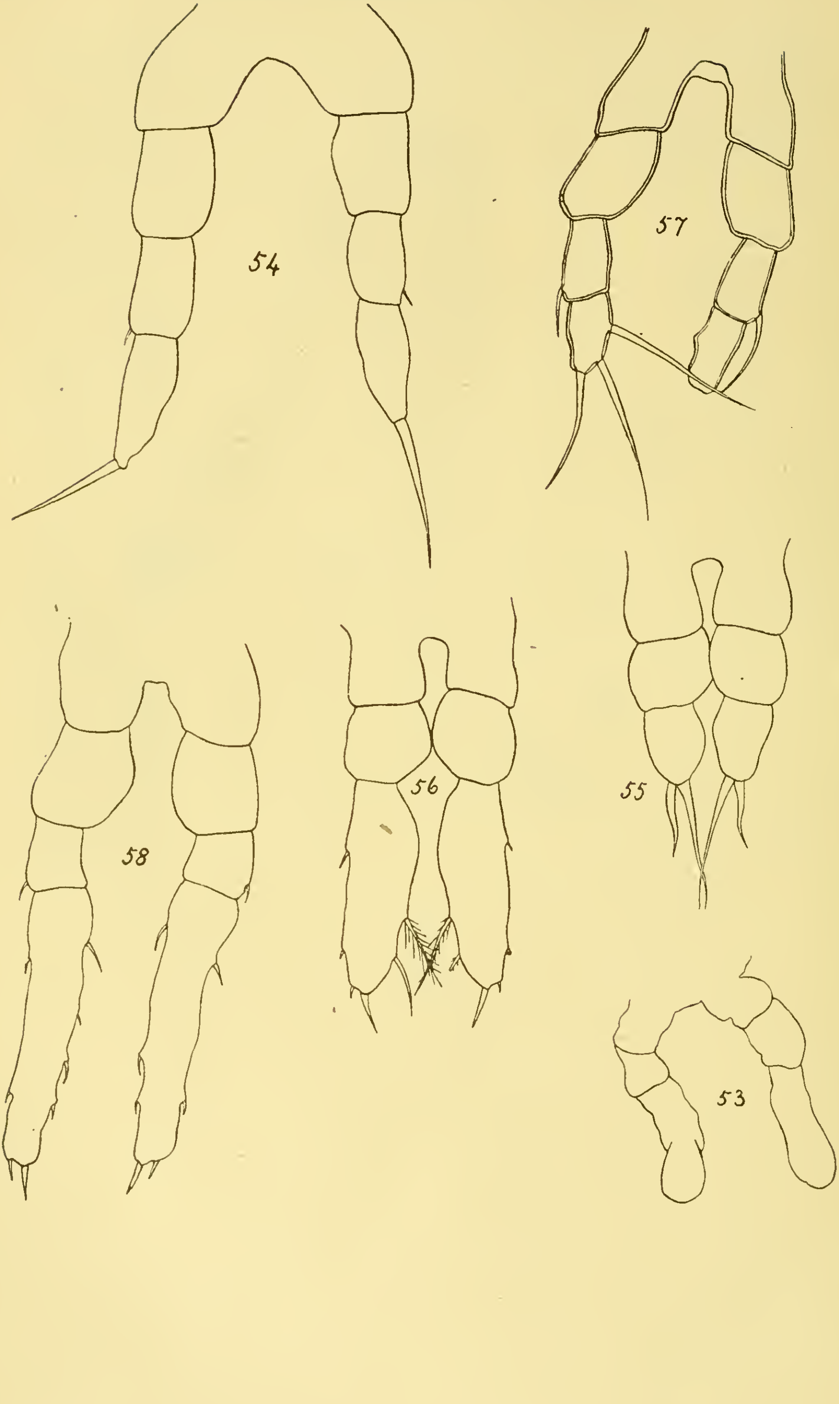
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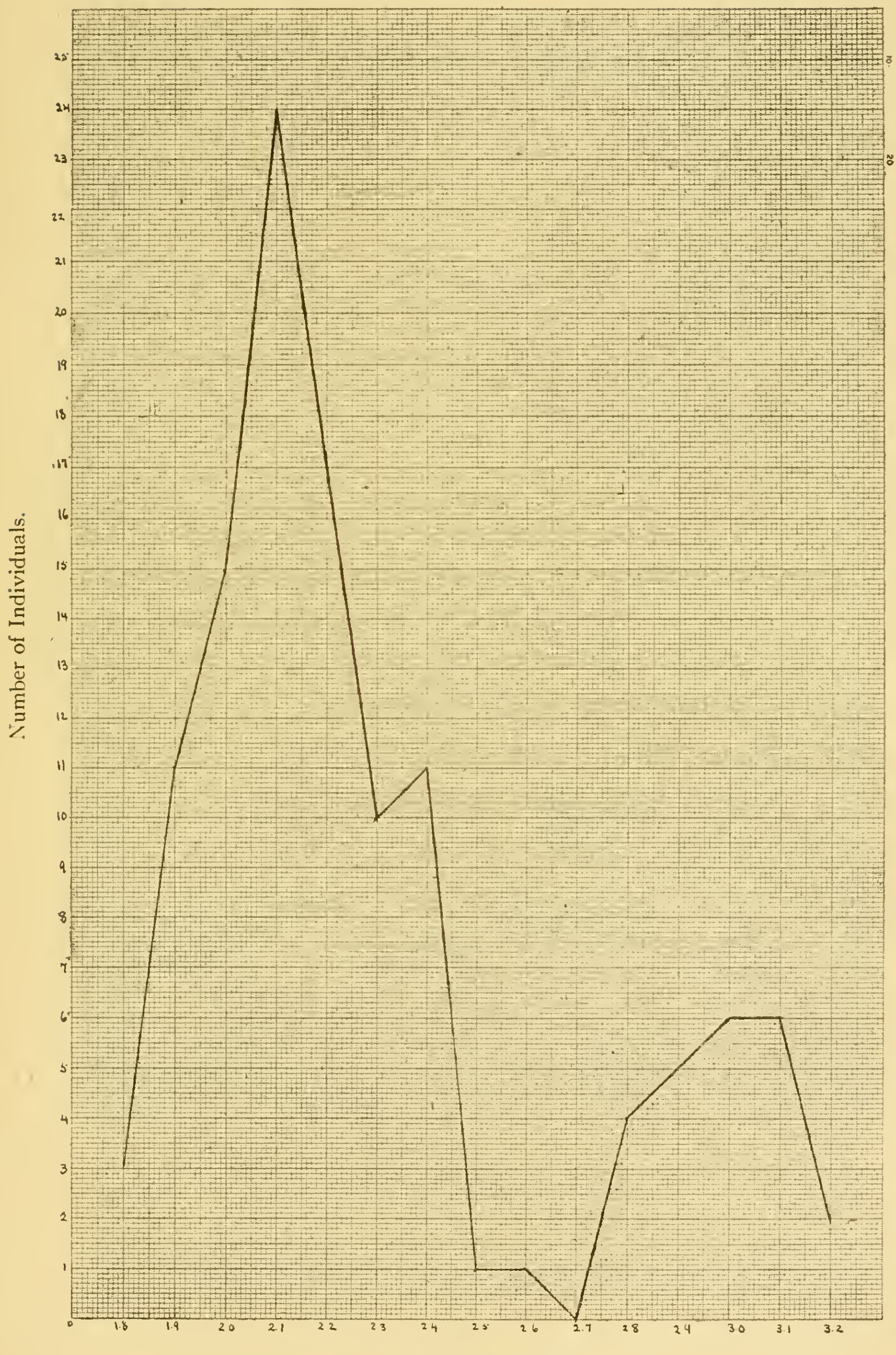
