TRANSACTIONS

OF

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VOLUME II., 1890-91.

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THE CANADIAN INSTITUTE,

1890-1891.

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OF

THE CANADIAN INSTITUTE,

SESSION 1890-91.

FIRST MEETING.

First Meeting, 1st November, 1890, the President in the chair.

Donations of books and pamphlets since last meeting, 279, including 151 volumes from Mrs. Seidler, and 61 volumes from Hugh Wilson, F.G.S., who also presented 45 specimens of Canadian woods.

Exchanges since last meeting, 2,042.

The following were elected members:—A. H. F. Lefroy, M.A., Dr. R. Orr, Widmer Hawke, Fred. A. T. Dunbar, Dr. Thomas Millman, J. J. Murphy, C. G. Cremer, and Hugh Wilson, F.G.S.

The Council reported the election of Frank Tweed as an associate.

The following communication from A. H. F. Lefroy, M.A., was read by Dr. Kennedy:—

"GENERAL SIR JOHN HENRY LEFROY, K.C.M.G., C.B., F.R.S.

"I desire to comply with the kind request of the Canadian Institute as contained in their resolution of April last, and furnish a short biographical notice of my father, General Lefroy, who died on April 11th of this year. He was a son of the Reverend John Henry George Lefroy, Rector of Ashe, in the County of Hampshire, in England, and was born at Crondall, in that County, in 1817. In his 17th year he obtained his commission in the Royal Artillery, one of the two scientific regiments in the service, and throughout his life his energies were largely occupied in scientific work, and especially in the scientific work of his profession. Thus it will be seen that he did not enjoy the advantages, which he esteemed so highly, of a University training.

"In 1839 he was sent to the Island of St. Helena as director of the Magnetical Observatory there. In 1842 he was chosen by the Royal Society to undertake the work of a Magnetic Survey of the British

possessions in North America, and during the years 1843 and 1844 he made a series of magnetic observations extending as far as Fort Good Hope on the Mackenzie River, the results of which were recently revised and published by him in a work entitled, "Diary of a Magnetic Survey of a Portion of the Dominion of Canada, Chiefly in the North-Western Territories:" (Longmans, Green & Co.) Mount Lefroy, in the proximity of Kicking Horse Pass, in the Rocky Mountains, was named after him, as was also the village of Lefroy, in the County of Simcoe, in this Province, thus preserving the memory of his name in the two parts of the Dominion in which his work and associations chiefly lay.

"In 1844 he was placed in permanent charge of the Magnetic Observatory in Toronto, and in 1852 was President of the Canadian Institute, having been Vice-President in the previous year, the year of its origin. In the first volume of the proceedings of the Institute are to be found papers by him on "Theometric Registers" and on "The Probable Number of the Native Indian Populations of British America." Returning to England in 1853, he was appointed secretary to the Royal Artillery Institution at Woolwich, which he had himself been mainly instrumental in founding in 1838. Passing by minor appointments, in 1857 he was gazetted Inspector-General of Army Schools, and in 1869 Director-General of Ordnance. In 1871 he was appointed Governor of the Bermudas, and during his term of office was made a Companion of the Bath, and Knight Commander of the Order of St. Michael and St. George. On his return home he published, in two large volumes, the early Chronicles of the Bermudas (Longmans, Green & Co); and one of his latest literary labours was to edit for the Hakluyt Society, from a manuscript in the Sloan Collection of the British Museum, "The Historye of the Bermudaes or Summer Islands," the authorship of which is attributed to Captain John Smith, the historian of Virginia, and covers a period from 1609 to 1622. In 1880 he was for a short period Governor of Tasmania. In 1881 he attained the rank of Colonel Commandant in the Royal Artillery, and in 1882 retired from the service with the rank of General

"My father belonged to a great number of the learned societies in London, and took an active interest in their proceedings. He was a fellow of the Royal Society, the Geographical Society, the Society of Antiquaries, the Royal Archæological Institute and the Hakluyt Society. He was also a member of the Council of the Royal Society from 1878 to 1880, and of the Geographical Society for one year. He was a life member of the British Association for the Advancement of Science, and in 1884 presided over the Geographical Society of that Association when it met in Montreal. He served on the Committee

of the Palestine Exploration Fund. He was a member of the Athenæum Club, which is the great literary club of London, and also of Nobody's Club. I should also state that in 1883 McGill University conferred upon him the degree of LL.D.

"In 1848 he married a daughter of the late Sir John Beverley Robinson, then Chief Justice of Upper Canada, who died in 1859. He subsequently married a daughter of Lieut.-Colonel Thomas Dundas, of Carron Hall, Stirlingshire, Scotland, who survives him.

"My father was throughout his life a frequent contributor to the proceedings of the various learned societies to which he belonged. He also took a keen interest in the political and public questions of the day, in literature, and in history. For matters of family history, of genealogy, and of heraldry he had a marked taste, and collected with much labour, and in 1868 privately published, the records of our own family. A devoted son of the Church of England, he made a life-long study of her theology, and was especially an admirer and student of Hooker's great work on Ecclesiastical Polity.

"It is, however, for others, and not for me, to speak of my father's deep religious convictions, and consistent Christian life; of the breadth of his mind and the unflagging zeal with which he flung himself into all his work; of his well-directed energy, of the activity of his mind, and his widely-extended interests; of the kindliness of his heart, and his charitable efforts on behalf of the Patriotic Fund and numerous other benevolent institutions, and of his high standard of honour and of principle. It would, I am sure, be a gratification to him to know that some record of his life, however imperfect, was preserved in the pages of the Journal of the Canadian Institute, in the welfare of which he felt so much interest, as indeed he did in everything connected with Canada."

Mr. David Boyle, Ph.B., read a paper on "The Canadian Institute of the Future." He referred to the approaching jubilee of the Institute as a fitting opportunity to look forward as well as backward. Reference was made to the work that has been performed, as evidenced by the many volumes of proceedings and transactions issued, and special notice was taken of the fact that Mr. Sandford Fleming first proposed the standard time system now rapidly becoming adopted. Mention was made of the many distinguished men who have been connected with the Society since its foundation, but, notwithstanding all this, it was deplored that the Institute did not accomplish all the good it was capable of. The condition and management of the reading-room, library, and museum were criticised, and the situation of the building and night of meeting (Saturday) were mentioned as hindrances to success. Want of funds was

referred to as crippling every effort to progress, and it was suggested that the annual fees be raised from $4 to $10, or even more. It was held that "after an existence of forty years the Institute should occupy a very much higher and more honourable position in Ontario and Canada than it does. Its *dicta* on scientific and historical matters should be respected, its library of works upon such subjects ought to be the best in the Dominion, its opinions should be quoted, and its wishes consulted. Its publications should be sent among the people by thousands, and not by a few paltry hundreds, and to be one of its members ought to be regarded as highly meritorious." A supposititious account of the Institute twenty years hence brought out by comparison many existing defects. The following were offered as suggestions for the future :—Summer and winter meetings elsewhere than in Toronto ; special meetings in the rooms during the regular session, with invitations to the public ; increased activity on the part of individual members ; increased annual payments and an entrance fee; removal to larger and more conveniently situated premises, and a change in the night of meeting ; failing increase of revenue and ability to secure better accommodation, to hand the library and museum over to the City Public Library, or the books alone to it, and the museum to the University. Reference was made to the attempts of some to secure Upper Canada College, and a suggestion to organize the Institute on a basis analogous to that of the Washington Smithsonian was discussed The paper closed with a suggestion that a committee be appointed to take the whole of this subject into consideration and " prepare a report whereby it may be deemed possible to place the Canadian Institute on such a footing financially, and influentially, as may tend to its becoming all it ought to be, and all its best friends fervently desire it should be, namely, the largest, most useful, and best accredited scientific association in Canada, and not inferior to the best in any other country.

Mr. O. A. Howland suggested the propriety of making a valid claim to the Upper Canada College grounds. He thought that a united effort should be made by the Institute and other societies for that purpose. The Institute would start with a certain amount of capital, and would be entitled to take the lead. The Upper Canada College grounds would be the very best site for the purpose. It would be the most suitable for the musical societies, for the Art Association, and for museum purposes, and would be one of the most prominent objects presented to the visitors of Toronto. He suggested that the members who had formerly been appointed on the committee to act with other bodies should be re-appointed.

Mr. William Houston was in favour of changing the night of meeting from Saturday to some other night of the week. It would be an advan-

tage to have newspaper men attend the weekly meetings, but reporters cannot attend on Saturday night.

Mr. Arthur Harvey would rather look to the labours of the few to form the strength of the Institute than to the accession of the many. He did not think that its prosperity was to be advanced by courting popularity. He referred to the large amount of valuable work that had already been done. He said that Mr. Boyle had not alluded to the fact that it was on the action of the Institute that the Provincial Government had made the grant for archæological purposes. The Canadian Institute of the future should have nothing to do with anything but the consideration and discussion of the subjects which were brought before it. It was on these lines that other important and valuable societies had worked. He had viewed with a good deal of interest the movement that Mr. Howland and his friends had inaugurated for obtaining the Upper Canada College grounds in conjunction with the other societies mentioned.

Mr. Pearce, in reference to what Mr. Boyle had said about handing over the museum to Toronto University, could not agree to the surrender of that portion of it that belonged to the Biological Section. As to the matter of obtaining funds, he recollected calling on 30 or 40 out of a list of 82 merchants, and did not succeed in getting more than five dollars. The efforts for getting up a conversazione last year had failed through the inability to raise the requisite funds. He was in favour of a location for the Institute further up town. Somewhere nearer the University would be much more convenient. He recommended that enquiries should be made about the lot on McCaul street that had been referred to.

Mr. Dewar was not in favor of removing to another locality. He thought that one near the University would not be so convenient for strangers in the city. He would like to see the professors and other men of eminence in scientific pursuits attend the meetings and take a more active part in the proceedings.

Mr. Squair: If the Institute was located farther up in the city, and nearer to where he lived, he would attend oftener, but it would not be wise to move for the sake of benefiting some when it may inconvenience others. He was altogether opposed to raising the amount of the annual subscription to ten dollars; he thought four dollars was quite enough. As to the want of prosperity, it would be necessary to look deeper for the causes. This was not a scientific country, and a good deal of the work of the Institute, though valuable in itself, did not interest any large body of the public. He referred to the amount of very valuable work that had been done by the active members. As to the Philological Sec-

tion, he was amused at the enthusiasm displayed by some of those who got it up, but who soon became tired of it.

Mr. Pearce spoke of the prosperity of the Biological Section. Not only was there a large amount of work done by the section, but also by the several sub-sections into which it had been divided. If all the other sections of the Institute were as strong as the Biological Section, it would be in a very prosperous condition.

Mr. Browning said the division into sections had worked well in the case of the Biological Section, but not in regard to the other sections. He would like to see some effort made to obtain the Upper Canada College grounds. He supposed, however, that these grounds would go to the University, and was afraid the Institute would not get any part of them. The next question was the sale of the present building and the erection of one in some other locality. He would like to see a building put up that would yield a revenue. They would require one costing about $75,000. He thought that something could be done in the way of raising funds outside the membership of the Institute.

The following were named a committee to take into consideration the matters relating to the Institute referred to in Mr. Boyle's paper :—The President, and Messrs. Boyle, Pearce, Howland, Houston and Harvey.

SECOND MEETING.

Second Meeting, 8th March, 1890, Mr. G. G. Pursey, in the chair.

Donations and exchanges, 57.

A circular was read from the Committee of Organization of the International Congress of the Geographical Sciences stating that the Congress would be held at Berne, in August, 1891, on the occasion of the festival commemorative of the seventh centenary of the founding of the City of Berne, explaining the objects of the Congress and requesting the co-operation of the Canadian Institute.

Mr. Boyle read a memorial to the Hon. the Attorney-General respecting the publication of certain historical documents, and moved the following resolution, which was seconded by Mr. Harvey, and carried :—

"That the Council of the Institute be empowered and requested to present to the Government of Ontario the facts now expressed by them, also to enquire if the correspondence of Governor Simcoe and the military

archives of the forces in Canada at and about the period of the establishment of the separate Provincial Government for Upper Canada, recently acquired by the archivist at Ottawa, have been examined by them with a view to the publication thereof, either in full or in abstract form, as is now being done in the case of similar documents by the Province of Quebec."

Moved by Mr. Houston, seconded by Mr. Douglass, and carried :—

"That the members of this Institute learn with pleasure that the Executive Committee of the National Teachers' Association of the United States have decided to hold their next annual meeting in Toronto, in July, 1891, and they earnestly urge upon all who are in a position to do so, to aid in making the Convention as successful as possible."

Moved by Mr. Cox, seconded by Mr. Boyle, and carried :—

"That the members of the Canadian Institute hereby acknowledge the invaluable services rendered to the Institute by Mr. A. F. Chamberlain, M.A., for many years past, and whilst regretting the loss of so useful and promising a fellow-member, heartily congratulate him on his advancement to a larger, and they would hope a more congenial, sphere of labor."

Moved by Mr. Boyle, seconded by Mr. Clark, and carried :—

"That the members of the Institute have heard with great regret of the death of Mr. Hugh Wilson, who recently became a life member, and who made valuable donations of books and specimens to the Institute, and instruct the Secretary to convey their condolence to his relatives."

The following were elected members :—Arthur Laughlin, J. S. Laughlin, and J. M. McEvoy, B.A.

Mr. W. A. Douglass, B.A., read a paper on "The Two Values."

The paper began by showing that in every community the assessor or census enumerator finds two distinct things : first, a quantity of houses, goods, etc., that labour places there, and the land that labour did not place there. He thereupon finds two values—1st, that of improvement ; 2nd, that of land. With every increase of population these two values increase. The differences between the characteristics of these two values were examined at some length, illustrated by diagrams, and may be thus summarized :—The aggregate value of the commodities increases as commodities become more abundant, while the value of land increases as it becomes relatively more scarce. The one value indicates abundance, the other scarcity. Commodities come only with toil ; land value is not the result of toil. Commodities soon disappear, consumed or worn out ;

hence their value is transient. Land value never disappears, but remains as long as population lasts. Hence the value of commodities demands the continuous exertion of toil every year to maintain it, while land value remains without any toil. The use of machinery, by economizing labour, can reduce the value of certain commodities ; but no machinery has ever been devised, or will be devised, to extinguish land values. Increased population also reduces the value of certain commodities, but it has the opposite effect with land values. Increased population leads to increased production, and consequent intensified competition between sellers ; but on the other hand it causes more demand for land, and hence lessened competition between sellers. A large portion of commodities, moreover, are such that they must be sold in season—bonnets and spring bonnets—hence holding for a rise is impossible; but land never rots, wears out, or goes out of fashion. These characteristics are so distinct that what is declared affirmatively of one must be declared negatively of the other; whatever character we find in one we find the opposite in the other. They are as diffierent as plus and minus, or asset and liability. And yet in our legislation, whether for assessment, assigning the rights of property, or distributing wealth, we treat these two opposite things as though they were one and the same—a fatal mistake, leading to monstrous divergencies in society. By this mistake we allow one part of society to secure large service from the rest of society, simply because land becomes more scarce, and thus every increase of society makes a widening of the gulf in society, carrying the landowner to greater fortune, and the industrious classes togreater misfortune. All these opposite characteristics between the two values show that the one only, namely, that of commodities, should be held as property by individuals, the other should belong to the State.

Mr. Harvey had listened to the paper with mingled sensations of pleasure and of pain. Of pleasure, because the author, like others who had adopted these new social doctrines, spoke with an air of conviction, as if he believed what he was saying, also with that charming air of resignation and pity which pleasantly distinguished the elect, the *illuminati*, of many harmless kinds, and with a grace of diction which might well awake envy in less gifted men. Of pain, akin to that which a cat might feel when its owner, in a fit of abstraction, was stroking its fur the wrong way. Every proposition laid down seemed thoroughly antagonistic to what he (Mr. Harvey) had been taught in his youth to believe, and every argument made use of seemed to be based on fallacies. He felt that the author of the paper was dealing out delusive sophistries, and propounding theories, every one of which needed but the touch of experience to burst them. Let him give one instance. He was the

owner of a piece of land in the enterprising, historical, and whilom ambitious city or town of Dundas. Twenty years ago the land was "encumbered," should he say, with a house; the house was burned, and the land had been held as a vacant lot for many years. Now, according to Mr. Douglass' theory, he ought to have been a millionaire. Surely by this time, according to Mr. Douglass' calculation, the land ought to have doubled in value, and quadrupled that; but alas! for the fruit of a vanished hope! and alas! for the trust in the "Two Values" test! when he had proposed to a friend in the locality to give him cats, dogs, anything, and take the blessed lot, that friend had smiled (as Mr. Douglass did) a pleasing smile, and remarked on his (Mr. Harvey's) plaintive way of putting it. Let him now take Mr. Douglass' arguments in hand on the port tack, after raking them on the starboard, and ask in which of his two categories, commodity or land, he would put a painting of Raffaelle or Annibale Caracci. In quantity limited, area fixed, produced with toil, preserved only by thought and care, enduring, and cherished by many generations, ever increasing in money value, and priceless in these other values which men of Mr. Douglass's school scarcely seem to admit—humanizing, refining, elevating influences,—such works or things surely traverse in lightning-like zigzags, and altogether confuse and confound the straight-laced lines of Mr. Douglass' parallel columns of fallacious attributes. The truth was that all commodities possessed different economic attributes. Food, buildings, money, metals, land, all differed; but to treat land otherwise than as a marketable commodity surely misled the deluded followers of this new school of unpractical dilettanti, *per ambages*, into a morass. He would have proceeded to ask how Mr. Douglass' theory worked with land in Arabia, or (if he said he meant good land and not sandy wastes) how it applied to the land of Babylonia, with its rich and varied yield and its many paradises, which he had doubtless read about in his Xenophon, but now seemed to have forgotten. Dissatisfied theorists reasoned on premises which might seem correct when they were tested by instances occurring in happy, peaceful and growing districts of country; but when they were applied to towns which were retrograding, or countries scourged by wars or bad government, they were plainly seen to be hideously false—the clay underpinning of their hollow, brazen simulacrum gave way. It had lately happened to him (Mr. Harvey) to cross the ocean on the "Servia" with Mr. Henry George for a fellow-passenger. On leaving the dinner table one day, during a swell time, Mr. George, coming between the rows of chairs, mostly empty, careened against one, rebounded from another, and came violently to moorings beside the speaker. "Mr. George," he had remarked, "you get on well in smooth weather, but this gale upsets your theories." So it was with

the extravagances of single-value men, two (and no more) values men, trade and labor union men, citizens of the world, professional negrophilists, soft-money men, and the like: they could delude themselves, and obtain more or less following for their "views," so long as sober, practical men of common sense governed affairs, and peace with honor and prosperity prevailed. But let the cyclones of panic and war, a Dakota-like change of climate and its attendant famine, or even the milder consequence of reckless municipal government (as did happen in Hamilton only one generation ago) once set in, and all was changed. Capital either became a tyrant, or, cowering, shrank away. Mr. Douglass' despised "commodities" of food and raiment became treasures beyond price; the *crescendo* of land values he affected, but only affected, to envy the possessors of real estate, became a *diminuendo*, with a *pianissimo* carefully to be underscored at the end; while as for the theories so mellifluously laid before the Institute that night—they were laid by until the tide should turn again.

THIRD MEETING.

Third Meeting, 15th November, 1890, the Vice-President in the chair.

Donations and exchanges, 33.

Dr. A. B. Macallum, in a paper on "Cell Structure and Cell Contents," referred briefly to the already known details of cell structures and the phenomena of cell division, and then gave an account of his studies on the epithelial cells of the intestine and on the cells of the pancreas of amphibia. In these cells a number of bodies are present in addition to the ordinary cell contents, and they may, according to their nature and origin, be classified as follows:—(1) parasites; (2) the remains of broken-down cells swallowed by their healthy neighbours; (3) plasmosomata extruded from the nucleus. In connection with the first class (parasites), the history of a new form of great interest was described. There is also present in the pancreatic cells of all cold-blooded vertebrates a round, oval, or elongated element situated beside the cell nucleus of a peculiar character, which, from its fibrillation and phases of degeneration, must be a parasite analogous to the forms which cause malaria in the human subject. They are absent from many of the amphibia altogether, and this is another argument for the view that they are parasitic. The new parasite discovered by Dr. Macallum has one stage in its development which resembles closely the body in the pancreatic cells, and if the latter is a parasite its degeneration and destruction in the pancreatic

cells prove that the pancreas has a hitherto undescribed function—that of a protective one. This might be the interpretation of some experiments by Italian biologists on the partial and total extirpation of the pancreas in pigeons, resulting in a diminished immunity from attacks of *Bacillus anthracis* or in a complete disappearance of immunity, according as a part or the whole of the pancreas was removed.

In regard to the other classes of intracellular bodies, the cells can be found and fixed in the act of swallowing the remains of their destroyed neighbours, and the bodies so swallowed derange the metabolism of the cells. Plasmosomata can also be found in the act of passing out of the nucleus, but what conditions favour this cannot be determined. The migration of plasmosomata from the nucleus has been again and again observed in cancer cells, and have in some cases therefore been mistaken apparently for parasites. The question of the function of the plasmosomata is connected with the origin of the digestive ferment of the pancreas. The studies on the plasmosomata of the pancreatic cells and on a compound diffused through the nucleus, show that the plasmosomata and the compound are both the primary stage of the zymogen which gathers in the cell in the form of granules, and which, again, gives origin to the digestive ferment (trypsin) of the pancreas. This indicates that the nucleus is of vast importance in the cell, controlling and directing its secretion and nutrition, and reinforces the view that the nucleus in red blood cells gives origin to hæmoglobin, and the observations of botanists, which show that the nucleus of vegetable cells builds up sugar out of carbon dioxide, and the only function of the vegetable cell itself is to convert the sugar into starch.

FOURTH MEETING.

Fourth Meeting, 22nd November, 1890, Mr. Harvey in the chair.

Donations and exchanges 73.

Mr. J. J. Mackenzie, B.A., read a paper on "The Typhoid Bacillus in Relation to Drinking Water," which was illustrated by a number of specimens. The characteristics of the bacillus were first described, then the contamination of sewage by the bacillus and its development therein. The conditions of its development in potable waters were then taken up, and the chances of the spread of a typhoid epidemic by such means explained. After this the methods used for the isolation of the bacillus were explained, and finally a number of samples given where

epidemics of typhoid had been traced to the water supply, and the typhoid bacillus afterwards isolated from the water.

Mr. Elvins referred to the amount of fever in Toronto during the last three years. He would like to know whether it had been confined to any geographical lines, or to any particular parts of the city.

Mr. Mackenzie had not been able to learn whether it had been confined to any special portions of the city or was generally scattered.

Dr. Ellis had learned that in many cases that occurred the patient had come from a house where there was a cess-pool. If it was pretty generally scattered the probability would be that it was caused by the city water. If it was confined to any special localities, one would imagine that the cases would come from the flats of the Don, but it seems that the cases came from more healthy localities, as from near Knox College.

Mr. Harvey mentioned a case that had come to his knowledge. It was from a house in Little York, that was built on a bed of gravel. Great pains were taken to analyze the water, and it was found quite pure; so that cases might occur in the healthiest locality.

FIFTH MEETING.

Fifth Meeting 29th March, 1890, the Vice-President in the chair.

Donations and exchanges, 48.

P. Jacobi and W. J. Shaw, M.D., were elected members.

Mr. R. Dewar read a paper on "The Occurrence of Gold and Silver in Galena and Iron Pyrites." He began by reviewing the geological occurrence of deposits, which he said were most abundant in the Palæozoic time in the Silurian and Carboniferous ages. He also gave the periods and epochs of all the deposits in America, which included Wisconsin, Missouri, etc. In Europe he referred to the deposits of England, Ireland, Scotland, Germany, France, Spain, Austria, and Bohemia, and remarked that iron pyrites occurred in all formations, from the oldest to the most recent. Galena occurred in granite, sandstone, argillaceous and limestone rocks, and had for its matrix quartz, fluorspar, baryta, and calcite, remarking that both galena and pyrites were found in both bituminous and anthracite coal, and in chalk and clay from the coal measures. Galena in the older metamorphic crystalline rocks was not to be com-

pared with that occurring in limestone in regard to its richness in gold and silver, also the metamorphic veins continued to a greater depth than the non-metamorphic, and that galena veins were often rich in one stratum but poor in others, providing the strata were of different composition. Mr. Dewar went on to give statistics of mines in Cornwall and Devon, and mentioned a table in Percy's metallurgy of lead regarding the presence of silver and gold in galena, which he said he did not propose to improve on. He also treated of auriferous pyrite, giving as an example the Morro Velho mine in Mimas Geraes, in Brazil, one of the richest of that country, in which the workings were on auriferous pyrites, and remarked that quite a portion of the annual production of gold was from iron pyrites. In regard to the different theories of the origin of metamorphic and non-metamorphic deposits, he found that the former originated as veins of segregation through hydrothermal fusion, and the latter as superficial deposits. In the non-metamorphic deposits the salts occurred as lead sulphate or carbonate, the silver as chloride, the gold as sulphide and chloride, while the solvent solutions were alkaline hyposulphites, chlorides, or carbonates. The paper also treated of the solvent power of ferrous and ferric sulphates in relation to gold.

SIXTH MEETING.

Sixth Meeting, 6th December, 1890, the President in the chair.

Donations and exchanges, 60.

The following Resolutions were passed :—

Moved by Mr. Hamilton, seconded by Mr. Harvey—

"That the Institute approve of the memorial presented by the Historical Section relating to the publication of documents in connection with the northern and western boundaries of Ontario. The Institute also desire to enquire if the correspondence of Governor Simcoe and the archives of the military forces in Canada at and about the period of the establishment of the separate provincial government for Upper Canada recently acquired by the archivist at Ottawa have been examined by the Government with a view to publication either in full or in abstract form as is now being done by the Province of Quebec in the case of similar documents. That the President and Messrs. Bain, Harvey, Boyle and the mover be a Committee to wait upon the Hon. the Attorney-General and bring the above matters before him and the Government."

Moved by Mr. Harvey, seconded by Mr. Hamilton—

"That the Secretary be requested to communicate with the Honorable the Provincial Secretary, asking him to inform the Government of the Province, that if they desire to purchase the Archæological and Mineralogical Museum of the late John Notman, Queen's Printer, now in the Legislative Buildings, and which is being advertised for sale, the Canadian Institute will be happy to house it and take charge of it upon the same footing as the Museum of Indian Archæology, namely, that at convenient hours, the public shall have free admission. Also that the Canadian Institute is about to consider the propriety of enlarging its building in early spring to meet the demand for enlarged space for museum purposes, and will be happy to meet the Hon. the Commissioner of Crown Lands to discuss the whole subject of a Museum of Minerals and of Natural History for the Province."

The Rev. Philip Tocque, A.M., read a paper on "Newfoundland or Terra Primum Vista." He gave a detailed account of the products and resources of Newfoundland, its timber and fisheries, and as to the minerals he said that on the western part of the country, at Codroy, St. George's bay, Bay of Islands, and other places there are gypsum or plaster of Paris, coal, iron, copper, lead, gold, silver, nickel, petroleum, flagstones, soft sandstones, limestones, marble of every quality and colour, some masses of which are four and five hundred feet in height. Here are the elements of future greatness—the elements to set in motion agriculture, manufactures, steam engines, railroads, and architecture. Here is a coal field thirty-eight miles long, ten miles broad, and three feet thick, containing 54,720,000 chaldrons, or 1,425,000 chaldrons per mile. Mr. Murray, late geological surveyor, says of three other seams having an aggregate thickness of eight feet:—"A seam of coal one foot thick would give per square acre 1,500 tons, per square mile 960,000 tons; multiply by eight and the result would be 7,680,000 tons." It is said this estimate equals the whole annual output from all the Cape Breton mines. This coal field is only eight miles from the sea, and twenty miles from St. George's Harbour, supposed to be a continuation of the coal mines of Cape Breton. A short time ago Tilt Cove, Bett's Cove, and Little Bay, on the northern part of the island, were shrouded in primeval silence; no sign of even a hamlet appeared in the horoscope of the future; but the elements of a mighty change were working, and now these places have grown into thriving villages. All appeared poverty on the surface, but glittering chambers of wealth were below.

Governor Hill, in his annual report to the Colonial Office in London, gives an interesting account of the rapid growth of these villages and of

the mines which he had visited. The Tilt Cove copper mine yielded in 1868, 8,000 tons of copper ore, which sold for $256,000. In 1869 a fine vein of nickel was discovered, intersecting the copper, from which ore was taken which realized $38,600. In 1879 Tilt Cove mine yielded nearly 50,000 tons of copper ore, valued at $572,154. The mines at Bett's Cove and other places amounted to 23,556 tons, the whole valued at $2,982,836. Little Bay is said to have one of the most valuable copper mines in the world. Up till 1879 the total amount of copper ore exported from all the mines amounted to $5,000,000. There is a pure galena mine at La Manche, of which Bishop Mallock says :—"Once while I was there 65 tons of lead were shipped off, and another time I saw 100 tons of dressed ore in barrels prepared for exportation." The sheriff of the Northern Circuit Court writes :—"Every day new discoveries are being made. Mining has been commenced at Southern Arm, Rouges Harbour, and Burton Pond. At present it is difficult to prognosticate what the future of this country will be." There is no doubt but that thorough and extensive prospecting would bring to light hidden treasures of immense value for the investment of capital. Careful explorations would show that copper deposits are not confined to Green Bay. Copper ore is known to exist in Conception Bay and other places. Mining generally in Newfoundland is an industry of great promise.

SEVENTH MEETING.

Seventh Meeting, 13th December, 1890, Dr. Meredith in the chair.

Donations and exchanges, 39.

Mr. Edward Meek was elected a member.

Mr. Arthur Harvey, Delegate to the Montpelier Congress on the Romance Tongues read his Report with remarks on some ancient races still existing in southern Europe, their languages and customs. The fact of the survival in France of several old races, whose physical characteristics and whose languages differ from what is adopted as the French standard was illustrated in reference not only to the Breton population, who are almost the only sailors France possesses, and who still speak a Celtic tongue, but also to the population of Southern France. The Roman type existing around Nimes and the Greek features and ways of the Marseilles folk were noted and commented upon, and the history of the Roman and Greek colonies in those places was discussed, with references in each case to the Latin and Greek authors

to whom we owe the original accounts. Mr. Harvey introduced to the Institute the modern Provençal poet, Frederic Mistral, whose charming volume, "Mireio," has been translated into French and English. He outlined the plot of this remarkable work and favoured the members present with specimens of the original Provençal—with metrical translations by himself of the portions quoted.

A cordial vote of thanks was tendered to Mr. Harvey for the valuable services he had rendered the Institute as delegate and for his very scholarly and interesting report.

EIGHTH MEETING.

Eighth Meeting, 20th December, 1890, Mr. Harvey in the chair.

Donations and exchanges 78.

Mr. James McNally was elected a member.

Mr. Harvey read the Report of the Committee on Historical Documents, which stated that they had an interview with the Hon. the Attorney-General and other members of the Ontario Government; they had been received with courtesy and attention, and have been requested to prepare in writing a list of the Historical and other documents they considered worthy of publication.

On motion of Mr. Hamilton, seconded by Mr. Browning, it was resolved, That the report of the Special Committee appointed by resolution passed on the sixth of December instant, be received and adopted, and that the said Committee be continued in office till the end of the current Institute year, and be instructed to obtain and submit to the Hon. the Attorney-General such further information, and take such other means as may lie in their power (not involving expense to the Institute) as they may deem advisable to carry out the objects of the resolution appointing them.

Mr. Fred. A. T. Dunbar read a paper on "Sculpture."

NINTH MEETING.

Ninth Meeting, 10th January, 1891, the President in the chair.

Donations and exchanges, 210.

A letter from the Secretary of the Royal Society of Canada respecting the meeting of the Society in Montreal on the 27th May, 1891, was read and referred to the Council.

A paper by H. R. Wood, M.A. was read entitled "Crystal Studies, No. I."

Mr. W. A. Sherwood, read a paper on "Colour in Nature in Relation to Drapery." He said that there was no element in the whole range of Nature's phenomena more universal than that of colour. Her forests, mountains, rivers, the plumage of birds, the blossoms of trees, and the whole of the flowery kingdom display the splendour of Nature's adornment. From this source of exhaustless materials the colors of our drapery should be chosen. Nature and not the fashion plate should alone guide us in the choice of colour. Costumes should have a distinct range of colour suiting the conditions of complexion and in harmony with our surroundings. For evening wear in our homes all that would suggest brightness, varying in every range of tint and tone, from the pink and pretty pale green tones of the costumes of children to the rich, deep moss green cloak fringed with gold lace and silvery-hued borders for those of riper years, should be worn. Deep crimson with warm brown tones, might happily replace the cold grey and black suitings of to-day.

Mr. Sherwood then referred to the different epochs of British history. Beginning with the Danish invasion, he said the first use of black began with these warriors of the North, their crest being the raven. Its presence, however, did not long hold in Britain. The Normans wore different colours. Edward III. declared for a distinct arrangement of colour and material for all of his subjects from the royal household down to the peasant, imposing heavy fines for the violation of his decree. In the Tudor period a great revival was effected in the colour of costumes. Velvets of warm purple, fringed with gold lace, and indeed all the primary colours were worn. The masterly dramas of Shakespeare were penned in such society. "Rare Ben Jonson," Sir Walter Raleigh, and Lord Bacon each selected for himself from the draper's shelf. Fairholt, in his "British Art," pays the highest tribute to the court of Charles I. for elegance and grace and picturesqueness of costume, denouncing at the same time the plainness of the Puritanic dress. This plainness, he asserts, was but the vulgar affectation of modesty. Dark drab, grey, and black became the prevailing colours from the ascendancy of Cromwell to the present time; with but short intervals this arrangement has been firmly fixed. By the harsh enactments of Cromwell the loose mantle of the Irish was torn off, but happily the heather hills, with their sturdy

clans, withstood the invasion, and have to this day the tartan plaid kilt and hose of undated epochs. The Puritan violated every line of grace, treading under foot every form of beauty and colour. Under this *regime* painting and sculpture degenerated. Square cut coats, slouching hats, and ugly boots were declared modest and proper and "pleasing unto God," as though the Creator of all that is beautiful should smile the more upon the violation of His divine laws of grace and colour.

In conclusion, Mr. Sherwood said often as he looked down the aisles of the church he could not help thinking, as he saw masses of drapery black as night and sombre as the grave, that the effect must be far from cheerful to many weary souls. The temple of God ought to be graced by the richest ranges of colour, being indeed a true counterpart of God's own house, the temple of nature.

TENTH MEETING.

Tenth Meeting, 17th January, 1891, the President in the chair.

Donations and exchanges, 66.

The following specimens were presented to the Museum:—Trilobite by Mr. McKay; Globigerinae and shells, piece of Labradorite, and Boeothick ornaments by Mr. Harvey.

The following were elected members:—John Young, G. A. Chase, B.A., Charles Rust, C.E., Robert M. Dennistoun and C. W. Armstrong.

A letter was read from the Governor-General's secretary, enclosing a despatch received from the Colonial Office relative to a memorandum by Dr. Sandford Fleming, C.M.G., on the "Movement for reckoning time on a scientific basis, by which the greatest possible degree of simplicity, accuracy and uniformity will be obtainable in all countries throughout the world." This memorandum had been transmitted by the Canadian Institute to the Colonial Office, and submitted to the Department of Science and Art, which reported the following resolutions, passed at a meeting of the Committee on the Prime Meridian Conference, held on the 25th April, 1890, there being present—the Astronomer Royal (in the chair), the Hydrographer of the Navy, and General Donnelly, C.B:—"Resolved (1) that it is desirable that Mr. Sandford Fleming's memorandum be forwarded to the Governments of all the colonies for their consideration, with a view to the adoption of the Hour Zone system of reckoning time generally, and of the 24-hour notation for railway time

tables. The committee desire to express their concurrence in Mr. Sandford Fleming's views as to the advantages which would result from this reform, and the ease with which it could be carried out. (2) That it would be advisable that a similar recommendation should be forwarded to the Indian Government, and that the adoption of the 24-hour notation for railway time-tables (which they understand has been adopted on several lines in India) should be recommended to the railway companies of the United Kingdom."

The Secretary was instructed to write to the Governor-General and call attention to the circumstance that the circular is directed to the colonies only, and request that the attention of foreign nations be directed to the circular.

A letter was read from Sir Daniel Wilson, stating that Dr. Sandford Fleming, having failed in his arrangements with The Canada Life Assurance Company to place the sum for which his life was insured at the immediate service of The Canadian Institute, had sent his cheque for $200, and proposed to pay the same amount annually as interest on the capital sum.

Moved by Professor Loudon, seconded by Dr. Kennedy, and carried,

"That the Canadian Institute has once more to acknowledge the interest and appreciate the kindness of one of its earliest and most distinguished members, Sandford Fleming, C.E., LL.D., C.M.G., who, during the whole period of his connection with it, has shown a deep and unflagging interest in all that concerns its welfare and prosperity, and who has ever been foremost in all movements pertaining to the advancement and extension of the work of the Institute. In addition to his generous provision of a paid-up policy of life insurance for the sum of $4,000 towards the funds of the Institute, he has given further evidence of his kindness in desiring to pay to the Institute yearly the interest on the above sum. Wherefore be it resolved that the best thanks of the Institute be tendered to Dr. Sandford Fleming for this fresh token of his interest in the Institute, that a copy of this resolution be sent to him."

Dr. A. B. Macallum read a Paper entitled "Studies on the origin of the Blood Pigment." The results given in the paper were obtained from an investigation extending over several years. The main points of the paper on the structure of the cell nucleus and of the compounds which it contains may be summarized as follows:—One of the nuclear compounds, the substance chromatin, so called because of its capacity for absorbing staining reagents, and confused by the chemist and biologist with a derivative of it, nuclein, constitutes the fundamental life substance

of the cell, and in it all the vital processes originate. When it is abundant the cell is vigorous or it is highly endowed vitally, and this is especially the case in embryonic cells. This substance is transferred from the maternal organism to the tissues of the embryo either through a special organ, the placenta, directly, or indirectly by means of the yolk of the egg in lower animals. The yolk contains a comparatively large quantity of the chromatin, and this is transferred to the embryonic organs partly by wandering cells, which absorb it and carry it thither. These wandering cells become gorged so to speak with chromatin, and they constitute the hæmatoblasts, or young blood corpuscles. Of the chromatin, which these corpuscles utilize a portion is converted into hæmoglobin, and this is the only source of that pigment in young blood corpuscles. As hæmoglobin contains iron, Dr. Macallum concluded that chromatin also possesses it. In the preparations of various kinds of chromatins iron could not be detected, but it was readily recognized in the ash of the substance. Dr. Macallum has quite recently found a way of detecting the iron of the chromatin in the intact nucleus. From all these observations it is proved that the fundamental life substance of the cell is a compound in which iron is present and more firmly combined than it is in hæmoglobin. As the latter is an oxygen carrier it may be concluded that the chromatin of every cell absorbs oxygen, and that through this the respiratory and chemical changes of the cell are brought about. The question of the absorption of iron in the body was also taken up, and facts were related which showed that the iron of the chromatins of the body comes into the system through the chromatins of the food, which the administration of iron or iron salts as therapeutic reagents protects from decomposition.

ELEVENTH MEETING.

Eleventh Meeting, 24th January, 1891, Mr. Harvey in the chair.

Donations and Exchanges, 54.

Ernest Cruickshank, George Mickle, B.A., R. P. B. Joyce, and E. C. Jeffrey, B.A., were elected members.

Dr. Canniff was added to the Committee on Historical Documents.

A communication was read from the treasurer of the International Congress of the Geographical Societies, to be held at Berne from the 1st to the 15th of August next, giving the programme of the congress and inviting the co-operation of the Canadian Institute and the presence of its members at the proceedings.

Mr. D. R. Keys, M.A., read, on behalf of Mr. A. F. Chamberlain, M.A., Fellow in Clark University, Worcester, Mass., a paper entitled, "African and American; the contact of the negro and the Indian." He said:—The history of the negro on the continent of America has been studied from various points of view, but in every case with regard to his contact with the white race. It must therefore be a new, as well as an interesting inquiry, when we endeavour to find out what has been the effect of the contact of the foreign African with the native American stocks. Such an investigation must extend its lines of research into questions of physiology, psychology, philology, sociology, and mythology.

The writer took up the history of the African negro in America in connection with the various Indian tribes with whom he has come into contact. He referred to the baseless theories of pre-Columbian negro races in America, citing several of these in illustration. He then took up the question ethnographically, beginning with Canada. The chief contact between African and American in Canada appears to have taken place on one of the Iroquois reservations near Brantford. A few instances have been noticed elsewhere in the various provinces, but they do not appear to have been very numerous. In New England, especially in Massachusetts, considerable miscegenation appears to have taken place, and in some instances it would appear that the Indians were bettered by the admixture of negro blood which they received. The law which held that children of Indian women were born free appears to have favoured the taking of Indian wives by negroes.

On Long Island the Montauk and Shinnacook Indians have a large infusion of African blood, dating from the times of slavery in the Northern States. The discovery made by Dr. Brinton that certain words (numerals) stated by the Missionary Pyrlaeus to be Nanticoke Indian were really African (probably obtained from some runaway slave or half-breed) was referred to. In Virginia some little contact of the two races has occurred, and some of the free negroes on the eastern shore of the Chesapeake peninsula show evident traces of Indian blood. The State of Florida was for a long time the home of the Seminoles, who, like the Cherokees, held negroes in slavery. One of their chiefs was said, in 1835, to have had no fewer than 100 negroes. Here considerable miscegenation has taken place, although the authorities on the subject seem to differ considerably on questions of fact. In the Indian Territory, to which Cherokees, Seminoles, and other Indian tribes of the Atlantic region have been removed, further contact has occurred, and the study of the relations of the Indian and negro in the Indian Territory, when viewed from a sociological standpoint, are of great interest to

the student of history and ethnography. The negro is regarded in a different light by different tribes of American aborigines. After mentioning a few isolated instances of contact in other parts of the United States, the writer proceeded to discuss the relations of African and Indian mythology, coming to about the same conclusion as Prof. T. Crane, that the Indian has probably borrowed more from the negro than has the negro from the Indian. The paper concluded with calling the attention of the members of the Institute to the necessity of obtaining with all possible speed information regarding :—(1) The results of the intermarriage of Indian and negro; the physiology of the offspring of such unions. (2) The social status of the negro among the various Indian tribes; the Indian as a slave-holder. (3) The influence of Indian upon negro and negro upon Indian mythology.

TWELFTH MEETING.

Twelfth Meeting, 31st January, 1891, Dr. Kennedy in the chair.

Donations and Exchanges 48.

A letter was read from the Governor-General's secretary, acknowledging the receipt of a communication from the institute on the subject of "Cosmic Time," and conveying the information that, in accordance with the suggestion of the Council of the Canadian Institute, his Excellency is taking steps with a view of bringing the correspondence which has passed relative to this matter to the notice of foreign powers, through her Majesty's Secretary of State for Foreign Affairs.