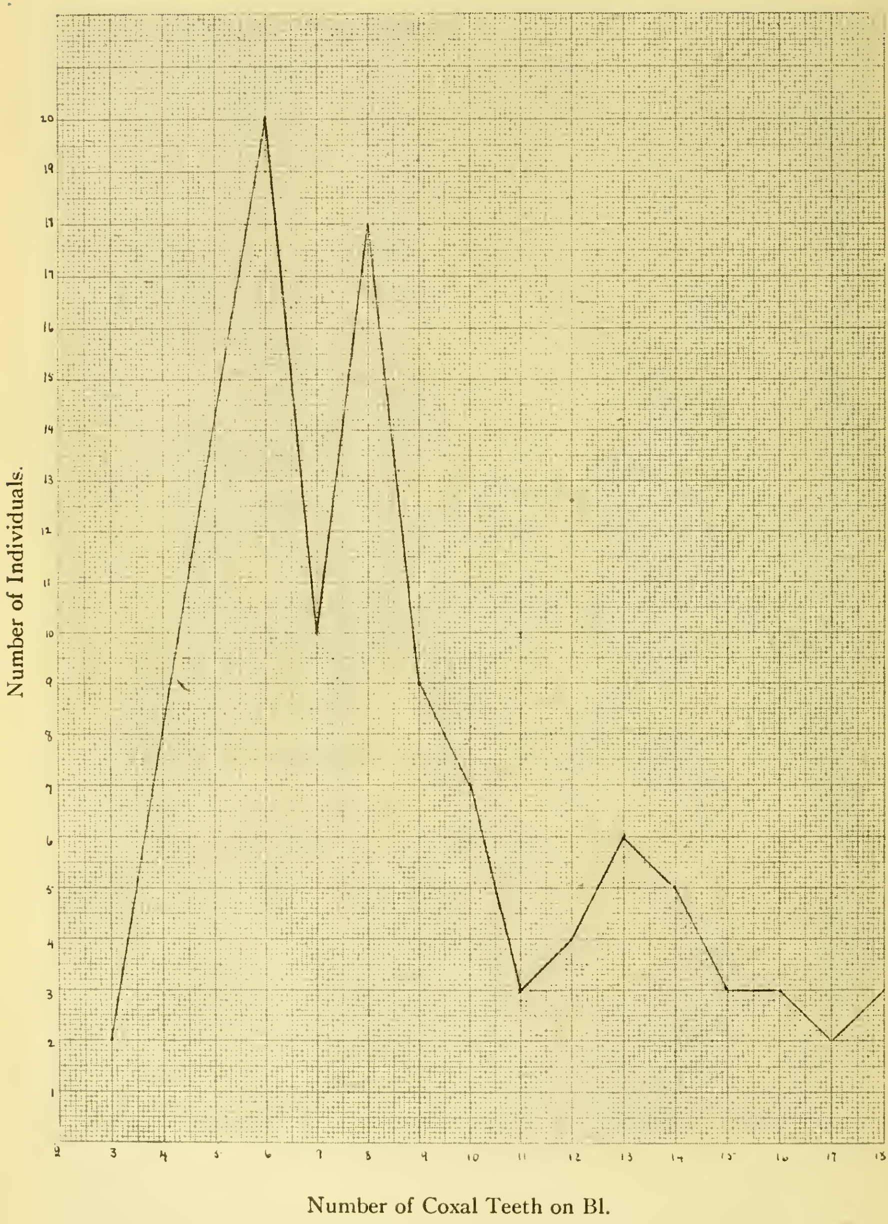
GRAPH I. *Calanus finmarchicus* stage IV "Prince" Sta. No. 3, June 28, 1916. 10 fm. tow. 116 individuals.