A paper on "Canadian Art of To-day" was read by Mr. J. W. L. Forster. He gave a list of brilliant Canadian names in the art roll of other nations—The Smillie brothers, Leclear, Woodward, Rattray, Sandham, Fraser, Walker, Glazebrook, Shannon, Peel, and others. During those years our field has been occupied by men from the old world—Bull, Hoppner Meyer, Paul Kane, Hamel, Krieghoff, Wandsworth, Westmacott, March, Hunt, Gush, Sawyer, Fowler, Creswell, Berthon, and many more. "Pilgrims, as all our fathers were," yet they helped to plant a stem in the soil of our country from whose vintage we drink to-day. Their style was mostly that of the British artists of their day. Their patrons were men whose tastes were the outgrowth of the same associations. Exhibitions held within the fresh memory of many were filled with examples of that careful academic work. Though the old tastes have largely died away with the old legacies that sustained them,

and an interim has passed in which little that was characteristically old or new was produced, there has never been an absolute dearth of pictures or of purchasers. Yet there was a long pause during the years when colonial life allowed little leisure for the culture of the æsthetic, and little means for its encouragement. Few artists remained. Paul Kane, the famous explorer, was being forgotten and neglected. Sawyer and Creswell barely lived and have passed away; Mr. Berthon's venerable hand still does honour to the Toronto Law Society in portraits of our eminent jurists. The Toronto Law Society, inheriting, as many of its members do, both the blood and the traditions of the distinguished founders of our local commonwealth, has kept alive the spirit of a generous age.

The first, or Upper Canada Art Society, was formed in 1841, and existed but a short time. The next was the Electoral Division Society, which held a few exhibitions, offering competitive prizes to both professional and amateur artists. The Agriculture and Arts Association assumed the patronage of the Fine Arts, and for years held the gauge of professional merit. In 1873 was formed the distinctly professional group known as the Ontario Society of Artists, and which, during these eighteen years, has placed annually before the citizens of Canada the best work of our artists. Two years before that date was formed the Art Association of Montreal, and in 1880 was formed in Ottawa the Royal Canadian Academy. The art of Canada to-day is a mingling of elements. Though they are as truly Canadian as we who first saw the sun in our own sky, yet among the fifty members of the Ontario Society of Artists not more than six or eight are native Canadians. Not only are the influences of the Old World evident in the work of most of our painters, but even our native artists, whose schooling has been abroad, are disposed to paint a Canadian sky with the haze of Western Europe.

Mr. Forster referred to the recent awakening of a national sentiment amongst Canadians as one of the most hopeful promises for the Art of this country. And the establishment by both Government and citizens of schools of industrial and fine art has in it the assurance of advancement in the direction of national art. One of the greatest needs of our country is a museum equipped with well-chosen specimens of the world's art.

Mr. Sherwood spoke of the necessity of infusing a national sentiment into Canadian art. He referred to Paul Kane as an artist in whom the spirit of nationalism was strong. He thought that a better day was dawning, and that there was a splendid future for Canadian art.

Mr. T. R. Clougher thought that one cause of the depressed state of Canadian art was that we lacked art critics. There were good critics and

well acquainted with art, but they lacked the power of expressing their ideas. In order to have a national art we must have a national sentiment. There were a large number of historical subjects relating to Canada that were never touched by our artists. If Canadian artists would give us such works they would soon find a revolution in art.

Mr. Forster said, in regard to competent art criticism, there was no lack of men with the true inwardness of art and the power of conveying their ideas, but the remuneration afforded by our magazines was not such as to induce them to take up the subject. He hoped that men of the right stamp would soon enter the arena.

Mr. Revell read a paper by Mr. Arthur Harvey, advocating the establishment of a national school of art, shewing its importance and possibility, and pointing out the vast range of subjects in nature, and historical incidents that awaited the genius of the Canadian artist. He also referred to the benefits to be derived by artists from contact with scientific and literary men, and the study of various branches of science. He instanced the case of an artist who was better able to paint the clouds from a knowledge of meteorology. So in geology and other branches of science.

THIRTEENTH MEETING.

Thirteenth Meeting, 7th February, 1891, the President in the chair.

Donations and Exchanges 157.

The council reported the election of Mr. Harvey A. Hunter as an associate, and the following associates were elected members:—Herbert H. Brown, John L. Jackson, J. Maughan, Jr., and Ernest C. Tyrrell.

A communication was read from "L'Academie Royale des Sciences, des Lettres, et des Beaux-Arts de Belgique," announcing the death of its permanent Secretary, M. le Lieutenant-General en retraite, Jean-Baptiste Joseph Liagre, ancien Ministre de la guerre, &c.

The committee of the Institute entrusted with the duty of complying with the request of the Hon. the Attorney-General and other members of the Government of Ontario, to be informed what historical documents the Institute thought worthy of the consideration of the Government, with a view to their publication, presented their report. They enclosed a letter from Mr. Douglass Brymner, the archivist of the Dominion at Ottawa, in answer to a communication from the committee, which they recommended to be submitted to the Government.

The Hon. William Proudfoot read a paper upon "Some Effects of Christianity on Legislation." Noting the difficulty of stating that any recent legislation could be selected as an outcome of Christian principle, without being met by the objection that it was as probably due to the general advance of civilization, to the progress of the human mind, to reasons of State or expediency, perhaps to the exigencies of party strife, he directed attention to those earlier times when Christianity, after more than three centuries of oppression, neglect, and persecution, during which its teachings and the pure lives and devotion of its worshippers had spread their beneficent effects in an ever-widening range, at length numbered the rulers of the world among the disciples of the Cross.

The laws particularly referred to were those having for their objects: The preservation and protection of infants; the support of the poor; the establishment of hospitals for the sick and incurable; the encouragement of the emancipation of slaves; the prohibition of gladiatorial combats; and the mitigation of punishments. That these were all duties inculcated by the Christian religion was established by a number of texts from the Scriptures. With what had these principles to contend? The Romans had long been renowned for their supremacy in the arts of peace as well as of war. But one of the institutions peculiar to them was that of the Paternal Power, or, as Livy terms it, the Paternal Majesty. A historian sums up the particulars of this authority as permitting fathers to beat their children with whips, to confine them in prison, to make them work in chains in the fields, to sell them, and in fine to kill them. The father was a family magistrate with the power of the sword. In later times the supreme authority was rarely exercised. But it was in full force in Cicero's time, when Fulvius, the son of a Senator, was slain by his father's command for conspiring against his country with the followers of Catiline; and at a later period Erixo whipped his son to death, and Hadrian banished a parent for killing his son. In the early part of the fourth century the practice of killing, exposing, selling, and pledging infants had become very prevalent in Italy.

Constantine the Great was the first Christian Emperor, and in the year 313 he issued an edict granting toleration to the Christians. With the view of deterring parents from destroying their offspring he provided in 315 (amended 322) that poor parents suffering from want of food and clothing might procure food, clothing, and necessaries from the public funds and from the private fortune of the Emperor. This law and several others of the same year are supposed to have been suggested by Lactantius, a Christian of great eminence for his learning and eloquence, and then the tutor of Crispus, the son of the Emperor. A

number of statutes in subsequent years were referred to for the purpose of more fully protecting infants. Before Constantine's time no provision was made for the poor, or for the sick, the helpless, the incurable. No hospitals, no poorhouses. The enactments in their favour are to be considered in connection with grants to churches. These grants were made usually with an expressed intention that they were to be employed for charitable purposes. Generally the property of the Church was declared to be inalienable: but even the most sacred property could be sold for these purposes. As soon as Christianity was freed from persecution, establishments sprung up with wonderful rapidity for the reception of travellers and sojourners, for the poor, for orphans, for foundlings, for the aged, and for the sick.

In 314 Constantine abolished the punishment of crucifixion, and in 315 that of branding criminals in the face. He also abolished the punishment of throwing the criminals to wild beasts and the bloody spectacles of gladiatorial combats in 325. Slaves abounded. Their lot was a hard one. Their masters could kill them without danger of punishment. Their condition was somewhat ameliorated before the time of Constantine. Hadrian forbade to kill them, but chastisements continued still to be immoderate. The law restricted this, and the punishments he prevented show what were actually in use—killing with a heavy stick, a stone, a javelin, or subjecting to torture, to claws, nails, red hot metal plates, the rack. Masters using these and causing death were to be guilty of murder, and provision was made for encouraging emancipation.

FOURTEENTH MEETING.

Fourteenth Meeting, 14th February, 1891, Prof. Ellis in the chair.

Donations and Exchanges 35.

Robert Jenkins and T. H. Ince were elected members.

A paper by H. R. Wood, M.A., was read, entitled "Crystal Studies, Nos. 2 and 3."

Mr. Alan Macdougall, C.E., read a paper on "The Bœothick Indians" of Newfoundland. The chief facts were supplied to him by Rev. M. Harvey, of St. John's, Newfoundland. This tribe, at one time aboriginal inhabitants of the island, can now only be counted by one or two skeletons and a few skulls, so completely have they been swept away. The French employed the Mic Mac Indians from Nova Scotia to fight against

and exterminate them. The Bœothicks were a peaceable and quiet race given to hunting and fishing. They used canoes made of birch rind, and of the skins of deer like the Esquimaux cayak. They were not potters, their utensils, culinary and drinking, were of birch rind sewn together by small roots of the birch. They used soap-stone dishes for lamps, which were well shaped and carefully made, the form being similar to that in use among the Esquimaux of the present day. They carved the horn of the deer, walrus, and bones of the seal into a number of ornaments, which they wore on their dresses, and ornamented their heads with combs. The carving is in triangular patterns, and out of the large collection in the museum at St. John's there are not two ornaments having the same pattern. The patterns seem to run in the shape of the letter H. They used flint arrow heads. Their stone implements were more rudely constructed than those of the Western Indians. No specimens of wampum belts or totems or pipes exist.

FIFTEENTH MEETING.

Fifteenth Meeting, 21st February, 1891, the President in the chair.

Donations and Exchanges 85.

Professor Andrew J. Bell, Ph.D., C. H. Needler, Ph.D., and Adam. H. Meyers were elected members.

A communication was read from the Committee of Organization of the Fifth International Congress of Geologists, which will be held at Washington on the last Wednesday (26th) of August, 1891, containing a cordial invitation to the members of the Canadian Institute, and all interested in the subject, to take part in the labours of the congress. The annual meeting of the American Association for the Advancement of Science, and the summer meeting of the Geological Society of America will be held in the same city during the preceding week.

W. H. Van der Smissen, M.A., read on behalf of Rev. Neil MacNish, D.D., LL.D., of Cornwall, a paper entitled, "A Review of a Work by A. W. Moore, M.A., on Surnames and Place-Names of the Isle of Man." This book of Mr. Moore's has recently been published, and contains very useful information, not for Manxmen merely, but also for Celtic scholars everywhere. "My aim," says the author, "is to give a complete account of the personal names and place-names of the Isle of Man." Mr. Moore is a gentleman of scholarly attainments, who has devoted much attention

to the literature and topography of the Isle of Man, and has earned an honourable reputation for his patriotic efforts to revive and perpetuate whatever is of value in the history and literature of his native island. This little island can at least boast that it has preserved its independence unimpaired, and that it still possesses its old legislature, which had its origin before the Battle of Hastings. Fifty thousand people still retaining their old laws and their old customs in the centre of the United Kingdom is a spectacle as unique as it is notable. Their annals necessarily possess a peculiar interest to the antiquarian and the historian. There was formed in 1858 a society bearing the designation, "The Manx Society, for publication of national documents of the Isle of Man." Up to 1886 twenty-nine volumes were published by that society. Mr. Moore divides the history of Man into three parts :—(1) When it was inhabited by a Celtic people exclusively. (2) The period of the Viking invasions and the establishment of Scandinavian rule. (3) The period during which Man came under English dominion. It is found that in nearly every case Scandinavian names are Celticized, *i.e.*, they have received the prefix "Mac." It does not appear that "O" ever took root in the Isle of Man, though "Mac" was widely prevalent. Mr. Moore avers that surnames in Europe may generally be divided into four classes :—(1) Those taken from the personal names of an ancestor. (2) Those taken from trades and occupations. (3) Those which originally indicated place of birth or residence. (4) Those which were originally descriptive of a person's appearance in character and residence. It has been ascertained that of the surnames which are now in use in man 68 per cent. are purely Celtic Numerous examples were given by the writer of the various classes of names with their signification. Mr. Moore's book cannot fail to find a very honorable place among the comparatively few books that are of highest value and that are most highly prized in connection with the early monuments and character and varied development of the several divisions of the great Celtic family.

SIXTEENTH MEETING.

Sixteenth Meeting, 28th February 1891, Mr. Browning in the chair.

Donations and Exchanges 46.

Mr. T. B. Browning, M.A., read the third of a series of papers on the "Codification of the Law," with special reference to "contracts." In opening he paid a tribute to the great codifier whose untimely fate has

cast a pall over the English-speaking world, and adverted to the fact that the later or historical school of legal thought in England, of which Judge Stephen is so prominent a member, is pronouncedly in favour of codification. He confined himself to two aspects of his subject, definition and division: (1) What is a contract in English law? (2) How should contracts be classified? (1) As an objective point Addison's definition was taken, that a contract is "an agreement by which two parties mutually promise and engage, or one of them promises and engages, to the other to give some particular thing or to do or abstain from doing some particular act." While a skilled profession may work well with almost any kind of instrument this definition is inadmissible for codification purposes. It is too wide, too narrow, and unsuited to our law. It is too wide because it includes gifts and agreements without consideration, which are not contracts, and practically necessitates a division of the subject into contracts valid and contracts invalid, illegal or void, the latter of which are treated by way of exceptions, under such headings as fraud, mistake, misrepresentation, or the vaguer term of public policy. The exceptions outweigh the rule, and are in themselves cross divisions. Mr. Greenwood gives 580 sub-classes of exceptions coming under public policy without exhausting his subject. But, as Mr. Holmes shows, a void contract is no contract at all. The Indian codifiers when face to face with the problem limited their definition to agreements "enforceable at law," and are followed by later text writers. The definition is also too narrow. A little straining of language may bring the greater number of unilateral contracts under the head of "agreements," but not so records, the highest form of contract; nor implied contracts, one of its chief divisions; nor enforceable claims under statutes, charters, by-laws, a department of law which, particularly in respect to companies, is rapidly increasing and must continue to develop as industrial processes multiply and consolidate. Thirdly, Addison's definition is taken from the French writer Pothier, is a summation, in its legal form, of the theoretic individualism so prevalent last century on the European continent, and is an exotic imposed on our legal system. While individual right is a wide and growing principle in our contractual law, the idea of duty or obligation in the wider sense is anterior to it in point of time, and of more general operation to-day. The very word contract is of late date with us. Our law of contract has three stages of development: obligations created and enforced by law analogous to *status:* those created by act of parties in presence of or with the permission of the court: the extension of this idea, by way of analogy, to acts of the parties outside the court, at first within strict, then within wider limits, but never at large. The placing of agreement

in the foreground as the principal element of contract is a reversing the natural or historical order of English law, and compels resort to the unscientific expedient of alternate expansion and limitation. Contract is to be defined from the standpoint of duty or obligation in the wider sense, the essential element of which is the formation of a legal bond or tie. (2) The long-established classification of English law, which places records in the first-class, accords with this theory. The distinction between contracts under seal and those not under seal, once important, has broken down from many causes: the more general education of the people, the reduction of seals to attenuated ghosts of their former selves and loss of distinctive character, intervention of the common law and Chancery Courts and statute to prevent fraud; followed by the amalgamation of the courts. Seals may continue for solemnization purposes and for evidence, but the affixing them to contracts should no more constitute these a class apart than the requirement of writing should make contracts coming under the statute of frauds a separate class from other simple contracts. In matter of substantive law the tests of the validity of both are identical. Reviewing Mr. Amos' list in respect to the distinction between status and contract, Mr. Browning classified contracts under two main heads; acts of the law immediate, acts of the law mediate.

SEVENTEENTH MEETING.

Seventeenth Meeting, 7th March 1891, the president in the chair.

Donations and Exchanges 75.

Mr. Levi J. Clark read a Paper entitled "A consideration of Sewage Schemes." He took up the subject under three heads: (1), A general survey of the position of sewage affairs in various parts of the world, particularly in England and Germany; (2), An elucidation of a gravity scheme for Toronto; and, (3), Some general defects in sewage works, and also some remarks on weak points in the scheme now before the city. Under the first heading he reviewed a recent work on sewage by W. Santo Crimp, assistant engineer of the London County Council, England. The book contains valuable information regarding the various methods of sewage disposal, such as sewage farming, precipitation works, filtration, irrigation, chemical treatment, electrolysis, and free outfall into the sea or other large body of water.

The general conclusion that Mr. Crimp comes to is that where a free

outfall can be obtained into the sea or other large body of water that is the cheapest way of disposing of sewage. Indeed, a novel method is proposed for the city of London, namely, to transport it in steamships constructed for the purpose out into the channel and dump it into the sea. This is supposed to be the most speedy, cheap, and cleanly way of disposing of it.

Where places are situated on tidal waters these can be utilized for the purpose of scouring the outlet pipe and carrying all offensive matters far out to sea. It was a consideration of the foregoing methods of sewage disposal, of which Portsmouth, England, affords a good example, which led Mr. Clark to devise a scheme which would secure the advantages of tidal waves and avoid the expense of pumping. By means of a high-level sewer along Gerrard street, extending from Yonge to Parliament streets, connected with a large automatic flushing tank, a head of 32 feet could be secured instead of 10 to 12 feet, the ordinary height of the tides around England. Then instead of twice a day the flushing could take place every hour in the day if desirable. From four to eight large flushes of half a million gallons each would be ample to keep the outlet pipe scoured.

Mr. Clark showed by illustration on the blackboard why deposits take place in sewers that are constructed too large. He also explained a formula of his own by which to determine the velocity of sewage flowing in sewers partly full. This is a fact too often lost sight of, and to which is attributable many of the present defects in drainage.

Mr. Clark also read a paper, "A Few Words on Lake Currents." He held that there are no regular, constant, well-defined lake currents, but that these are variable, dependent on the conformation of the shore and the storms that affect the surface. This is important in view of the proposal to discharge our sewage into the lake. The effect of a continued strong easterly gale is to drive the surface water to the west, where it piles up on the shores at the western end at Hamilton beach, and by the head thus produced a portion of the water is forced backward as an undertow, thus producing a current in the opposite direction to the waves on the surface. This undercurrent then in flowing to the east would first pass the intake of Toronto water supply, and then pass the contemplated place of discharge of sewage, so that a sewage outfall to the east would in no way endanger the water supply. When the winds were in the contrary direction it would not produce a counter-current below, as the outlet is towards the east, and as the waters flow down the lake they would make their exit by the St. Lawrence. This makes plain the danger that would arise from having sewage disposal outlets to the west.

Mr. Macdougall referred to the great importance of the question of Lake Currents. The matter had not been sufficiently investigated. He gave a table of float observations taken off Victoria Park, six miles east of Toronto, in October, 1888 :—

Oct. 22nd, light east wind,	30 feet deep,	3hrs. 40min.,	½ mile	east.
" " " "	50 "	4hrs. 30min.,	¾ "	
" 30th, light west wind,	surface	2hrs. 5min.,	¾ "	
" " " "	50 feet deep,	2hrs. 45min.,	⅔ "	
" " " "	70 "	3hrs. 00min.,	½ "	
" " " "	100 "	3hrs.	200 yds	west.

The floats were of canvas, cross-armed, 4 feet. long, 15 inches deep.

In September, 1887, he took a few temperature observations of the lake on the sailing course from Niagara to Toronto. The summer of that year was remarkable for its great heat.

	Depth.	*Shade.*	*Surface.*	*Deep Water.*
At mouth of river,	30 feet	65°	65°	66°
3 miles out,	30 feet	65°	65°	66°
4½ miles out,	50 feet	65°	65°	63°
7 miles out,	175 feet	60°	64½°	48°
7½ miles out,	100 feet	60°	64½°	45°
	240 feet			43½°
9 miles out,	100 feet	61°	64½°	44°
	200 feet			42°
	275 feet			42½°
10½ miles out,	100 feet		66½°	42°
	200 feet			42°
	325 feet			41°
12 miles out,	50 feet		65½°	50°
" "	200 feet			42°
" "	350 feet			41°

EIGHTEENTH MEETING.

Eighteenth Meeting, 14th March, 1891, Mr. Harvey in the chair.

Donations and Exchanges 45.

Letters from the Town Councils of Penetanguishene and Midland inviting the Institute to hold its summer meeting at those places, were read and referred to the Council.

The Geological and Mining Section reported the following resolution:—"We are of opinion that until a provincial department of mines is established the mining and metallurgical interests of Ontario cannot receive that attention which their importance demands, and therefore recommend that a mining convention be called to meet in the City of Toronto, at the Canadian Institute, on the 31st day of March, at 10 a.m., to consider measures for the advancement of the mining industry, and the advisability of establishing a provincial department of mines. The Canadian Institute is hereby requested to give notice calling upon the various mining localities throughout the province to send delegates to meet the delegates appointed by the Institute for the purpose of laying their views before the Provincial Government." It was resolved that the institute adopt the resolution passed by the Geological and Mining Section, and refer it to that section to carry out the details.

Mr. David Boyle read "A Summary of the Archæological Report for 1890-91." He referred to the increased interest in matters relating to archæology, the discovery of many valuable ethnological facts in connection with the year's operations of the Institute, and the large number of specimens that had been added to the Provincial Museum during that time.

Mr. Boyle also read a paper by Mr. G. E. Laidlaw on "Indian Remains and Relics Found in the Neighborhood of Balsam Lake." In illustration of the statements made he exhibited several remarkably beautiful, curious and instructive specimens of aboriginal workmanship, forming part of the Laidlaw collection in the museum. There was also on view a unique specimen of Hydah wood-carving, in the shapeof a group of three animals, the central and chief of which is a seal, about five feet in length, and supported at each end by fantastically cut figures. Mr. Boyle explained that this specimen came from a remote island in the Queen Charlotte archipelago, and had been secured for the Institute through Mr. W. H. Jones of the Vancouver *World*. A small canoe model from the same place was also shown. Both specimens are painted in red, white and black, after the manner peculiar to Hydah artists.

Mr. J. W. L. Forster said there seemed something pathetic in the artistic efforts of these rude people. There was a striving after some higher ideal amid their antagonistic surroundings. There was a striving after the arts of peace amid the contentions of savage tribes. The brotherhood of man was here brought out in these rude efforts of art.

Mr. Arthur Harvey referred to the mounds in Florida. They were 100 feet in height and 100 feet across. The only things now found in them are shells. These shell mounds are similar to those now found in

Denmark and in other places. It was remarkable that copper implements were found in them, and some gold. These metals are not produced in Florida. He had no doubt that the copper came from the north-west of Lake Superior, and the gold from Mexico, indicating the intercommunication between the tribes. In the shell mounds of Jamaica no gold was now found, though the Spaniards found gold there, which probably came from Mexico.

NINETEENTH MEETING.

Nineteenth Meeting, 21st March 1891, the President in the chair.

Donations and Exchanges, 111.

Mr. Harvey presented a dragon-fly from Bogota, Columbia, from Mr. Croll of the SS. "Alene," also a gamboge apple and shells from Jamaica. The Rev. Vincent Clementi, B.A., of Peterborough, having written offering to present to the Natural History Department of the Institute a work entitled "The Nests and Eggs of the Birds of Ohio," and to have the same bound at his own expense, a resolution was passed accepting the same and returning thanks for the valuable gift.

Mr. Harvey and Dr. Meredith were appointed Auditors for the current year.

The President, Vice-President, Secretary and Treasurer were named delegates to the mining convention to be held on 31st March.

Mr. D. R. Keys, M.A., read on behalf of Mr. A. F. Chamberlain, M.A., fellow in anthropology in Clark University, Worcester, Mass., a paper on "French-Canadian Folk-Lore" The writer called attention to the desirability of further investigation of the folk-lore of the people of European descent resident in the Dominion of Canada. More has been done for Quebec than for Ontario in this respect, the literary men of the former province not being oblivious of the fact that much of the legendary lore of the other France across the sea still lingers in the quiet valleys of Lower Canada. The paper was devoted to the discussion of certain items of folk-lore which are preserved for us in the writings of the French-Canadian novelists and historians, Faucher de Saint Maurice, J. E. Taché, P. A. de Gaspé, P. Lemay, etc. The belief that the "northern lights" can be made to dance by singing or whistling on a calm evening was referred to, and similar beliefs cited as prevalent amongst certain Indian tribes of the North-West. The *feux-follets*, or

Will-o'-the-Wisps, were noticed, and the legends of the "Follet de la Mare aux Bars" and the "Feu de la Baie" were reviewed; reference was also made to the "Feu des Roussis." Attention was called to the widespread belief in goblins and sprites, in which the farfadets, lutins, gobelins, diablotins, etc., of the *habitant* get sometimes very strangely mixed up with the manitous and wendigoes of the red men. A well-known example is the "Phantom of the Rock" that appears every time a member of the family of Frasers is about to die. M. Aunaud Parent, of Oka, chronicles the survival in his younger days of the belief in the werwolf or loup-garou. There are also stories of the appearance of the devil in the form of a large black cat, etc. The beliefs in the *main de gloire* (hand of glory) and in the *chandelle magique* (magic candle) have not yet died out. Particular attention was called to the rural festivals of the French-Canadians, their huskings, bees, and the like. The folk-lore of of these gatherings is very important, and it is desirable that data should be accumulated before these festivals become obsolescent and die out. These festivals and the songs that are sung while they are in progress are valuable for comparison with like customs and songs in old France.

Mr. Geo. Kennedy, LL.D., read, on behalf of Mr. Sandford Fleming C.M.G., a paper on "Reforms in Time Reckoning."

TWENTIETH MEETING.

Twentieth Meeting, 28th March, 1891, the Vice-president in the chair.

Donations and Exchanges, 52.

Prof. W. H. Ellis read a paper on "Milk Analysis." He said that normal milk had a composition about as follows:—

Fat	3·8
Albuminoids	4·0
Milk sugar	4·0
Inorganic salts	0·7
Water	87·5
	100·0

For purposes of detecting adulteration one analysis of milk resolves itself into the determination of the quantity of total solids, of the fat, and the solids other than fat; that is, the sum of the sugar, albuminoids, and inorganic salts which are spoken of together as "solids not fat." The numerous methods of milk analysis in common use of late years

fall into three classes:—(1), Drying the milk in a small dish at the temperature of boiling water, and extracting the fat from this residue by boiling repeatedly with ether. (2), Drying the milk after mixing it with some powder such as sand, sulphate of lime, etc., and extracting the fat from the powdered residue in an extraction apparatus. (3) Sucking up the milk by some absorbent substance such as paper or asbestos, drying in a water-oven, and extracting the dry mass in an extraction apparatus. It has been abundantly shown that all the fat is not extracted by the methods of the first class. The methods of the second class give better results, but those of the third class give the best of all. Of the various processes of the third class the most rapid and convenient, as far as his experience goes, is that devised by Mr. Macfarlane, Dominion chief analyst. This method is at least as accurate as any of the others and deserves general adoption. It consists in absorbing the milk in a short glass tube filled with asbestos, drying to constant weight in a water oven, exhausting in an extraction apparatus with petroleum ether, drying and weighing the residue. In his opinion this plan of weighing the solids not fat, and deducing the fat from the difference between the weight of the total solids and the solids not fat, is preferable to weighing the fat direct. The experiments of Heberes and others, as well as his own, show beyond doubt that the fat gains weight when heated in a water oven. To prevent this change from taking place while the total solids are drying, he has devised an apparatus which was exhibited for drying in a current of hydrogen or coal gas.

TWENTY-FIRST MEETING.

Twenty-first Meeting, 4th April, 1891, the President in the chair.

Donations and Exchanges 57, including specimens of Grape and Gem iron ore, from Ishpeming, Mich., by Mr. M. J. Paterson.

The following resolution passed by the Mining Convention was read:—"That the thanks of this Convention are hereby tendered to the Canadian Institute for having invited the members of this Convention to assemble in Toronto and meet in the Institute to discuss the questions that have been passed on during the last two days in the interests of mining; and this convention believes that the action of the Canadian Institute in this matter, and the adoption of the resolutions that have been passed will be found to greatly advance the interests of the mining community in all parts of this province; and it is further

resolved that a copy of this resolution be transmitted by the Secretary of this Convention to the Secretary of the Canadian Institute."

On motion by Mr. Clark, seconded by Mr. Macdougall, it was resolved,

"That before any further steps be taken to promote the construction of the trunk sewer it is necessary that more definite and precise information be obtained regarding the currents in the lake between the mouth of the Humber and the south side of the Island and Victoria Park.

"That the City Council be requested to take a series of float observations for a period of at least three months, extending through the summer and a portion of the fall—say from July to October, with temperature observations of the water at various depths, and readings of the velocity and direction of the wind taken on the lake at the same time the floats are put in; these floats to be placed in deep water commencing at thirty feet in depth, and extending to sixty feet or even deeper.

"That the co-operation of the Provincial Board of Health and Board of Trade be enlisted, and that a copy of this resolution be sent to each of the boards, and to the City Council; and that a delegation consisting of Mr. Carpmael, Dr. Canniff, Mr. A. Harvey, and the mover and seconder, be appointed to bring the matter before the above-named corporate bodies."

Mr. James H. Coyne, B.A., was elected a member.

The following amendment to Section IV., Clause 4 of the Regulations, of which due notice had been given, was adopted:—

"Associates must be recommended by two members, who shall certify to their fitness, and all male associates must be under the age of 21 years, and on attaining that age shall cease to be associates, and are thereafter eligible for election as members."

Dr. E. A. Meredith read a paper on "Miss Dix and Her Life Work."

Mr. William Brodie read a paper on "Modern Ornithology." A short sketch was given of the history of ornithology in America from the time of Catesby (1731), mentioning the names of a few of the best known ornithologists—Wilson, Audubon, Baird, Dr. Coues, Ridgeway, and in Canada, Mr. McIlwraith, of Hamilton. Reference was made as to the general character of the work of these men, and the general widening of the field of research. A few of the special lines of investigation now pursued were indicated, such as food and food habits of old and young, migrations, distribution, variation, psychology, and others. The value of collections to students of the science was pointed out, and the necessity for accurate and full labelling of specimens to give them any scientific

value. The procuring by the Canadian Institute of a full collection of specimens of foreign and native species was urged in the interest of the science in Ontario. The decrease in the desire for "stuffed birds" as household ornaments and trimming for ladies' hats was commented on favorably. The careful and just manner in which our bird laws were administered by the Department of Agriculture in the public interest was also spoken of. A plan was submitted for the consideration of the Institute for the promotion and popularizing of the study of scientific ornithology in Ontario by securing the co-operation of many corresponding observers throughout the province, and thus compiling accurate and full statistics of migration, food, nesting habits, relations to agriculture, and all other particulars relating to birds. It was also held that an intimate acquaintance with the life history of birds, as well as other animals, cauld be recommended on moral grounds as inducing habits of mercy and truth.

TWENTY-SECOND MEETING.

Twenty-second Meeting, 11th April, 1891, Mr. Harvey in the Chair.

Donations and Exchadges 102, including 28 publications of the Geological and Natural History Society of Canada, by Mr. Thomas Shortiss.

Mr. Tozo Ohno read a paper on "Japanese Literature." After a short sketch of the early intercourse between Japan and Europe, and of the second opening of the ports by Perry in 1853, Mr. Ohno stated that since the opening of the C. P. R. and of communication between Canada and Japan the latter had become of all Asiatic countries the nearest to the Western world, and in particular a close neighbor to Canada. In 1890 the Japanese established a representative Government, being the first Eastern country to do so, and to-day Japan is the one Asiatic country where the people enjoy the civilization of the nineteenth century. The Japanese language had been said by Max Muller to be "the strangest in the world." An account of the Japanese syllabic alphabet followed, the reader illustrating the various scripts on the blackboard, and giving specimens of the many foreign words that Japanese like English have borrowed from other civilized and uncivilized languages. Like the English language in America, too, Japanese has no dialects. The distinction between the different scripts was briefly stated thus :—The katakana or male character is practical, the hirakana or female is poetical, and the kangi is rhetorical; that is, the male character is used in speaking of

simple, every-day subjects, the female is used for poetry, and kangi, or Chinese, for the expression of high-flown and magniloquent ideas. In books of poetry mostly the female manner of expression is found. Among the common people the male and female are both understood and in use. In the newspapers, however, all three forms were combined, so also in novels and in general literature other than poetry. The development of Japanese literature was stated to have begun in poetry, under the influence of woman, and the force was still felt very powerfully, especially at the Court of the Mikado. The next period in the history of the literature was that dominated by the Buddhist priests, when history flourished to a remarkable extent, such popular treatises as "The History of the Middle Kingdom" in 125 volumes, being still read by the Japanese school boys. The third stage in the development of Japanese literature was that of the Samurai or Knights, and is characterized by Confucianism in philosophy, and a lighter style of prose. It was the most brilliant period of Japanese literature, and lasted about 200 years. Its decay was followed by the introduction of European learning, which has been so eagerly received by the Japanese, who have translated from English, French and German, and are now beginning to be recognized in the universities of the Continent as the possessors of a literature worthy of being studied for its own sake.

TWENTY-THIRD MEETING.

Twenty-third Meeting, 18th April, 1891, Dr. Kennedy in the chair.

Donations and Exchanges, 64.

Thomas Hodgins, M.A., Q.C., was elected a member.

Rev. Prof. G. M. Wrong read a paper on "The Study of History." The student of history is something of a prophet—a prophet looking backwards, as Schlegel said. To know history is to know not only facts but the deep significance of facts. The historian has nothing to do with praising or blaming; his work is to paint men as they were. Macaulay took Thucydides as his model of a historian. But there is a writer that rivals Thucydides—the writer of the book of Genesis. He gives a vivid moving picture of the people he depicts, of their virtues and vices, and writes scarcely a word of praise or blame. A variety of endowments is necessary to study history well, and scarcely anyone possesses them all. There are moral endowments. Sympathy—to enable us to stand with the men of the past and see as they saw; unselfishness, that we may

justly estimate what runs counter to our own convictions or interests; moral earnestness, that we may see the purpose in the tragedy of history. The spirit of patient research is necessary for the historian; but he must be more than a book-worm. He must be a man who knows men, who feels the pulse of human emotion throb warmly in his veins. Severe thought is necessary for the student of history. He must rise above the Zeit Geist of his own age, and live in that of the age he would depict. Buckle draws up a formidable list of what he must know—Political economy, law, ecclesiastical affairs, physical science, etc. He must have imagination, too, for "narrative is linear, action is solid," and he must fill a dead outline with moving life. We may ask lastly, what has history to tell us of the future? Without doubt the development of man takes place under law. If we could know the whole of the present we should also know the whole of the future. In this sense there is a science of history. But man cannot know all the present, and history deals with the most subtle of phenomena—the will, the affections, etc. The science of education tells us what influences will develop certain characteristics, but history is concerned with the production of these very influences—a much more obscure question. Yet history has something to say regarding the future. The countryman complained that he could not see the city for the houses, and we, too, cannot see the future because we are so closely hemmed in by the present. We must go to the past and study the tendencies that are fully worked out there, and then we can come back to the present and plan wisely for the future. Lord Chesterfield, a keen man of the world, who had studied history, predicted the French Revolution a quarter of a century before it came. The future is not determined, any more than a people's language is determined, by theories. A wise, wide study of facts and induction based upon these is the only foundation of historical prophecy. A thread of purpose runs through the ages, and, as Mr. Goldwin Smith has said, theistic belief is the only thing that can preserve us from despair.

On behalf of Mr. Wm. Houston, a paper on the "Genesis and Growth of Capital," was read by Mr. Alan Macdougall, C.E., in which the following statements were made:—One of the most important features of the economic condition of the world, and especially of America, at the present day is the accumulation of large masses of wealth in the hands of individuals. Millionaires abound in the United States, and not a few men are reputed to be worth a great many millions each. These men do not let their wealth lie idle. If "capital" is rightly defined to be that portion of wealth which is devoted to the production of more wealth, then practically the whole of each man's wealth is "capital." It is not the purpose of this paper to trace the effect of such aggregations of

capital on the industrial and commercial conditions of society; its aim is to enquire how such fortunes have been accumulated, and, assuming that a more equable distribution of wealth would be an improvement, to point out how this can be effected. "Capital," using the term in the sense assigned to it above, is the result of the operation of some general principle or law in economics. There is nothing like unanimity amongst economists as to either its origin or its nature. The older economists generally concurred in attributing its existence to "abstinence" or "saving." This was the view of Smith, Senior, and Mill. To some extent it accounts for the existence of "capital," but it does not account for the massing of it in large quantities in few hands. Men like Jay Gould, Vanderbilt, Huntington, or Rockefeller do not "save" to any appreciable extent. They spend on themselves as much as they can personally consume, and indulge in luxuries of the most costly kind, and yet their wealth goes on increasing with enormous rapidity. As that wealth is employed in production it is practically all capital, for each of these men is an active producer. Something more than mere abstinence is necessary to explain the accumulations of capital. Karl Marx endeavours to explain the phenomenon by what is called the "surplus-value" theory. Every commodity when produced has either use-value or exchange-value, or both. Use-value depends on the value of the raw material and the value of the labour expended on it, and the commodity ought to equal in value the sum of these two values. But it ordinarily exchanges for more than this, and this additional amount is called "surplus value" (German "*Mehrwerth*"). The conditions of capitalist production, with which all are familiar, enable the capitalist to appropriate this surplus value without sharing it with the labourer, who is reduced by the iron law of competition in wages to working for bare life. Without going into the ingenious analysis of Marx in detail, it is sufficient to admit here that it has shed valuable light on the source from which masses of capital are drawn and the processes by which they are collected. All this, however, does not yet explain the phenomenon of the enormous fortunes made by individuals in our own day, so much more frequently than they were made a few years or a generation ago. It is alleged of some great capitalists that they make money by dishonest devices, such, *e. g.*, as depreciating the shares of a railway, buying them up, and then appreciating them—restoring to them their original value or more. This practice may, probably does, explain some of the cases, but not all. The enormous accumulations spoken of seem to be due chiefly to two causes: (1), Monopoly of opportunity, and (2), the law of inheritance. Given a limited range of opportunity to produce some article that is in general demand, with the control of this oppor-

tunity by one man, and he must accumulate wealth whether he desires to do so or not. The supply of petroleum in the United States is controlled by the Standard Oil Company, which owns many of the wells and can dictate terms of distribution of the product of many others. The Standard Oil Company, therefore, are in a position to levy a toll on all the oil that goes into use, and even a moderate toll soon accumulates. This is the main source of Mr. Rockefeller's wealth, though since he has been placed in so advantageous a position he makes money rapidly in other ways also. Money accumulated by one man in his lifetime would not remain long in one man's hands after his death if it were not that he is able before he dies to say how it shall be disposed of. Cornelius Vanderbilt left the bulk of his wealth to his son, and his son left it to his grandson, who is now one of the most wealthy of the millionaires. But for this power of *post-mortem* conveyance each mass of accumulated wealth would soon disolve and pass into a number of hands, instead of being controlled by one. That in the main it is economically desirable to avoid extremes in the matter of wealth is quite certain. The sociological conditions of the community are improved by having a large number of moderately wealthy persons rather than by having a few enormously wealthy in the midst of a mass of poor people. If great accumulations of wealth are due chiefly to monopoly of opportunity and to *post-mortem* control of accumulations, it is obvious the remedy must be two-fold. The monopoly must be broken up and the succession to property must be regulated. The former can best be secured by the single tax on opportunity, and the latter by the succession tax on bequests or inheritance. If the Standard Oil Company were forced to pay over a large share of their monopolistic gains to the community in reduction of, or substitution for, other taxation, Mr. Rockefeller would never have possessed so much wealth. If the younger Vanderbilts had each in succession been required to pay a heavy succession tax each would have been just as well off in all important respects as he is now, and the community would have been better off than it is now, or might have been. It is not necessary here to defend the principle of either a monopoly tax or a succession tax. In my opinion each is defensible on the ground of justice, and also on the ground of expediency. My object is simply to call attention to the relation which these two forms of taxation bear to the great economic questions which grow out of the accumulation of capital in the hands of a few individuals, leaving millions of others the poorer for their wealth.

TWENTH-FOURTH MEETING.

Twenty-fourth Meeting, 25th April, 1891, Mr. Harvey in the chair.

Donations and Exchanges, 60.

Mr. Morley Parker was elected a member.

Nominations for officers for the ensuing year were made.

The Secretary read the report of Mr. Arthur Harvey, who had represented the Institute at the Jamaica Exhibition.

A paper by Rev. Dr. MacNish on "A Gaelic Cuneiform Inscription" was read by Dr. Kennedy.

Mr. J. Castell Hopkins read a paper on "British and Canadian Trade Relations."

Mr. William Brodie read a paper on "Intelligence of Insects as Exemplified by Pelopœus Cementarius."

Mr. W. Knox exhibited and explained plans for certain proposed additions to the Institute building.

FORTY-SECOND ANNUAL MEETING.

Forty-second Annual Meeting, 2nd May, 1891, Dr. E. A. Meredith in the chair.

Donations and Exchanges, 59.

The Forty-second Annual Report and the Reports of Sections were read, received and adopted on motion by Mr. Macdougall, seconded by Dr. Canniff.

On motion by Mr. Pursey, seconded by Mr. Elvins, it was resolved—

"That the thanks of the Institute be tendered to the press, and particularly to the *Mail* for the full reports of the proceedings of the Institute.

The election of officers for the ensuing year resulted as follows :—

President—Arthur Harvey, Esq.
Vice-President—James H. Pearce, Esq.
Secretary—Alan Macdougal, M. Inst. C.E.
Treasurer—James Bain, Jr., Esq.
Librarian—D. R. Keys, M.A.

Curator—David Boyle, Ph.B.
Editor—George Kennedy, M.A., LL.D.
Members of Council—A. B. Macallum, Ph.D.
W. H. Ellis, M.A., M.B.
B. E. Walker, Esq.
C. Carpmael, M.A.
William Brodie, Esq.

FORTY-FIRST ANNUAL REPORT.

The Council of the Canadian Institute has the honor to lay before its members its Forty-first Annual Report.

The work of the Institute has been well maintained during the year. An increased interest and impetus to original research have been imparted through the visit of the American Association for the Advancement of Science.

The Council takes much pleasure in reporting that the visit of the above-named society to this city, between the 27th August and the 3rd September, 1889, was most successful; there was a large attendance of members, 421 being present, and it was remarked as a rare occurrence, that there were so many ex-presidents present. Out of 62 new Canadian members, 35 were members of the Institute. The number of papers contributed by Canadians was large, the members of the Institute contributing their full proportion.

The Council desires to express its hearty thanks to the several bodies who gave up the use of their buildings, to the Press for the close attention given to the meetings and the very extensive reports of them, and to the ladies and gentlemen, who, through their kind hospitality, aided so much in the social part of the meetings.

The interest in the movement for the introduction of cosmic time is well-maintained, and is increasing. The American Society of Civil Engineers has issued several valuable reports detailing its extension on this continent and in other countries; over 230 railway companies in North America use this system; the Kingdom of Prussia has adopted it, and it is being introduced into Austria. Dr. Robert Schram, of Vienna, and Prof. Pasquier, of Louvain, have been directly instrumental to much of its extension in Europe. Petitions from the Institute have been presented to His Excellency the Governor-General, the House of Commons,

the Senate, His Honor the Lieutenant-Governor, and the Legislative Assembly of the Province of Ontario, praying for the legalizing of this mode of time reckoning. A bill has been read for the first time in the Senate, entitled " An Act respecting the Reckoning of Time."

The thanks of the Institute are due to Dr. Fleming for his unremitting interest in this subject.

The Council deplores the destruction of our Provincial University by fire; a resolution of sympathy has been sent to the Senate and College Council.

The meetings continue to be well attended; there were 21 ordinary meetings, at which 30 papers were read, and 36 meetings of the several sections, at which 32 papers were read.