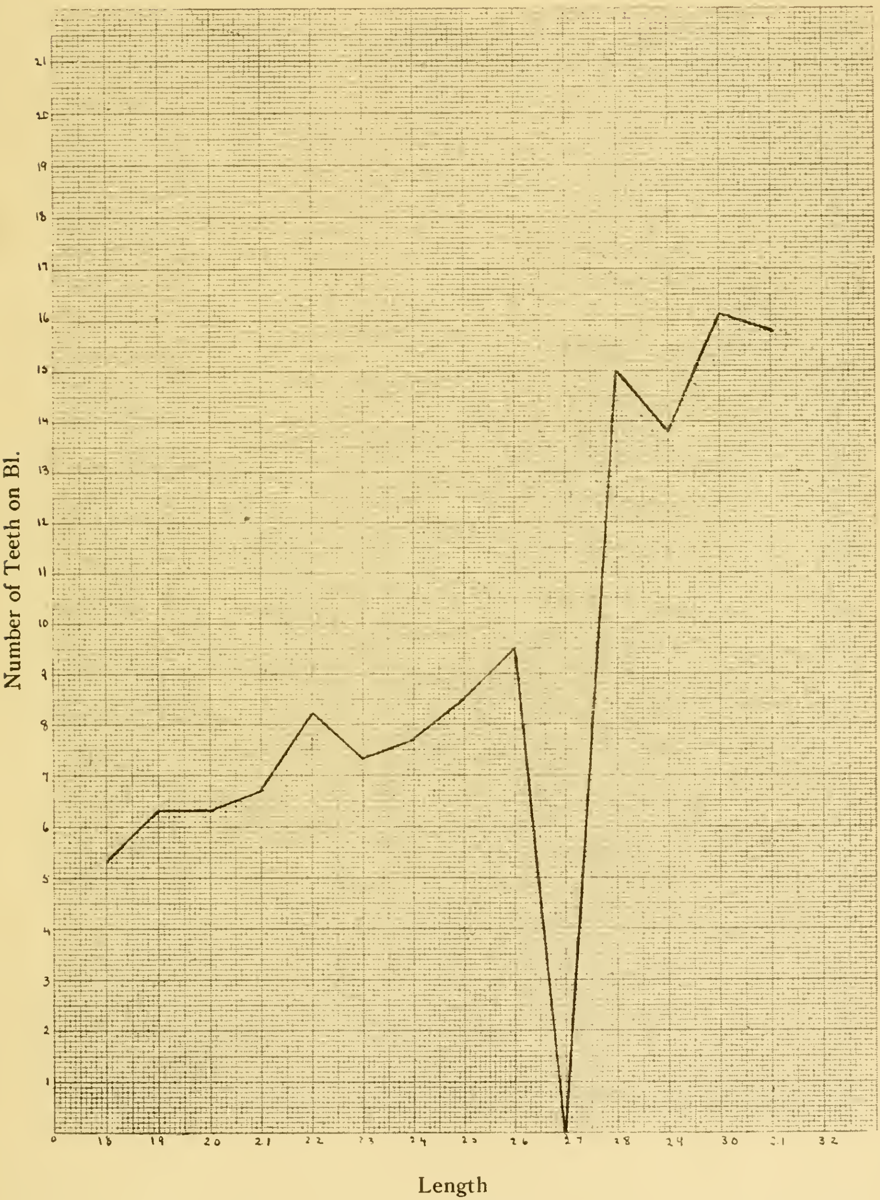


Length of Individuals.

GRAPH II. *Calanus finmarchicus* stage IV "Prince" Sta. No. 3, June 28, 1916.
10 fm. tow.



GRAPH III. *Calanus finmarchicus* stage IV "Prince" Sta. No. 3, June 28, 1916. 10 fm. tow.



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