The Council again acknowledges its thankfulness to the generosity of the Provincial Government, for once more placing the sum of $1,000 at the disposal of the Institute for archæological research. Many of the cases have been re-arranged to facilitate the study of the specimens, and the history thereby imparted. A very full descriptive catalogue has been compiled and appended to the valuable report prepared by the Curator and published as an appendix to the report of the Honorable the Minister of Education.

The museum was visited by a large number of leading American archæologists, who were very much pleased with the collection, and surprised at the result arrived at by such a moderate expenditure of money.

The Institute has received invitations from the Towns of Orillia, Barrie, and Niagara, and the Chautauqua Company of Niagara, to hold a summer convention in each town. The Council has accepted that of the Town of Niagara, and preparations are being made for holding a meeting there.

Increased shelving is being put up in the library; this will permit the books to be better arranged and classified, and more readily accessible to members. There is urgent need of a fund for binding purposes. Valuable additions are being made constantly, and the destruction of the university library makes ours of greater increasing value as a library of reference.

The Treasurer's statement shows a satisfactory balance at the credit of the Institute.

The membership has been increased during the year by 26 elections, of whom 18 have fulfilled the conditions and become active members. The policy entered upon last year of enforcing the regulations regarding

arrears has been carried out this year; there are now very few members in default.

The Council expresses its deepest regret for the loss sustained by the Institute in the sudden death of Mr. Alexander Marling, LL.B., who was a member of Council, and one of our most highly esteemed members.

In the death of General Sir J. H. Lefroy, F.R.S., K.C.B., etc., the Institute has lost one of its earliest presidents, and a member whose distinguished career has been an honor and gain to his country and the cause of science.

We have also to record the death of Mr. John Notman, who always took a deep interest in the welfare of the Institute, was a valuable member of Council, and was the treasurer for ten years, during which period the present building was erected; and of Mr. Samuel Keefer, also one of our earliest members, an engineer of high standing, who was elected the second president of the Canadian Society of Civil Engineers.

The reports of the various sections are appended.

All of which is respectfully submitted.

CHARLES CARPMAEL,

TORONTO, 3rd May, 1890. *President.*

APPENDIX I.

MEMBERSHIP.

Number of Members, 1st April, 1890:—

Honorary Members	8	
Life Members	12	
		20

Ordinary Members:—

1. Who have paid their subscriptions to 31st December, 1890, including new members	125	
2. Who have paid their subscriptions to 31st Dec., 1889	62	
3. " " " 31st Dec., 1888	26	
4. Who are two years and more in arrears	20	
		233
Total, 1st April, 1890		253

5. Losses through death and withdrawals	10	
6. Struck off	4	
7. Suspense	2	
		16
8. Members elected during the present session who have paid their first annual subscription	18	
9. Who have not yet paid	9	
		27
Associates, 1st April, 1889	32	
1. Who have paid to 31st December, 1890	14	
2. " " 31st December, 1889	20	
3. " " 31st December, 1888	3	
4. Two years in arrears	3	
		40
Elected during the session	5	
		5

APPENDIX II.

FINANCIAL STATEMENT.

The Treasurer in account with the Canadian Institute for the year ending March 31st, 1890.

To Summary.

To Balance in Imperial Bank	$ 137 00
" Cash in hand	38 07
" Annual subscriptions	706 00
" Life memberships	100 00
" Rents	166 00
" Government grant	1,000 00
" Periodicals sold	46 66
" Journals sold	9 41
" Interest on deposits	9 68
" Refunded from Archæological Grant	42 08
" Building Fund (Insurance)	244 00
	$2,498 90

By Summary.

By Salaries	$413 00
" Printing (proceedings)	641 13
" " (miscellaneous)	33 75
" Stationery	33 01
" Postage	161 46
" Freight and express charges	11 19
" Repairs	49 53
" Gas	44 31
" Water	7 30
" Periodicals	73 04
" Furniture	174 78
" House cleaning	68 10
" Fuel	27 00
" Taxes	9 66
" Advertising	5 50
" Binding	178 65
" Type writing	11 40
" Bird stuffing	21 10
" Chemicals	4 32
" Valuator's fees	25 00
" Archæological grant	30 00
" Interest	200 00
" Balance in Imperial Bank	270 45
" Cash in hand	5 22
	$2,498 90

ASSETS AND LIABILITIES.

ASSETS.

Building and ground	$18,000 00
Library	5,000 00
Specimens	3,000 00
Personal Property	1,000 00
	$27,000 00

LIABILITIES.

Mortgage No. 1, due 1892	$ 3,000 00

Mortgage No. 2, due 1892	1,000 00
Balance in favor of the Institute	23,000 00
	$27,000 00

Examined and found correct, April 15th, 1890.

(Signed) ARTHUR HARVEY, W. E. MIDDLETON, } *Auditors.*

James Bain, Jr., in account with Archæological Grant.

1889.		
May 27.	To Balance from last year	$ 5 25
	Government Grant	1,000 00
		$ 1,005 25
1889.		
May 27.	By David Boyle on account expenses	$ 100 00
" 28.	" R. W. Young, sundry expenses	11 63
" 28.	" C. J. D. Rutzer, specimens	25 00
June 29.	" David Boyle, on account salary	100 00
July 24.	" C. W. Riggs, Cincinnati	100 25
" 30.	" David Boyle, salary	100 00
Aug. 17.	" John B. Baker	94 08
Sept. 5.	" David Boyle, salary	100 00
" 28.	" David Boyle on account expenses	100 00
Dec. 2.	" John Notman, specimens	10 00
" 19.	" David Boyle, salary, extra vote	100 00
1890.		
Mar. 28.	" Toronto Engraving Co	54 75
Apr. 11.	" Father Laboureau, specimens	10 25
" 24.	" J. B. Baker, case	93 86
	" Balance in Bank	5 43
		$1,005 25

By Summary.

1889	By Purchase of specimens	$ 166 12
	" Travelling and working expenses	112 25
	" Salary of Curator	400 00
	" Express charges, postage, and sundries	63 56
	" Cases	187 94
	" Engraving	54 75

" Balance in hands of Curator	15 20
" Balance in Bank	5 43
	$1,005 25

Certified correct, 24th April, 1890.

(Signed) ARTHUR HARVEY, W. E. MIDDLETON, } *Auditors.*

TORONTO, April 15th, 1890.

The Auditors having examined the accounts and vouchers, which, as usual, are in perfect order, beg to report:—That the distribution of the various items of revenue and expenditure made by the Treasurer corresponds with the cash accounts kept by Mr. Young. We have also checked the Bank book.

The Auditors' recommendation of last year, to have the various assets of the Institute valued, has been carried out as respects the building and ground, and it appears that the whole property is more valuable than previous balance sheets disclosed. We have had an entry made which shows approximately the true present value of the property.

We do not see that any report has been made as to the value of the library and museum. Though it is difficult to appraise these assets, we think an attempt should be made.

ARTHUR HARVEY, W. E. MIDDLETON, } *Auditors.*

APPENDIX III.

PAPERS READ SESSION, 1889-90.

1889, Nov. 2. "Pelotechthen Balanoides,"— Arthur Harvey, Esq.
"Prison Reform in the United States,"—Dr. A. M. Rosebrugh.

" " 9. "French Relics from Village Sites of the Hurons,"—A. F. Hunter, B. A.

" " 16. "City Sanitation and the Sewage Problem,"—L. J. Clark, Esq.

" " 30. "Scientific Time Reckoning,"—Sandford Fleming, C.M.G., I.L.D.

" Dec. 7. "The Canadian Indian Research and Aid Society."—Rev. E. F. Wilson.

" " 14. "The Cruel Plant (Physianthus Albens),"—Arthur Harvey, Esq.
"Birds recently added to the Museum,"—J. B. Williams, Esq.

1889, Dec. 21. "Codification of the Law,"—T. B. Browning, M.A.
1890. Jan. 11. "Personal Experiences in Haiti under President Lègitime,"—Chas. G. Y. King, Esq.
" " 18. "Distribution of Wealth as related to Production,"—W. A. Douglass, B.A.
" " 25. "The Indians of Canada,"—A. F. Chamberlain, M.A.
" Feb. 1. "The Maroons of Jamaica and Nova Scotia,"—J. C. Hamilton, LL.B.
" " 8. "The Edison System of Electric Light,"—J. F. Cummings, Esq.
" " 15. "Sun Spots during 1889,"—A. Elvins, Esq.
" " 22. "Color in Nature."—W. A. Sherwood, Esq.
" Mar. 1. "Natural History of Drinking Waters,"—P. H. Bryce, M.A., M.D.
" " 8. "Canadian Faunal Lists,"—E. E. Thompson, Esq.
" " 22. "Defective Vision in the Public Schools,"—Dr. G. S. Ryerson.
" " 29. "Ossianic Poetry,"—David Spence, Esq.
" April 5. "Preliminary List of Algae,"—J. J. MacKenzie, B A.
" " 12. "Meteorological Conditions during the past Winter,"—R. F. Stupart, Esq.
" " 19. "The American Indian in Literature,"—A. F. Chamberlain, M.A.
" " 25. "Gleanings from European Art Fields,"—J. W. L. Forster, Esq.
"The Dènè Languages,"—Rev. A. G. Morice.
"Codification of The Law (Real and Personal Property)," T. B. Browning, M.A.
"Present Efficiency in Sewage Disposal,"—Alan Macdougall, C.E.
"Formation of Toronto Island,"—L. J. Clark, Esq.

Classification of papers by subjects :—

Anthropology	3	Philology	2
Archæology	1	Physics	2
Astronomy	2	Physiology	1
Botany	3	Sanitary Science	3
Economics	1	Social Science	1
Fine Arts	1	Sociology	1
Geology	1	Voyages and Travels	1
Jurisprudence	2	Zoology	2
Literature	2		
Meteorology	1	Total	30

Read at meetings of Sections :—

Biological Section	20
Geological "	6
Historical "	2
Philological "	4
Total.....	32

REPORT OF THE BIOLOGICAL SECTION.

TORONTO, April, 1890.

This Section has to report favorable progress during the past session, and is at present in thorough working order.

The Museum is gradually increasing. We have received from the Institute a cabinet for ornithological specimens, costing nearly $100, and two table cases for miscellaneous specimens. The Council of the Institute also voted the Section $100 for biological purposes, and a considerable number of bird skins have been mounted through this grant. Field-day excursions were organized during the summer with more success than in preceding years, and we have good hopes for the coming season in this department on account of the forming of the sub-sections.

The ornithological sub-section which was organized on Dec. 21, 1888, has compiled its first report, which will appear in due course in the Proceedings of the Institute. The report will no doubt be well received and appreciated, as it gives particulars of work done, that would do credit to a much older society, and which the ornithological sub-section may well be proud of.

A mammalogical sub-section has lately been formed, also a botanical sub-section, under Mr. Hollingworth, which promises well.

"Gossip meetings" have been held at the President's residence, 226 Beverley street, once a month, where some pleasant and useful evenings were spent.

The number of papers show a slight decrease from last year, but we expect they will be largely increased during the coming session.

A schedule showing the papers read is attached.

The officers for the coming session are :—James H. Pearce, *Chairman*; William E. Middleton, *Secretary*.

CHARLES W. ARMSTRONG,
Assistant-Secretary.

List of Donations and Additions to the Natural History Department of the Museum during the past year :—

5 Mounted specimens of Polypoid Animals of the Pacific.	*Donor*—W. B. Wright, Los Angeles, Cal.
Specimen of Cruel plant	*Donor*—Arthur Harvey, Rosedale.
1 Evening Grosbeak	
2 Hairy Woodpeckers	*Donor*—W. P. Melville, Muskoka.
1 Arctic Three-toed Woodpecker ..	
1 Yellow-bellied Sapsucker	
2 Redpolls	
1 Juncos	
3 Specimens, English Rabbit.....	*Donor*—E. E. Thompson, Toronto.
2 Specimens, American Rabbit....	
Collection of Mounted Specimens of English Plants.	*Donor*—W. Knox, Toronto.

The following mounted specimens have also been added to the collection ; most of them have been procured in the neighborhood of Toronto, by members of the Biological Section :—

Bonaparte's Gull,
Caspian Fern,
Stilt Sandpiper,
Red-backed Sandpiper,
2 Yellow-billed Cuckoo,
Black-billed Cuckoo,
Red-headed Wookpecker,
2 Belted Kingfisher,
Rough-legged Hawk,
2 Least Bittern, with nest and eggs,
Crested Flycatcher,
Olive-sided Flycatcher,
Yellow-bellied Flycatcher,
Wood Pewee, with nest and eggs,
Cowbird,
2 Red-winged Blackbird,
Song Sparrow,
Tree Sparrow,
Indigo Bunting,
Fox Sparrow,
Redpoll,
Pine Siskin,
2 Pine Grosbeak,
2 Evening Grosbeak,
Horned Lark,
Scarlet Tanager,
Cedar Waxwing,
House Wren.
Winter Wren.
Long-billed Marsh Wren,
Catbird,
Myrtle Warbler,
Chestnut-sided Warbler,
American Robin.

J. B. WILLIAMS,
Natural History Curator.

SCHEDULE OF PAPERS.

1. James H. Pearce ..... *Chrysanthemum Cinerariæfolium.*
2. W. E. Middleton ..... *Some Low Forms of Life.*
3. Wm. Brodie ..... *Clays exposed by Don Cuttings.*
4. An evening spent in the museum by the members.
5. Geo. Atkinson ..... *Report of the Ornithological Sub-Section.*
6. James H. Pearce ..... *President's Report.*
7. C. Armstrong ..... *Physianthus Albens.*
8. An evening spent in the museum by the members.
9. W. E. Middleton ..... *Pollen.*
10. C. Armstrong ..... *Pollen.*
11. J. B. Williams ..... *Abstracts from Ornithological Report.*
12. Wm. Cross ..... *Rare Birds.*
13. W. E. Middleton ..... *Algæ.*
14. Ernest E. Thompson ..... *Rare Birds in University.*
15. Wm. Brodie ..... *The Zoology of Indian Mounds.*
16. James Thurston ..... *Notes on the Mammoth.*
17. Geo. Atkinson ..... *Notes on Ontario Birds.*
18. C. W. Nash ..... *Food of Birds.*
19. J. J. McKenzie, B.A. ..... *Bacteria.*
20. Geo. Atkinson ..... *Notes on Ontario Birds (Continued).*

REPORT OF THE GEOLOGICAL AND MINING SECTION.

TORONTO, April 22nd, 1890.

The Geological and Mining Section has the honor to report that the past session has been a very interesting and instructive one to those who have followed the various papers and the discussions thereof.

The subjects treated of have been :—

"The Copper and Nickel Deposits of Sudbury," Dr. Richardson.

"The Coals of Western Canada," W. H. Merritt, F.G.S.

"Arsenic and Sulphur as Metallurgical Agents in the Treatment of Canadian Argentiferous and Auriferous Ores," R. Dewar.

"The Physical Phenomena of Underground Water," P. H. Bryce, M.D.

"On Boulders," Arthur Harvey. (To be read on the 24th instant.)

In addition to these a most interesting paper was read by Prof. J. W. Spencer, State Geologist of Georgia, on "The Building of the Great Lakes."

This paper the Secretary was desirous to secure for publication in the Proceedings, but Prof. Spencer was reluctant to allow the proof-reading to escape his supervision. As the paper is an important and original contribution to the geological speculations on the origin of the lakes, it is to be hoped that on Prof. Spencer's return from Europe the Institute may have the honor of publishing it. Prof. Spencer is a Canadian, whose earliest geological studies were carried on in this neighborhood, and it was with peculiar pleasure that he introduced his completed study of the problem of the lakes to a Canadian scientific body.

The museum of the Institute has been enriched with some valuable specimens, and when more room can be given, the Section is ready to devote time and attention to this important branch of its enjoyable duties.

ARTHUR HARVEY,
Vice-Chairman.

REPORT OF THE PHILOLOGICAL SECTION.

TORONTO, April 15th, 1890.

In accordance with the Constitution of the Institute, I beg to submit the following as the Report of the Philological Section for the year 1889-1890. A programme for the Session was arranged as follows :—

1889. Nov. 12. "The Study of Gaelic."
" " 26. "The Study of Modern Languages in Canadian Universities." A historical sketch, by D. R. Keys, M.A.
" Dec. 10. "The Study of Gaelic."
" " 24. "Jargons and Mixed Languages, I." By A. F. Chamberlain, M.A.
1890. Jan. 14. "The Study of Gaelic."
" " 28. "Jargons and Mixed Languages, II." By A. F. Chamberlain, M.A.
" Feb. 11. "The Study of Gaelic."
" " 25. "Scandinavian Influence upon Contemporary English Literature." By D. R. Keys, M.A.
" Mar. 11. "The Study of Gaelic."
" " 25. "German words in English." By A. F. Chamberlain, M.A.
" April 9. "The Study of Gaelic."

The first half only of this programme has been carried out, and I regret to say that it does not seem possible, in the present circumstances, to go on with the work of the Section. The formation of the new Historical

Section will, no doubt, enable some of the members to lay before it the results of their investigations on lines in which Language, Anthropology, and History converge. It is to be hoped that no very long period will elapse before it may be possible to successfully maintain a Philological Section of the Institute.

A. F. CHAMBERLAIN,
Secretary.

REPORT OF THE HISTORICAL SECTION.

TORONTO, April 22nd, 1890.

The Historical Section was formed on the 15th February last, for the study of the history of Canada and cognate subjects, such as Archæology, Genealogy and Ethnography, the officers being :—James Cleland Hamilton, LL.B., *Chairman;* D. A. O'Sullivan, LL.D., Wm. Houston, M.A., Geo. M. Rae, Esq., *Committee;* Arthur Harvey, *Secretary (pro tem.)*

It has held two monthly meetings, at each of which a paper of much interest was read. Mr. Houston favored the Section with a *resumé* of a forthcoming work, his subject being, "The Genesis and Development of Legislative Functions in the Northern Parts of America." Mr. J. G. Ridout read an account written by the late Hon. Thomas Ridout, Surveyor-General of Canada, of his captivity among the Shawnees in 1788. This narrative will also be soon made public property in a volume written by Mrs. J. D. Edgar. Several papers upon subjects of deep historical interest are promised for next session, and it is possible that fortnightly meetings may be necessary so that full opportunities may be given for their discussion.

A resolution was passed at the last meeting enabling the officers of the Section to take part in preparing for the approaching celebration of the centenary of this Province. The attention of the Council is called to the subject, as the officers would prefer that the Institute as a whole should take an interest in the commemoration.

The Section will in due time bring before the Council its views respecting the providing of cases for the collection of coins and medals now in the Institute's possession, and of safes for the valuable MSS. with which it may be entrusted.

J. C. HAMILTON,
Chairman.

REPORT OF THE LIBRARIAN.

TORONTO, April 15th, 1890.

Since my election as Librarian in May of last year, I have devoted what time I could reasonably spare to an examination of the books in the library, with a view to their proper arrangement and classification. The lack of shelf space has hindered systematic arrangement, but a short time ago it was wisely determined by the Council to provide new shelving for some 1,500 volumes, and with this increased accommodation it is to be hoped that the books will be so arranged during the coming summer as to admit of ready consultation.

The value of the series of scientific societies' proceedings, transactions, etc., now in the Institute's library is very great, and such value must tend to increase. The total number of exchanges received by the Institute for the year (April 1st, 1889, to April 1st, 1890) is 485, consisting of 2,402 separate volumes and fasciculi. For facility of reference these exchanges must be bound, and it is evident that the Institute, in having them all bound as soon as possible, would only be doing what is clearly to the advantage of its members and of students of science in all its branches. I therefore have no hesitation in recommending and requesting that a certain fixed sum be appropriated annually towards the binding of volumes in the library.

The exchange list of the Institute's Proceedings is yearly increasing, and the widened circulation given to the papers read before it must result in benefit to the Institute in general and to the individual authors.

I cannot refrain from congratulating the Institute upon the great value of its library to men of science throughout Canada, for the volumes it contains excited in no small degree the admiration of the American friends who were our guests and visitors in August last. I hope the time is not far distant when there will be few scientific libraries in America that will exceed in value and importance that of our own Institute.

Finally, I beg to recommend that some steps be taken towards securing the proper cataloguing of the library, and disposing of such miscellaneous books as it is not desirable to retain in a purely scientific library. It will also be necessary to provide for the proper safe-keeping (should the Institute not see fit to dispose of them) of the many valuable pamphlets now in the possession of the Institute.

Annexed will be found the usual statement of the accessions to the

library during the year (April 1st, 1889, to April 1st, 1890), and other information connected therewith :—

STATEMENT.

I.	Donations to the Library	191
II.	Exchanges :	
	1. Canada	154
	2. United States	668
	3. Mexico and South America	53
	4. Great Britain and Ireland	501
	5. Austria-Hungary	164
	6. Belgium	17
	7. Denmark	6
	8. France	326
	9. Germany	134
	10. Italy	124
	11. Netherlands	35
	12. Norway	9
	13. Portugal	10
	14. Roumania	1
	15. Russia	38
	16. Spain	24
	17. Sweden	47
	18. Switzerland	9
	19. British India	19
	20. Java	21
	21. China	4
	22. Japan	8
	23. Cochin-China	1
	24. Africa	7
	25. Australasia	22
	Total separate numbers and volumes	2,402
III.	New exchanges added during the year	56
	Exchanges discontinued during the year	6
	Increase during the year	50
IV.	Total number of exchanges	485
V.	To the Periodicals subscribed for last year have been added : "The New Review," "Scribner's Monthly," "The Bystander," "The Photographic Societies' Reporter,"	

and "The Photographic Quarterly," making a total of 36

The total number of separate numbers received 778

VI. The number of books and periodicals taken out from the library and reading room during the year 1,622

A. F. CHAMBERLAIN,
Librarian.

REPORT OF THE SOCIOLOGICAL COMMITTEE.

TORONTO, May 3rd, 1890.

The Sociological Committee begs leave to submit to the Council its report for the year 1889-90.

1. Your Committee enlarged its circular of last year so as to include matters of philological import and distributed about 1,000 copies of it throughout the Dominion. The enlarged circular is printed in the last fasciculus.

2. Your Committee was allotted twenty-five dollars ($25.00) for its expenses of printing, postage, etc. The accounts have been audited by the auditors and show a balance in the Institute's hands of four dol and twenty-five cents ($4.25). About five hundred (500) circulars are yet undistributed.

3. Your Committee submits to the Council the following papers read before the Institute by title :—

(1) The Déné Languages considered in themselves and in their relations to the principal linguistic groups, by the Rev. Father Morice, O.M.I.

(2) The Philology of the Cree Language, by the Rev. E. B. Glass, B.A.

(3) The Cree Indians sociologically considered, by the Rev. Father Végréville, O.M.I.

And recommends their publication in the Proceedings.

4. Your Committee takes much pleasure in again expressing its indebtedness to the press at home and abroad.

5. Last year your Committee had the pleasure of reporting that the Honorable the Superintendent-General of Indian Affairs, at the instance

of your Committee, had undertaken to have copied and printed, all Indian treaties in his Department now or formerly in force, which affect any portion of the Dominion and yet remain unpublished. Annexed to this report will be found a letter from the Deputy Superintendent-General, written in reply to an enquiry by your Committee as to the completion of the work.

6. Your Committee has much pleasure also in acknowledging receipt from the Superintendent-General of Indian Affairs of a copy of all reports on Indian affairs made to his Department since the inception of the Dominion (1867-89) and requests that the same be placed in the library for the purpose of reference.

T. B. BROWNING,
Chairman.

OTTAWA, 21st April, 1890.

SIR,—I am directed by the Superintendent-General of Indian Affairs to inform you, in reply to your enquiry of the 17th instant, that the work of copying the treaties is much greater than was anticipated, and is not yet nearly completed. When the copying is done, the MSS. will be put in the hands of the printer; but the completion of the work cannot be expected for some time.

I have the honor to be, Sir,
Your obedient servant,
R. SINCLAIR,
For Dep. Supt.-Gen. Indian Affairs.

T. B. BROWNING, Toronto, Ont.,
Chairman Sociological Committee, Canadian Institute.

FORTY-SECOND ANNUAL REPORT.

The Council of the Canadian Institute has the honor to lay before its members its Forty-second Annual Report.

The Council has again the pleasure of recording an increased interest in the work, and a continued extension in the influence of the Institute.

The great work in which we are deeply interested, the adoption in

every part of the world of the use of cosmic time, has received much attention and consideration from the Council and Institute. The movement has made marked progress during the past year. The use of this system of marking time has been adopted by the Governments of many countries, from Germany to Japan.

The circulars of Lord Knutsford, of dates 26th July and 21st Nov., 1890, being addressed only to the Colonies and dependencies of the British Empire, your Council, observing this, directed the attention of His Excellency the Governor-General to this fact, and respectfully suggested that he should direct the attention of foreign Governments to this important movement, which he agreed to do.

Two years ago, when the Royal Commission on Mines was formed, Mr. Hamilton Merritt, F.G.S., chairman of our Geological Section, was placed upon it. A most interesting and valuable report was issued last summer. Recognizing the value of the work done by the Commission, the Institute, on the petition of the Geological Section, called a Mining Convention to be held here on the 31st March, which was held on that day and the two succeeding days. The Convention was largely attended, nearly all the leading miners and persons interested in mining matters in the Province being present. The resolutions submitted through our Section on the establishment of a Provincial Mineralogical Museum; the establishment of a properly equipped school of mines, and the appointment of a departmental head for mining matters, were all adopted by the Convention. Before the convention broke up, a deputation had several interviews with the Government, which have led to the enactment of legislation which will have direct and practical bearing on the future of our mining development.

The Biological or Natural History Section, with its sub-sections in Microscopy, Ornithology and Botany, has added considerably to our museum, as well as encouraging largely an interest in all these important branches among many of our young men in the city.

The Historical Section, formed on the 15th Feb., 1890, for "the study and investigation of the history of Canada and cognate subjects, such as Archæology, Genealogy and Ethnology," has been most active in promoting the objects for which it was formed.

At an interview with the Government the Hon. Atty.-General Mowat requested the deputation to forward a memorandum in writing of such documents as they thought should receive consideration. A memorial on "Historical documents deserving the attention of the Administration of the Province of Ontario, with a view to their publication," was for-

warded on the 15th Feb., 1891. The memorial also prayed that special enquiry be made for the loan of documents relating to early family history, now in private possession, with a view to their being copied; and a collection formed of interesting relics of pioneer life for a Provincial museum.

A memorial was also presented to the Hon. Minister of the Interior on the same date, requesting the Dominion Government to aid the Institute in "research into the various subjects connected with the early Indian occupation of the Dominion." The Council regrets to say an unfavorable reply was received to this petition.

The invitation of the town of Niagara to the Institute to hold its first summer convention in that charming old historic centre was readily accepted. A well attended convention was held there on the 2nd and 3rd July, 1890. Several papers were read by the residents which added greatly to the interest of the meeting. The Council cannot refrain from expressing its pleasure and acknowledging its thanks for the excellent paper contributed by Miss Carnochan on "Two Frontier Churches."

The Archæological branch of our work suffers no loss. The curator, indefatigable as ever, has again enriched the museum and saved to the Province a large collection of relics, which will ere long be of inestimable value to the students of anthropology, ethnology, archæology and sociology. Special mention may be made of the Geo. C. Laidlaw loan collection of stone, earthenware, and other specimens obtained in neighborhood of Balsam Lake; a collection lent by Dr. Tweedale, from Elgin County; and the Long collection of bone ornaments and implements collected near Toronto, first loaned by Mr. Long and now the property of the Institute by purchase.

The Annual Report of the Curator this year, a work surpassing in interest any of his former reports, has been distributed among the members. The Council commends it to the careful study of every member interested in the history of our Province.

The Institute was ably represented at the Congress of Romance Languages, held in Montpelier, France, 26th May, 1890, by Mr. Arthur Harvey, and in February of this year he presented his credentials to the Institute of Jamaica, during the time of the Exhibition. His reports from both places are full of interest.

The Council takes pleasure in acknowledging once more the generosity of the Ontario Government in placing the sum of $1,000 at its disposal for the extension of archæological research, and for assistance in printing the report on archæology.

Dr. Sandford Fleming, on learning that he could not at present pay over the capital sum of his policy of life insurance made out in favor of the Institute, has generously resolved to pay the interest thereon, amounting to $200 per annum, during his life time.

A large number of donations to the library and museum have been received. A valuable and scarce book, "The Nests and Eggs of the Birds of Ohio," presented to the Institute through the Biological Section by the Rev. Vincent Clementi, of Peterboro', Ont.

A fine specimen of Haida Indian wood carving from Queen Charlotte Island group, through Mr. J. F. Jones, of Vancouver, B.C. The Laidlaw and Tweedale loan collections, and gifts to the archæological museum from Messrs. Cyrenius Bearss, W. and D. Melville, A. Robertson, of Madoc; A. Crawford, of King; H. F. Switzer, of Midland City; T. A. Beeman, of Bancroft; Ag-wah-setch, of Baptiste Lake; W. Mitchener, of Humberstone; C. Henderson, of Southwold; —McCallum, of Dunnville; P. E. Jones, of Hagarsville; J. B. Freeman, M.P.P., of Simcoe; — Henderson, of Toronto; A. E. Otway Page, of Bertie; W. A. Reaveley, of Simcoe; Waters, Heath and Crouse, of Brantford; W. Ireland and J. W. Fitzgerald of Parry Sound, and Rev. Mr. Gaviller, of Parry Sound.

The general work of the Institute has been well maintained. There were one special general meeting, twenty-four ordinary meetings, at which 33 papers were read, four meetings of the Geological section, at which four papers were read, fourteen meetings of the Biological section with fifteen papers read, independent of work done by sub-sections and "gossip" meetings, six meetings of the Historical Section with six papers read, making a total of 58 papers for the session.

The Librarian reports accessions to the library as under—

Donations	390
Exhanges (Vols.)	3,700

Of the above donations, 151 were presented by Mrs. Seidler, and 61 by the late Hugh Wilson, Esq. The list of exchanges embraces 516 societies; among the exchanges are many of considerable value. Through this means the Institute is acquiring a library of reference in science in almost every branch, which will be greatly valued ere long. The importance of this part of our work was dwelt upon in the very able presidential address of Prof. Loudon in 1873, who at that early date recognized the great value of the interchange of publications between the scientific societies, as they tended to prevent individual workers from wasting time, money and strength in going over ground already

occupied, and brought workers in far distant and young countries into contact with the greatest minds of the older countries.

It is gratifying to notice the frequent reference to our transactions in our exchanges and to see papers written by our members translated into various foreign languages.

The much needed shelf space having been acquired, the books are now more readily accessible for reference. It is hoped that a catalogue will be prepared during the summer and be ready by the opening of next session.

The Council has special pleasure in acknowledging the services rendered by Mr. R. W. Young, M.A., the Assistant Secretary, in selecting and advising on the most advantageous exchanges, and his help in building up the Library. The commencement of the 4th series, under the name of the "Transactions of the Canadian Institute," has been very favorably noticed by many of our exchanges.

The Treasurer's accounts have been audited and found correct.

The membership has been increased by 37 elections. Eleven members have resigned, and 14 have been struck off the list for non-payment of annual subscriptions in arrears. There are 17 associates on the list.

An invitation from the Town of Penetanguishene asking the Institute to hold its next summer convention there has been accepted.

The thanks of the Institute are due and are tendered to the Press, especially the *Mail*, for its full reports of our meetings.

The Reports of the Sections are given as separate appendices.

The pressing needs at present are increased space for museum purposes and more funds.

The intellectual vigour of the Institute is being fully maintained. The practical part is suffering greatly from lack of funds to carry on the work.

A sketch plan has been prepared by one of our members, Mr. W. Knox, architect, outlining a scheme to utilize the vacant plot to the north, on Berti street, for museum purposes, at an estimated cost of about $5,000.

All of which is respectfully submitted.

CHARLES CARPMAEL,
President.

ALAN MACDOUGALL,
Secretary.

TORONTO, 1st May, 1891.

APPENDIX I.

LIST OF MEMBERS.

Honorary Members			7
Life Members			11
Ordinary Members, May 1, 1890		264	
Deaths	3		
Resignations	11		
Names erased	14	28	
		236	
Members elected in 1890-91		37	
			273
Total, May 1, 1891			291
Associates as at May 1, 1890		29	
Resignations	3		
Names erased	9		
		12	
Total, May 1, 1891		17	

APPENDIX II.

FINANCIAL STATEMENT.

James Bain, Treasurer, in account with the Canadian Institute, for the year ending March 31st, 1891.

To Summary.

To Balance in Imperial Bank	$ 270 45
" Cash in hand	5 22
" Annual Subscriptions	636 19
" Life Memberships	50 00
" Rent	12 00
" Government Grant	1,000 00
" Received from A.A.A.S.	510 79
" Periodicals sold	29 44
" Journals sold	17 61
" Interest on Deposits	18 10
" Sandford Fleming's Annual Donation	200 00
" Book sold	5 00
" Tickets to Niagara sold	16 65
	$2,771 45

By Summary.

By	Salaries	$442 00
"	Printing (Proceedings)	505 63
"	" (Miscellaneous)	45 75
"	Engraving	56 95
"	Extra copies of Report	49 00
"	Stationery	19 35
"	Postage	109 21
"	Freight and express charges	6 14
"	Repairs	23 85
"	Gas	31 29
"	Periodicals	200 03
"	Water	6 50
"	Furniture	101 29
"	House cleaning	58 75
"	Fuel	80 30
"	Taxes	10 28
"	Advertising	3 00
"	Museum expenses	25 25
"	Insurance	59 50
"	Interest	200 00
"	Bust of Dr. Workman	10 00
"	Niagara meeting	8 80
"	City Directory	4 00
"	Petty charges	3 85
"	Balance in Imperial Bank	668 39
"	Cash in hand	42 34
		$2,771 45

Examined and found correct.

(Signed) ARTHUR HARVEY, } *Auditing*
E. A. MEREDITH, } *Committee.*

April 17, 1891.

ASSETS AND LIABILITIES.

ASSETS.

Building and grounds	$18,000 00
Library	5,000 00

Specimens	5,000 00
Personal property	1,000 00
	$29,000 00

LIABILITIES.

Mortgage No. 1, due 1892	$3,000 00
Mortgage No. 2, "	1,000 00
Balance in favor of the Institute	25,000 00
	$29,000 00

Examined and certified. The "Specimens" are probably mostly not ours, only held in trust, so that this is only a memo., so far as that item is concerned.

(Signed) A. HARVEY, E. A. MEREDITH, } *Auditors.*

April 17th, 1891.

ARCHÆOLOGICAL FUND.

James Bain, jr., Treasurer, in account with the Archæological grant Canadian Institute, 1890-91.

To Balance in hands of Curator	$ 15 20
" " Treasurer	5 43
" Government Grant	1,000 00
	$1,020 63

By Purchase of Specimens, W. G. Long	$ 75 00
" " " per D. Boyle	15 45
" Cases	139 31
" Lithographing, Rolph, Smith & Co.	40 00
" Salary of Curator	400 00
" Travelling and Miscellaneous Expenses, Curator	170 82
" Balance in Bank	180 05
	$1,020 63

Examined and compared with vouchers which Mr. Bain pronounces correct. Charges and expenses reasonable.

April, 17th, 1891. (Signed) A. HARVEY, E. A. MEREDITH, } *Auditors.*

The undersigned auditors beg leave to report that the distribution of the various items of revenue and expenditure made by the Treasurer corresponds with the cash account kept by the Assistant Secretary, Mr. Young. They have checked this cash account with the vouchers and examined the bank book, finding the whole in order. The account of assets and liabilities includes as "specimens" property which the Institute is only holding in trust, and so far as this item is concerned, it is a mere memorandum. The auditors have also examined the accounts referring to the application of the special archæological grant, which are correct.

Respectfully submitted,

E. A. MEREDITH, } *Auditors.*
ARTHUR HARVEY. }

APPENDIX III.

PAPERS READ, SESSION 1890-91.

1890. Nov. 1. "The Canadian Institute of the Future,"—David Boyle, Ph. B.

" " 8. "The Two Values,"—W. A. Douglass, B.A.

" " 15. "Studies in Cell-Structure and Cell-Contents,"—A. B. Macallum, B.A., M.B., Ph. D.

" " 22. "The Typhoid Bacillus in relation to Drinking Waters,"—J. J. Mackenzie, B.A.

" " 29. "Occurrence of Gold and Silver in Galena and Iron Pyrites,"—R. Dewar.

" Dec. 6. "Reminiscences of Newfoundland."—Rev. Philip Tocque, A.M.

" " 13. "Report of the Delegate to the Montpelier Congress on the Romance Tongues, with remarks on some Ancient Races still existing in Southern Europe, their Languages and Customs,"—Arthur Harvey.

" " 20. "Sculpture,"—Fred. A. T. Dunbar.

1891. Jan. 10. "Colour in Nature (in relation to Drapery),"—W. A. Sherwood.

"Crystal Studies (No. 1),"—H. R. Wood, M.A.

" " 17. "Studies on the Origin of the Blood Pigment,"—Dr. Macallum.

" " 24. "African and American: the Contact of the Negro and the Indian,"—A. F. Chamberlain, M.A.

" " 31. "Canadian Art of To-day,"—J. W. L. Forster.

" Feb. 7. "Some Effects of Christianity on Legislation,"—Hon. William Proudfoot.
" " 14. "The Bœothick Indians,"—Alan Macdougall, C.E.
"Crystal Studies (Nos. 2 and 3),"—H. R. Wood, M.A.
" " 21. "Review of a Work by A. W. Moore, M.A., on Surnames and Place-names of the Isle of Man,"—Rev. Neil MacNish, LL.D.
" " 28. "Codification of the Law, 3rd Paper (Contracts),"—T. B. Browning, M.A.
" Mar. 7. "A Consideration of Sewage Schemes,"—Levi. J. Clark.
"A Few Words on Lake Currents,"—Levi J. Clark.
" " 14. "Indian Remains and Relics found in the neighborhood of Balsam Lake,"—G. E. Laidlaw.
" " 21. "Notes on French Canadian Folk-Lore,"—A. F. Chamberlain, M.A.
"Reforms in Time-Reckoning,"— Sandford Fleming C.M.G.
" " 28. "Some Points in Milk-Analysis,"—Prof. W. H. Ellis.
"The Administration of Governor Simcoe,"—Capt. Ernest A. Cruikshank.
" April. 4. "Miss Dix and her Life Work,"—E. A. Meredith, LL.D.
"Modern Ornithology,"—W. Brodie.
" " 11. "Japanese Literature,"—Tozo Ohno.
" " 18. "The Study of History,"—Rev. Prof. G. M. Wrong, M.A.
"The Genesis and Growth of Capital."—W. Houston, M.A.
" " 25. "A Gaelic Cuneiform Inscription,"—Rev. Neil MacNish, LL.D.
"British and Canadian Trade Relations,"—J. Castell Hopkins.
"Intelligence of Insects, as exemplified by *Pelopœus Cementarius*,"—W. Brodie.

Total, 33 papers, which may be classified as follows :—

Anthropology	3	Jurisprudence	1
Archæology	1	Literature	1
Astronomy	1	Metallurgy	1
Biography	1	Mineralogy	2
Biology	3	Miscellaneous	1
Chemistry	1	Philology	3
Economics	3	Sanitary Science	2
Fine Arts	3	Zoology	2
Geography	1		—
History	3	Total	33

READ AT MEETINGS OF SECTIONS.

Biological Section	15
Geological and Mining Section	4
Historical Section	6
Total	25

LIBRARIAN'S REPORT.

(Session 1890-91.)

To the President and Council of the Canadian Institute:—

GENTLEMEN,—Your Librarian begs leave to report as follows:—

The accessions to the library have been—

I. Donations	390
II. Exchanges	3,700

Of the above donations 151 were presented by Mrs. Seidler, and 61 by the late Hugh Wilson, Esq. The members are to be congratulated on this evidence of the interest taken in the Institute by the citizens of Toronto.

With reference to the exchanges, your Librarian would urge upon the Council the importance of this department of the Institute's work. In the very able address presented to the Institute by its then President, Prof. Loudon, in 1873, the great value of such scientific bodies was shown to be the conservation of energy that resulted from them, as they prevented individual workers from wasting time and strength in doing work that had already been done, besides affording our own workers access to the publications of similar bodies throughout the world. The praiseworthy efforts and eager interest of our Assistant Librarian in its extension have brought our list of exchanges up to its present magnitude, and with the assistance of the Council there is no reason for us to stop here. If we look at the cost we shall find that this magnificent collection of scientific publications, already the finest with perhaps one exception in Canada, while one of our most valuable assets, has been purchased by the exchange of our own Transactions; in other words, by the increase of our reputation at home and abroad. Were the scientific spirit lacking, a sense of corporate, civic, and national pride should urge us to extend the knowledge of the important work being done by our members. Toronto is becoming one of the scientific centres of the New World, and with the

rapid growth of her colleges and technological schools the advantages of such a collection of exchanges will continually increase. It is the earnest hope of your Librarian that nothing will be done to decrease the progress of our exchange list, and thereby limit the usefulness of the Institute to all scientific workers.

With the object of increasing the interest of members in our exchanges, the Librarian has in contemplation a plan for abstracting the contents of the Transactions, etc., received, which he hopes to bring into effect during the next session.

A more pressing need, however, is that of a library catalogue. The exertions of the former librarian, Mr. Chamberlain, having introduced an orderly arrangement into the library, the important task remains of cataloguing the books. The majority of our members are probably ignorant of the varied collection of general literature which will be at their command when the catalogue is completed. This will probably be by the beginning of next winter's session.

DISTRIBUTION.

III. The number of societies, individuals and periodicals to which the publications of the Institute are sent	516
IV. Reading Room, Periodicals subscribed for	36
V. Total of separate numbers rec'd by purchase	834
VI. Number of books and periodicals taken out	1,551

Appended will be found a list of exchanges arranged according to countries, by the Assistant Librarian.

All of which is respectfully submitted.

DAVID R. KEYS, M.A.,
Librarian.

DONATIONS AND EXCHANGES.

(April 1, 1890, to April 1, 1891.)

I. Donations to library (of which 151 were presented by Mrs. Seidler, and 61 by the late Hugh Wilson)	390
II. Exchanges received from—	
Canada	200
United States	800
Mexico, West Indies and South America	73
Great Britain and Ireland	473

Austria-Hungary	145
Belgium	18
Denmark	5
France	572
Germany	901
Italy	177
Netherlands	36
Norway	16
Portugal	16
Russia	42
Spain	27
Sweden	24
Switzerland	24
British India	68
Java	28
China	4
Japan	24
Cochin China	2
Africa	5
Australasia	20
Total	3,700

REPORT OF THE BIOLOGICAL SECTION.

This Section has just closed another very successful session of fourteen meetings, at which fifteen papers have been read. One field-day excursion was taken to Howard Lake, at which there was a numerous attendance of members and friends. The Microscopical Sub-section, lately formed under the charge of Mr. G. G. Pursey, has held several meetings, and is now in good working condition.

The Ornithological Sub-section has done good work, judging from the report in the last issue of the Proceedings.

The Botanical Sub-section has done excellent work during the past session. Since it was formed about a year ago, 389 species of plants have been collected and identified, of which 325 species were found in the vicinity of Toronto, the balance (for most of which we are indebted to Miss Alice Hollingworth, of Beatrice, Muskoka), were collected in the northern parts of Ontario. This Sub-section having been considerably inconvenienced in its work by not having suitable accommodation for

the specimens collected, it was decided to file an application for a Botanical cabinet, which was granted by the Council of the Institute. The cabinet has been designed to hold pressed specimens, Coniferæ, and Cellular Acrogens, and to answer all the requirements of an Herbarium, besides being an ornament to the museum.

The Biological Section of the museum is now undergoing a thorough revision by Mr. James Noble, the present Curator. A schedule of papers is attached.

The officers for the ensuing year are,—James H. Pearce, *Chairman*; Chas. W. Armstrong, *Secretary*.

CHARLES. W. ARMSTRONG,

Secretary.

PAPERS READ.

1. James H. Pearce ..... *President's Address.*
2. An evening spent among the scientific books of the Public Library.
3. Wm. Brodie ..... *Accumulation of drift-wood by the River Don.*
4. G. Atkinson ..... *Notes on Ontario Birds (Continued).*
5. An evening spent in the museum by the members.
6. Chas. W. Armstrong..... *Review of the work done by the Botanical Sub-section.*
7. Chas. W. Armstrong..... *Ferns around Toronto.*
8. Wm. Cross ..... *Notes on Hybrids.*
9. Wm. Brodie ..... *Objects of the study of Ornithology.*
10. G. Atkinson ..... *Ornithological Report.*
11. G. Atkinson ..... *Habits of Native Birds in Captivity.*
12. Arthur Harvey ..... *Bone Caves of Europe in relation to pre-historic man.*
13. Wm. Cross ..... *Art of Taxidermy.*
14. James H. Pearce ..... *Ginseng, its medicinal properties and commercial value.*
15. Andrew Elvins ..... *Lower forms of Life.*
16. James H. Pearce ..... *Technical Etymology.*
17. Arthur Harvey ..... *Herpestes griseus in Jamaica.*

REPORT OF THE GEOLOGICAL AND MINING SECTION.

To the President and Council of the Canadian Institute :—

GENTLEMEN,—The Section can report on a very interesting session, which, although it started late in the season, aroused a great deal of interest, owing to the fact that the Ontario Mining Convention was held under its auspices.

At the meetings held during the year the attendance has been fairly good, and the members have evinced great interest in the proceedings, Mr. Mickle's series of papers on Nickel being followed with great attention and earnestness by many outside the scientific world, owing to the recent developments at Sudbury. These papers inaugurated an important new departure, in that they led from the scientific up to the practical working in connection with the subject. This treatment of mining and metallurgical matters is well worthy the attention of contributors of papers to the Section, even though it may necessitate more than one paper to carry it out.

The Section has continued its efforts to establish a provincial mineralogical museum, and a resolution calling the attention of the Government to the matter was passed by the Mining Convention. The establishment of a school properly fitted for education in mining was also pressed upon the Governmen

The Section had moreover the gratification of seeing their action in moving for the appointment of a Department of Mines adopted by the Convention.

Officers have been elected as follows for the years 1891-92 :—Wm. Hamilton Merritt, F.G.S., *Chairman*; Arthur Harvey, *Vice-Chairman*; G. Mickle, B.A., *Secretary*; D. Boyle, A. Elvins, T. R. Clougher, R. Dewar, P. H. Bryce, M.D., *Committee*; James Noble, *Curator*.

The following papers were read before the Section :—

Jany. 29th. "Notes on the Production of Iron and Steel in Ontario."—Mr. Hamilton Merritt.

Feby. 26th. "Progress of Mining Legislation in Ontario,"—Mr. Hamilton Merritt.

March 26th. "History and Occurrence of Nickel,"—Mr. Geo. Mickle.
April 16th. "Nickel Assaying,"—Mr. Geo. Mickle.

(Signed) WM. HAMILTON MERRITT, *Chairman.*
GEORGE MICKLE. *Acting-Secretary.*

REPORT OF THE HISTORICAL SECTION.

The Historical Section, organized on the 15th July, 1890, for "the study and investigation of the history of Canada and cognate subjects, such as Archæology, Genealogy and Ethnography," reports with pleasure that 27 members of the Institute have signed the roll.

1. The officers for the past year have been:—Mr. J. C. Hamilton, M.A., LL.B., *Chairman;* Mr. Arthur Harvey, *Secretary;* Messrs. Wm. Houston, M.A., D. A. O'Sullivan, LL.D., G. M. Rae, *Committee.*

2. The following papers have been read at meetings of the Section:—

Wm. Houston, M.A., on "The Genesis and Development of Legislative Functions in the Northern Parts of America."

J. G. Ridout—"An account, written by the late Hon. Thos. Ridout, Surveyor-General of Canada, of his captivity among the Shawnees in 1788."

Wm. Houston, M.A., on "The Development of Legislative Autonomy in Canada."

J. C. Hamilton, M.A., LL.B., on "Afro-Canadian Incidents, and the Career of John Brown in Canada."

D. B. Read, Q.C., on "Incidents in the Life of Gen. Brock."

J. G. Ridout, on "The Campaign of 1815 (Waterloo)."

Wm. Houston, M.A.,—A Transcript (with illustrative maps and comments) from the diary of Mr. Alex. Macdonell, who had accompanied Gov. Simcoe on an expedition from the Humber Bay to the Georgian Bay, by way of Lake Simcoe, in 1793.

3. The subject of publication by the Provincial Government of manuscripts of importance to the history of Ontario was brought before the Institute by this Section, and a deputation appointed to wait upon the Administration in reference thereto. At the interview which shortly followed, the Hon. Atty.-General Mowat requested that deputation to forward a memorandum in writing of such documents as they thought should in this connection receive consideration. The preparation of this

memo. having been by the Institute referred to this Section, that duty was carefully performed, and a report duly sent to the Hon. the Atty.-General, after its adoption by the Institute. The last clause of that report is repeated here, viz., "The committee think that some person should be employed to make special enquiry about the valuable historical documents in the possession of private families, and to procure the originals or copies thereof. The same person could be instructed to procure the interesting relics of pioneer life for a provincial museum."

4. The section has supported a proposal to join with others in celebrating the centenary of this Province in the present year.

5. The officers for next year are:—Mr. J. C. Hamilton, M.A. LL.B., *Chairman*; Mr. Arthur Harvey, *Secretary*; Messrs. Wm. Houston, M.A., John G. Ridout, W. Canniff, M.D., M.R.C.S., *Committee.*

Respectfully submitted, as adopted by the Historical Section on the 23rd April, 1891.

ARTHUR HARVEY,

Secretary.

NOTES ON NICKEL.

By George Mickle, B.A.

(*Read 26th March, 1891.*)

The purpose of this paper is to describe briefly the history of Nickel and the Nickel production down to the discovery of the Canadian deposits. What the history of Nickel in the future will be is impossible to foresee and depends on many uncertain factors. Nickel occurs in nature :—

(1) As native Nickel in meteorites, and one occurrence is reported in Greenland in basalt.

(2) In combination with Oxygen—Ni O as Bunsenite, but only as a mineral curiosity—occurs in small green octahedrons of glassy lustre.

(3) With Carbon dioxide—as Texasite ; occurs as a fine coating over Chromeiron ore in Texas, Spain.

(4) With Silica. There are a number of compounds of Nickel and Silica, and they play an important part. The few specimens here will serve as types of the rest. First we have Chrysopras and Chrysopal, which are simply Quartz and opal respectively, containing a small amount of Nickel Oxide.

Then there are a number of Silicates with slightly varying amounts of water and having all a greenish appearance. One will serve as a type of the rest.

The most important, however, of the silicates is the Garnierite (of New Caledonia). It is a Magnesia Silicate containing varying amounts of Nickel. I have here also another Magnesia Silicate containing Nickel. The Silicates deserve attention, not only because a large part of the supply of Nickel is derived from Silicates, but also because important finds of Silicates are reported in various parts of the world.

In combination with Sulphuric Acid it occurs in nature only as a curiosity (Lake Huron, Spain).

The arsenic compounds of Nickel are—

Nickeline Ni As light copper red in color, high specific gravity; frequently has a green coating; an important mineral.

Chloanthite Ni As_2 tin white in color, crystalized in cubes ; also important.

Rammelsbergite Ni As_2, belongs to the rhombic system.

In combination with Sulphur, as Millerite Ni S, brass yellow color,

crystals grouped together like a sheaf or in fine, hair-like crystals. There are also two other compounds of Nickel with Sulphur Saynite Ni_3, S_1, and Beyrichite Ni_6, S_7, which are very rare, and Lillihammerite, found in Norway, 2 Fe_2, S + Ni S, not magnetic.

In combination with Antimony, as Breithauptite Ni Sb, isomorphous with Nickeline, light copper red color.

As a Sulpho-Arsenide, Gersdorfite, Ni As S, greyish tin white in color, occurs in octahedrons.

As a Sulpho-Antimonide. As Ullmannite, rare.

As an Arsenate, as Nickel Bloom, an Arsenate containing water, and is a product of decomposition of the arsenides.

Besides these Nickel minerals we have the Pyrrhotite, containing Nickel, and some Lead, Copper and Silver ores give considerable amounts of Nickel during the process of smelting.

The composition of the Meteorites is especially interesting, and I will not pass them over with a mere mention.

Meteorite, composed of non-metallic and metallic components.

Non-metallic	48.94%
Metallic	61.06%
	100.00

The metallic part was made up of

Nickel-Iron (Fe_3 Ni)	98.995
Phosphor Iron, Fe_2 P	0.539
Phosphor Nickel Iron (Fe Ni)$_4$ P	0.293
Silicium Iron (Fe_2 Si)	0.330
Mono-Sulphide of Iron (Fe S)	0.030
Carbide of Iron	Trace
Copper	0.035
Asmanite	0.056
	100.278

Analysis of whole metallic part:

Iron	89.99
Nickel	9.74
Cobalt	0.23
Copper	Tr.
Phosphorus	0.15

Silica	0.04
Carbon	Tr.
	100.15

Analysis of Phosphor Nickel Iron:

Iron	40.68
Nickel	48.16
Phosphor	11.16
	100.00

This analysis is only for one particular Meteorite, the composition varies somewhat in all. One case is known where Nickel predominates, namely, Meteorite from Oktebbeha, Ni 60% Fe 30%. Each meteor iron has a continuous structure and is a single individual, and is found to consist of a kernel of iron poor in Nickel, (Kamacite); imbedded in a thin leaf of Iron, richer in Nickel, (Taenite). These lamellae are arranged according to the surfaces of an octahedron; and filling up the cavity of the octahedron is a third Iron, poor in Nickel. Imbedded promiscuously in the mass are a Mono-Sulphide of Iron and a Phosphor Nickel Iron.

The chief difference between meteor Iron and artificial Iron is the lack of the continuous structure in the latter, and in fact this is carefully avoided, because artificial Iron as a rule contains no Nickel, but a not inconsiderable amount of Carbon, which in the case of a continuous structure produces a high degree of brittleness, as the Carbon in the form of Graphite collects together in leaves along which the Iron is easily cleavable. In the case of meteor Iron the continuous structure is due to the scaly structure of layers of Iron containing greater or less amounts of Nickel, whereby the Iron gains an enormous amount of toughness. If it were possible to imitate this structure and produce a Nickel Iron of this scaly form, it would be a great stride in the manufacture of Iron.

Schreibersite or Phosphor Nickel Iron has also been found imbedded in the basalt of Greenland.

Of the other Nickel Minerals, Nickeline, Chloanthite, Smaltine containing Nickel, and Millerite are of importance. It is remarkable that the two ores from which by far the greater part of the Nickel supply of the world is obtained are not Nickel Minerals at all, the Nickel is only present as an accident. Thus Garnierite is a Magnesia Silicate containing water and impregnated with varying amounts of Nickel Oxide, sometimes to 45%, and forms a vein in olivine bearing basalt. And the Pyrrhotite, which we are so familiar with and which is a Sulphide of Iron, in which

some of the Iron is sometimes, not always or even generally, replaced by Nickel.

With regard to the mode of the occurrence of Nickel, there are several types. Nickel minerals, as most others, shew a preference for certain associations. One such is the occurrence of Nickel, Cobalt and Bismuth in veins. Especially in this connection do we find Smaltine ($Co\ As_2$), Linneite ($Co_3\ S_4$), Nickeline, Chloathite, Gersdorfite, Millerite. The gangue matter is brownspar and ironspar, and this occurrence is found in granitic schists, porphyry and gneiss (Northern Italy, Saxony).

Another association is Nickel and Cobalt with Quartz. In the Ural there is a vein over six feet wide in chlorite shales and serpentine, the rock matter is quartz and chrysopras. In the cavities of the quartz is a clay which contains lumps of Nickel Arsenate as large as apples.

A third is Nickel, Cobalt and Silver with Carbonates (Dopschau Hungary). One such occurrence is found in gabbro surrounded by clay-slates, at the boundary of the gabbro and clayslates the veins are found. The veins are compound and consist of rock with fine veins of ore yielding about 20% Nickel. The carbonates with which it occurs are ironspar, calcspar, brownspar (also Saxony and California).

A fourth association is Cobalt, Nickel and Silver with Baryta, also Bismuth and Uranium. The Nickel occurs as Speiss Cobalt and Nickeline chiefly and forms veins in cyrystalline slates. (Saxony, Bohemia.)

The next association is that of the Silicates. Of the Silicates the New Caledonia deposit is by far the most important, and is especially interesting because there is strong reason to believe that we have here a genuine case of lateral secretion; that is, the Nickel was contained in the neighboring rock; in this case, in the olivine probably as a Silicate. Now the Silicate of Nickel is soluble in water, and still more soluble in water containing Carbon dioxide. The rock matter on either side of the vein is decomposed for a considerable distance, and it is believed that the Nickel has been dissolved, carried by water through minute crevices to the vein and there deposited. Other occurrences of Nickel as Silicate bear a marked resemblance to this. I may mention in this connection an important find of Nickel lately made in Germany, also a Silicate. The rock matter in this case is a clay colored reddish by Iron Oxide and occurring in a zone of decomposition of serpentine. The ore is formed exclusively of Silicates. Schuchardite, a soft green Silicate, predominates.

The last occurrence I shall mention is Nickel in Magnetic Pyrites. This occurrence is the most interesting to us, but has also been found in many other places. In Norway the most important occurrence of Nickel

is near the town of Lillehammer. The region consists of gabbro and Amphibolite, and the ores are Magnetic Pyrites with 2 to 3% Ni and Lillehammerite with 22% Ni.

Also in Black Forest, Germany, occurring in gneiss rock, and Rooras in Norway. Here the ore only contains 0·25% Nickel. Also at Tunaberg, in Sweden, where a limestone containing Magnetic Pyrites and Copper Ore occurs in gneiss. These are all in crystalline slates.

In the massive rocks we have another occurrence at St. Anthony's Nose, in New York, in syenite. One such deposit is 45 feet in width; the Magnetic Pyrites contains 3% Nickel. One occurrence in Diorite is at Val Sezia, in Italy. It has been observed that hornblende bronzite and olivin seem to be favorable to the occurrence of Nickel.

METALLURGY.

The metallurgy of Nickel is comparatively young, so far as the European nations are concerned; but Nickel was known to the Chinese, and had been employed by them from remote times. In 1776 Engestrom drew attention to Nickel. He found on analysing the alloy called Packfong, of which various implements brought from China were made, that it contained Nickel as an essential component, and Nickel had probably been employed in China for hundreds, perhaps thousands of years, for Baktrian coins, bearing the inscription of King Euthodymus, who lived about 200 B.C., are found to have almost the identical composition of the nickel coins of the present day.

The history of nickel in Europe begins with the fruitless efforts of German miners to produce Copper out of a Nickel mineral, which from its appearance they thought must contain Copper. As their efforts were unsuccessful, true to nature, they abused the mineral and called it Kupfernickel or Copper-devil, a name which it retains to the present day. This mineral was, up to the middle of the 18th century, considered as partly a Copper compound, from the green color of its solution, and partly as a Cobalt ore from the blue color which it imparts to glass fluxes, due to Cobalt contained in the ore. It was not till 1751 that Cronstedt shewed that there was no Copper in this mineral, and explained the true nature of Nickel. He also shewed that the Speiss, which remained in the manufacture of Cobalt blue, was essentially Nickel and not, according to the belief of that time, a burnt Cobalt that had lost his soul.

Cronstedt's view met with much opposition. Bergmann in 1775, misled by the magnetic property of Nickel, said that Cronstedt had the

metal in an impure state and that it still contained iron. At about this time the fall of meteorites, containing considerable quantities of Nickel, was announced from different parts of the world, so that towards the end of the 18th century the existence of Nickel was admitted and its properties understood.

The first Nickel works in Europe were built in 1824, in lower Austria, by Gersdorf, whose name we have preserved in the mineral Gersdorfite. The operations were at first confined to the arsenides, and it was not till 1838, when Berzelius, the celebrated Swedish chemist, discovered Nickel in the Pyrrhotite of Klefva in Sweden, that Metallurgists began to pay attention to the Sulphides. The first experiments were not very successful; the Iron was not separated till all the Sulphur had been removed; the ore was roasted as strongly as possible and an iron alloy with about 60 per cent Ni produced. This was smelted down several times with Quartz, and finally a product was obtained which contained 70 to 80 per cent Ni, 18.22 Cu, 1.52 Fe, and was called crystallized Nickel. This process required a great outlay in fuel and labor, and more Nickel was lost in the slag than was won.

Later, about 1850, other experiments were made, leaving the Sulphur in the ore, till all the Iron had been removed.

In 1856, the discovery of an extensive deposit of Nickel ore in Pennsylvania increased the use of the metal still more, and again in 1874, through the discovery of Nickel in New Caledonia, the price of Nickel was still further lowered and many of the works in Norway compelled to stop work. Finally, the discovery of extensive Nickel-bearing deposits in Algoma district (Canada) must exercise a great influence on the use of Nickel.

Physical Properties.—Nickel has specific gravity, 8.9. Point of fusion 1392°-1420° C. Nickel has the property of absorbing gases in the molten state and giving them out again on cooling, thus forming blisters and making castings very difficult. Through the improvements of Wharton in Philadelphia, and Fleitmann in Iserlohn, who employed various methods to purify the metal, castings of 100 lbs. or more can be made. It possesses great malleability; sheet Nickel of .015" thickness can be produced without difficulty.

One gram can be drawn out into wire 600 feet long Nickel can be welded on Steel or Iron, the covering can be made so thin as .00039 in. The strength of Nickel is greater than that of Iron and about equal to Bessemer Steel.

Chemical Properties.—Nickel does not oxidize at ordinary tempera-

tures, even in moist air; in the presence of acids it rusts, although not so much as iron. It is only slightly attacked by cold acids, except dilute nitric. The molten alkalies also do not attack it. Here are analyses of some of the alloys of Nickel, also of the Nickel coins. Experiments made to protect Iron from rust by alloying it with Nickel have shewn that the alloy rusts as easily as Iron, and it is not till the alloy contains 37 per cent Ni. that the Nickel makes its influence felt.

Various impurities exercise a great influence on the physical properties of Nickel. Of these, Iron, Arsenic, Sulphur, Silicum and the oxides have the greatest influence on the brittleness of Nickel. Arsenic and Sulphur when .1 per cent is present make Nickel cold short.

Oxygen present as Nickel Oxide to the amount of 0.304 per cent. makes castings brittle. Malleable castings are found to contain not more than 0.084.

Silicum, which is taken up when Oxide of Nickel is smelted in presence of Quartz and Charcoal, shews its influence when present in very small quantities.

Phosphorus, up to 0.30 per cent., increases the hardness at the expense of the malleability.

Chlorine is always found in Nickel prepared in the wet way when chlorides are present. Such Nickel cannot be rolled.

ALLOYS.

	Copper.	Zinc.	Nickel.	Iron.	Silver.
Packfong (China)	40·4	25·4	31·6	2·6	—
German Silver (Sheffield)	63·4	17·01	19·13	—	—
German Silver (Germany)	54·0	28·0	18·0	—	—
Silverine	71-79	1-7·5	16-16·5	1-1·5	—
Argent de Mousset (Paris)	59·06	9·57	3·42	—	27·36

COINS.

	Copper.	Nickel.	Zinc.
Switzerland	—	100	—
United States	75	25	—
Brazil	75	25	—
Venezuela	75	25	—
Germany	75	25	—
Belgium	75	25	—
Chili	70	20	10

PRODUCTION OF NICKEL *(According to Kerl).*

(China not included.)

In 1880. Price of Nickel $1.10 per lb.

Germany.....	480 Tons.	
United States.....	150 "	(130-190).
Austria	110 "	
Brazil	110 "	(In 1875 price $2.60 per lb.)
Sweden and Norway	75 "	Norway 310 Tons.
Belgium	20 "	Sweden 50 "
France.....	20 "	
	965	

In 1888. Price of Nickel 60 cts. per lb.

New Caledonia.....	450 Tons.	(8240 tons of ore at $25 per ton.
Germany	400 "	
United States	95 "	
Austria	75? "	(No further statistics to hand since
Brazil.....	75? "	1881.)
Norway and Sweden	50 "	
France	30 "	
Belgium.....	20 "	
	1195	
Canada	?	

N.B.—These statistics are given in meter tons (=2214 lbs ; to reduce to tons of 2000 lbs. add one-tenth), and the amounts are credited to countries which produce the ore ; England accordingly, as she manufactures her Nickel from imported ore and matte, does not appear on this list.

It will be seen from the above statistics that the fall in price of Nickel has not materially increased its use, and also that the amount produced in the various countries has undergone a considerable change. The reason for this will be apparent when we have gone into the methods of smelting the various ores. I shall therefore come back to this point again.

The method of the production of Nickel can be divided into two groups, namely : the production from Arsenides and Sulphides, and the production from Silicates. I shall first briefly describe the treatment of Arsenides and Sulphides ; and, as the treatment varies slightly, I shall take the Arsenides first.

We have here to deal with the Nickel Arsenides already mentioned, and the different products from the smelting of Lead, Silver and Copper ores, which contain Arsenic, and in which Nickel can only be detected in traces or not at all in the charge; but through repeated smelting the Nickel becomes concentrated in the Speiss in such quantities that it is worth working. Thus in smelting Silver ores from Mexico, in which no Nickel can be detected, a small amount of Speiss is found, which is concentrated and sold. This amounted, in 1889, to 61 tons, and was sold for $7,700.—(Freiberg.)

This is interesting not only as shewing how minute quantities in the charge through concentration attain important proportions, but also shews the great affinity of Nickel and Cobalt for Arsenic, and of Copper for Sulphur, all the Copper almost combining with Sulphur and forming a Matte, and the Nickel and Cobalt forming a Speiss. Furnace bears also contain Nickel.

In order to collect all the Nickel in the Speiss, the ores are generally first roasted and then smelted. Roasting is necessary when Sulphur or an excess of Arsenic is present; that is, more Arsenic than is necessary to form the compounds—Ni_2As. Co_2As.; because, during the subsequent smelting, Nickel and Cobalt are protected from slagging so long as the above compounds can be formed. When this roasted product is subjected to a reducing smelting in a blast furnace, the Arsenates are reduced in the upper part of the furnace, and the reduced mass on coming in contact with the blast is oxidized again, and generates arsenious acid; the Nickel and Cobalt Oxides in contact with Iron Arsenide form Nickel, and Cobalt Arsenide and Ferrous Oxide is set free, which is immediately taken up by the slag. It is therefore necessary that Arsenic is only so far removed by the roasting that only the Iron is oxidized.

The Speiss contains, however, still considerable amount of Iron, and in order to remove this it must be subjected to the same process repeatedly.

The following furnace has been employed with good success:—(Flechner's furnace).

Or instead of this repeated roasting and smelting the Speiss is sometimes subjected to a blast in a reverberating furnace, sand or quartz is strewn on the molten surface, and the slag is repeatedly drawn off till all the Iron is gone and the slag begins to be colored blue by the Cobalt.

The metals are slagged in the following order, according to their respective affinities to oxygen—Iron, Cobalt, Nickel. Iron, while slagging, shews a film or scales on the surface. Cobalt is clear, and Nickel

shews the scales again. This process is, in fact, Plattner's assay for Cobalt and Nickel carried out on a large scale.

I now come to the treatment of the Sulphides. This is a more tedious operation, as the ores are generally not so rich as the Arsenides. The same principle is pursued, namely, to collect all the Nickel in a matte and then treat the matte further. The ore is first roasted to remove part of the Sulphur, and is converted partially into oxides. This product is then smelted, and the Nickel combines with the remainder of the Sulphur, while the Iron in conjunction with the Silicates which are already present in the ore, or are added purposely, forms a slag. It is impossible to effect this separation of Iron and Nickel in one operation, because it would produce such an enormous amount of slag at once; the operation must therefore be repeated several times. The resulting matte is then smelted under a blast in a reverberatory furnace or in a Bessemer converter, and then further refined with Baryta and Quartz or with Saltpetre and Soda in order to be finally treated in the wet or dry way.

The reaction of the Baryta and Quartz on Iron Sulphide is interesting.

$3\,Ba\,SO_4 + 4\,Si\,O_2 + Fe\,S + Ni\,S.$
$= 3\,Ba\,Si\,O_3 + 3\,S\,O_3 + Si\,O_2 + Fe\,S + Ni\,S.$
$3\,S\,O_3$ in the high temperature breaks up into $4\,S\,O_2 + O.$
$= Ba\,S_1\,O_3 + 4\,S\,O_2 + O + Si\,O_2 + Fe\,S + Ni\,S.$
$= 3\,Ba\,S_1\,O_3 + 4\,S\,O_2 + Fe\,Si\,O_3 + Ni\,S.$

The method of treating the Sulphides can be divided into the following parts:—

1. Roasting the ores.
2. Smelting the roasted ore to matte.
3. Roasting the matte.
4. Smelting the roasted matte.
5. Blowing the concentrated matte.
6. Refining, smelting of matte.

The ore is generally roasted in heaps, with wood as fuel. Analyses of different parts of the roast heaps shew that a concentration towards the middle and bottom of the heap takes place, which can probably be explained by assuming that the easily fusible Sulphides of Copper and Nickel sicker out through the mass, grown porous by the roasting.

We have perhaps here an explanation of the fact frequently observed in the deposits of Nickel-bearing pyrites, namely, that the deposit becomes richer in Nickel as one goes down. Assuming that the molten mass of Iron and Nickel Sulphide was originally homogeneous, as it

gradually cooled off the more difficultly fusible Iron Sulphide would harden first, leaving a spongy mass, while the Nickel Sulphide, still remaining liquid, would seek the lower levels. The next operation, smelting the roasted ore, generally takes place in a shaft furnace, not high, on account of the formation of Iron bears, which takes place when the ore is exposed long to a reducing action. The great difficulty of this smelting is the formation of bears in the furnace, so that the furnace can not run more than about three weeks. These bears are extremely tough and must be sometimes broken by dynamite. Recent improvements have, however, greatly reduced this difficulty. (Sudbury).

The next operation, the roasting of the matte, can be done in heaps or a reverberatory furnace. The smelting of the roasted matte can be performed either in shaft or reverberatory furnaces. Quartz and limestone must be added here in order to slag the Ferrous Oxide in an easily fusible, double Silicate. We have now to do with a mixture of FeS, NiS, Cu_2S, with metals dissolved in them, which is proved by the fact that on cooling, crystals of a metallic appearance separate out, which, on being analysed, shew their metallic nature.

The next operation, blowing the concentrated matte, can be performed on a small refining hearth, like a Copper hearth. The hearth is first warmed with charcoal, then filled with coke, and when the coke is burning well, it is charged with the concentrated matte in large pieces. This soon melts and collects under the coke. The blast is now let play on the surface of the molten metal, the Iron thereby oxydized, and forms in connection with the material forming the hearth and coke, a slag which flows off regularly. The smelter can tell the end of the process by observing whether the fresh fracture of a test piece possesses a light gray colour. The coke is then taken off and the blast continued till the mass has hardened.

The composition of this product had in one works (Ringer)—

29.79 Copper,
40.45 Nickel,
6.1 Iron,
22.27 Sulphur.

In Lyons, the raw matte is treated in a Bessemer converter till the Iron is nearly all gone. Thus out of a raw matte containing—

6.0 Nickel,
2.0 Cobalt,
0.75 Copper,
38.25 Iron,

53.00 Sulphur,

a product was obtained which held—

55 per cent. Nickel,
15 per cent. Cobalt,
6 per cent. Copper,
2 per cent. Iron,
20 per cent. Sulphur,

which is given over to the electrolytical process.

We now come to the conversion of Speisses and mattes into crude Nickel. This can be done indirectly in two ways, a dry and a wet. Let us first take the dry way. The Speisses and mattes are roasted strongly with constant stirring in the furnace described before, till a test piece, taken from the mass, does not smell any more of Arsenious or Sulphurous Acid; the last traces of Arsenic and Sulphur are removed by a fusion with Saltpetre and Soda. The fusion can take place in any furnace which is built in such a way as to exclude the formation of reducing gases; the following reaction takes place: The Sulphur combines with Sodium to form Sodium Sulphate, and sets free Carbon Dioxide. As the heat increases the Sodium Sulphate fuses, the whole mass swells up and Carbon Dioxide escapes, and the remaining traces of Sulphides and Arsenides are laid bare and oxidized by the Saltpetre. When the process is finished no smell of Sulphur Dioxide or Arsenious Acid can be detected.

We now come to the conversion of Speisses and mattes to Nickel Oxide in the wet way. This is simply a laboratory process on a large scale, and is not often employed. Briefly, it consists in dissolving in Sulphuric or Hydrochloric Acid, precipitation of Copper, Lead, Arsenic, &c., with Hydrogen Sulphide; oxidation of Iron by Chlorine or Chloride of Calcium and precipitation of Iron with Carbonate of Calcium; separation of Cobalt by Chloride of Calcium (in warm and neutral solution) (or Ammonium Sulphate separates Nickel); precipitation of Nickel with Chalk or Soda.

Then the Nickel-hydrate precipitate is ignited in order to convert it into a difficultly soluble condition. The Gypsum which is formed during the process must be removed. This can be done by fusing with Carbonate of Soda, thereby forming a Sulphate of Sodium and Carbonate of Calcium, both of which can easily be extracted by water containing Hydrochloric Acid.

The next step is the reduction of oxide to metal. Either Nickel powder is made or small cubes. To make the powder the oxide is stamped together with charcoal and fused in a crucible. To make the

cubes the Nickel Oxide is formed into cakes, then ignited with coal dust. The ignition takes place also in crucibles.

Care must be taken not to let the Nickel, after the reduction, remain long in contact with coal, otherwise Carbon will be taken up and the physical properties of the Nickel thereby deteriorate.

As Nickel is almost always alloyed with Copper, an alloy can be made direct from the concentrated Matte, by treating it in a Bessemer Converter till only traces of Iron and Sulphur remain.

Thus, here is a Matte and the resulting alloy—

Nickel,	32·59	39·90
Copper,	52·00	59·50
Iron,	0·42	0·64
Sulphur,	17·11	——
Arsenic, Antimony	0·11	——

The direct process by electrolysis was at first not successful. The Speisses and mattes containing Copper were hung as electrodes in a bath of dilute Sulphuric Acid, and the Copper deposited on the negative electrodes. The Nickel and Iron were allowed to collect in the bath till the acid is nearly neutralized. A great part of the electrical is thereby wasted on the generation of hydrogen, and the Copper is deposited impure. An amount of Sulphuric Acid equivalent to the Nickel contained in the positive electrode is used, which is lost in Nickel vitriol. The iron is then precipitated by Ammonia, and the liquid is evaporated down to produce pure Nickel Sulphate, or is electrolyzed to produce Metallic Nickel. This process proved to be not economical.

This process must be carried out analogous to the Copper deposition; that is, the Nickel and Iron must be dissolved out of the anode or positive electrode with the proper strength of current. The precipitation of Iron on the negative electrode can be avoided by the alkaline nature of the bath. Copper and Sulphur must remain in the anode and be treated separately afterwards.

The processes we have hitherto considered closely resemble the Copper smelting processes; but, when we come to the treatment of the Silicates, a different picture is presented to us. Here we have to do more with an Iron process.

The New Caledonia ores, for instance, are smelted with coke in a furnace about 25 feet high, under 12cm. mercury pressure of hot blast The temperature of the blast is 400° C. Fluorspar, soda, manganese ores, Iron ores, are added to the charge. Out of one ton of ore

about 230 lbs. of crude Ferro Nickel is produced, of the following composition :—

Carbon,	1·70	per cent. to	3·40	per cent.
Silicum,	2·40	"	0·85	"
Sulphur,	0·55	"	1·50	"
Iron,	23·30	"	32·35	"
Nickel,	75·50	"	60·90	"
Cobalt, Copper, Manganese,	Traces.			

This crude Ferro Nickel is taken to France and treated in a Siemens-Martin furnace on a hearth of Nickel Oxide, where it is decarbonized, while Iron, Silicum and Manganese are slagged. During the process Nickel Oxide is added to remove the Carbon. Towards the close of the operation, a crude Nickel containing oxygen is added in order to remove the excesses of oxygen. Ferro-Nickel is used in the manufacture of Nickel Bronze, along with Tin, Zinc, Copper.

The ore is sometimes mixed with an equal weight of Sulphuric Acid, then boiled with water and Ammonium Sulphate added. This precipitates Nickel as Nickel Ammonium Sulphate, which is the form it is required in for plating. The poorer ores, that is ores with less than 7 per cent. Nickel, are melted with Pyrites, Gypsum and Iron ore. The resulting product contains about 50 per cent. to 60 per cent. Ni., 15 per cent. to 25 per cent. Iron, 25 per cent. Sulphur; or instead of adding Iron ores, Copper ores can be used, and the result is a crude Copper Nickel.

The New Caledonian ores and the Silicates generally can be treated by a wet process, resembling the treatment of Speisses and mattes.

I now come to the refining of crude Nickel. During the process of producing crude Nickel, new impurities are taken up and the amount is sometimes increased. This is especially the case of Silicum Oxygen and Carbon. It is impossible, for instance, to decarbonize Nickel by a puddle process without the metal absorbing oxygen ; besides, the molten Nickel absorbs Carbon Monoxide, which is formed in the process of decarbonization and makes it impossible to make solid castings. The method of refining it is first of all to remove Silicum and Oxygen, and then reduce the newly-formed Nickel Oxide.

The Carbon can be best removed by a puddle process or by the addition of Nickel Oxide. Garnier, of New Caledonia, decarbonizes his Nickel in a Bessemer converter, and lets the blast play on it till all the Iron is oxidized and goes off in the slag. This method is open to the objec-

tion that the point to stop the blast is difficult to determine, and either a good deal of Iron is left behind or some Nickel is lost in the slag. The removal of oxygen without generation of Carbon Dioxide, which would of course blister the metal, is effected by the addition of various substances, such as Phosphorus, Manganese, Potassium Ferrocyanide, Magnesium. The addition of 1.20 of a per cent. Magnesium has been found to be sufficient to remove all the oxygen (Fleitmann, Iserlohn). About 2 per cent. Manganese ore is used by some metallurgists.

Phosphorus is largely used in France. Garnier employs an equal amount of a Phosphorus Nickel alloy, containing 6 per cent. Phosphorus.

A patented process employed in Paris produces wrought Ferro-Nickel direct from Nickel Matte, by smelting the Matte with Potassium Ferrocyanide and Manganese Super-Oxide, and then adding a small amount of Aluminum at the moment of tapping. The product of 70 per cent. N., 30 Fe., was produced from 71.9 Ni. Matte, 12 per cent. of 63 per cent. Manganese Oxide, 16 per cent. Ferrocyankalium, 0.1 per cent. Aluminum.

I wish now to say a few words in explanation of the statistics given and to explain the effect the fall in price has had on the industry in the various countries.

The collapse of the Nickel industry in Norway and Sweden is due not to any deterioration in the ores or to their exhaustion. The ore was there a magnetic pyrites, containing in the best mines 2.3 per cent. Nickel, but no other metals of value.

In Germany, the mode of occurrence is altogether different. There are small quantities of the rich Cobalt and Nickel Arsenides associated in the one case with Bismuth, and in the other with Silver, and small deposits of Silicates. The mines are worked more for the sake of the other metals associated with the Nickel, and the Nickel must be separated in the course of smelting, and is, as it were, a bye-product, and the amount produced is not generally affected by the price.

Thus one works (Schneeberg) smelted in one year :—

700 tons	Cobalt,	in value,	$299,000.		
119 "	Nickel,	"	131,000.		
55 "	Bismuth,	"	88,000.	$518,000.

The Nickel industry in the United States has met with the same fate as the Norwegian, although to a somewhat less degree, the chief ore being there also a magnetic pyrites bearing Nickel. The occurrence in Austria is similar to that in Germany.

When we consider the methods of production of Nickel from the various Sulphides or Arsenides, and then see the simplicity of the Silicate smelting, how by one operation a rich alloy of Nickel with very few impurities is obtained from the raw ore, it is not to be wondered at that the New Caledonian mines control the price of Nickel for the whole world, and will continue to do so till the deposits are exhausted. This time is by all indications not far distant, for formerly the medium quality of the ore contained 7 to 15 per cent. Nickel, and the rich ore over 15 per cent. Nickel, but at present 5 or 6 per cent. is ranked as the best quality. And when this deposit is exhausted the price of Nickel must go up again, totally irrespective of any new use to which it may be put in forming alloys. The Canadian mines should then occupy the position that the New Caledonian ones have in the past.

THE LUMINIFEROUS ETHER.

By J. M. Clark, M.A., LL.B.

(*Read 19th January, 1889.*)

Before proceeding to point out some of the properties of the luminiferous ether, I may be asked, How do we know that such a substance exists? Is not the very existence of the ether a mere theory, and as such a part of one of those systems of which Tennyson says, "They have their day and cease to be?" Eye hath not seen it, ear hath not heard it, the hands of man have not handled it. The balances of the most skilful physicist have not weighed it, nor has the most powerful reaction of the chemist detected it.

Yet not only are physicists certain of its existence, but Tyndall has justly remarked (in his work on Molecular Physics) that its relations to the matter of the universe must mainly occupy the investigations of future scientists; and in his recent lectures on Molecular Dynamics, Sir Wm. Thomson said that we know the luminiferous ether better than we know any other kind of matter in some particulars; that we know more about it than we do about air, water, glass or iron.

In the first place we all know that the heat and light of the sun, which are now conclusively established to be *forms of energy*, are transferred to the earth, and from the sun our main supplies of energy undoubtedly come.

Some recent writers seem to think that the demonstration of the impossibility of what is called "action at a distance" has been the work of recent years. But long ago Newton said (in one of his famous letters to Bentley), "That one body may act upon another at a distance through a vacuum without the mediation of anything else by and through which their action may be conveyed from one to another is so great an absurdity that no man who has in philosophical matters a competent faculty of thinking can fall into it."

We have seen that the sun acts on the earth through the transmission of heat and light from the sun to the earth.

From this one of two things follows, either (1) heat and light are substances, forms of matter, which has been conclusively established to be impossible, or (2) the heat and light being, as they indisputably are *forms of energy*, must be transformed by the mediation of *something*.

That something, whose existence is thus proved, we call ether, and since its function was at first supposed to be the transmission of light it was called the luminiferous ether.

Now, however, it is supposed and indeed may be considered as proved that this wonderful ether (whose name is derived from its connection with the now generally accepted undulatory theory of light) performs functions of a much more varied and important nature. The recent investigations of natural philosophers show that it also acts as a medium for conveying not only light but also radiant heat, magnetic disturbances and other forms of energy. Indeed the term luminiferous is so misleading and inadequate that in a paper read before this Institute seven years ago I rather presumptuously ventured to suggest that the term 'energipherous' would be more appropriate. Not only does the ether act as a medium for the conveyance of heat, light, &c., but it also plays a very important part in transforming one kind or rather form of energy into various other forms. The well established fact that light is capable of producing various chemical changes shows that the vibrations of the ether particles in which consists light may be transformed into the motions of the atoms of bodies, since all chemical changes result from accelerations of these motions.

The fact that heat is developed in certain chemical transformations indicates the relation of the forces of chemical affinity to heat. The relation of heat to light may be seen by considering the nature of radiant heat but is best shown by considering certain experiments of Leslie, which prove that bodies are heated by absorbing light. In performing one of the experiments devised by him for the purpose of ascertaining the mechanical equivalent of heat, Joule discovered that current electricity was a form of energy and subject to the law of conservation. His results were extended by Helmholtz, Meyer, Clausius and Thomson, till the law of conservation has been shown to govern all natural forces. Thomson demonstrated that Faraday's discovery of the rotation of the plane of polarization of a polarized ray of light produced by media under the influence of a powerful magnet, involved the dependence of magnetism on motion in the case of both magnetic and diamagnetic bodies.

To Helmholtz and Carpenter is principally due the credit of having extended the principles of the conservation and transformation of energy to physiological phenomena.

From data supplied by Weber, Maxwell found that electro magnetic disturbances were propagated with the same velocity as light. The

explanation of this he held to be that electricity, like light, was due to the undulatory vibrations of the medium which is beyond question necessary for the propagation of light. This fact is at the foundation of Maxwell's electro-magnetic theory of light which is no doubt destined to play no unimportant part in the development of the true Theory of Energy. Thus by considering in succession all the so-called natural forces it will be seen that they are all simply manifestations of an unchangeable amount of indestructible energy. Every form of energy is capable of being transformed by suitable manipulations into all its other forms without in any case involving any increase or decrease in the total quantity of energy. But, while the quantity of energy in the universe is invariable, yet by virtue of laws of which we have a particular instance in Clausius' Second Main Principle of the Mechanical Theory of Heat, the amount of available energy is being constantly exhausted. This is simply another method of saying that no known natural processes are perfectly reversible. In the transformation of these various forms of energy into one another the ether plays, as at once follows from what has been said above, an important part.

Then not only does the ether convey light from the sun to the earth but also from the remotest visible star. Indeed the functions performed by it are so varied and of such a nature that this mysterious ether must pervade not only all interstellar but also into intermolecular and interatomic space

Not only does the existence of the ether explain the fact of the propagation of light from the sun and stars to the earth, but it also very clearly explains all the other known phenomena of light. As pointed out by Sir Wm. Thomson, all these properties come out as a matter of course from the dynamical consideration of the subject. So much so that any one not knowing these phenomena would have discovered them in working out the matter dynamically. He would have discovered anomalous dispersion, fluorescence, phosphorescence, etc. Indeed, Sir Wm. Thomson says that he never heard of anomalous dispersion till "he found it lurking in the formulas," and as a consequence he very pertinently remarks that the dynamical treatment which discovers what is afterwards verified by experiment, is a very important piece of dynamics. We have then the observed and ascertained facts which are explained by the existence of the ether, and there being no other known method of accounting for the facts, we conclude that the ether is a reality and not the creation of scientific imagination.

Having thus proved the existence of the ether, and having pointed out a few of the functions fulfilled by it, let us briefly consider some of its more

important properties. In the first place then ether is matter, since in order to the performance of the functions which we have above described, it is absolutely essential that it should possess inertia, and inertia is the distinguishing test of matter. That matter is inert, and that inertia is the distinguishing test of matter, are propositions, the truth of which lie at the foundation of modern physics.

Before leaving this subject we may refer, by the way, to the bearing of this on the important question, Are there two essentially different kinds of energy, *kinetic* and *potential*? If potential energy be defined as the *energy of position*, its existence is utterly inconsistent with the above propositions. In this sense potential energy involves a contradiction in terms. But though there is and can be no fundamental difference as the basis of the distinction between potential energy and kinetic energy, all energy being in its nature kinetic, yet if we regard potential energy as a convenient name for those kinds of energies whose nature is not yet understood, the term is convenient and admissible, though liable to create considerable confusion.

From a moment's consideration of the constitution of matter it follows that the ether must of necessity be a highly attenuated substance.

Yet, in order to convey heat and light with the enormous velocity with which they travel, and to account for the almost instantaneous transformations of energy observed in explosions, etc., the ether must be so elastic and incompressible that Stallo in his "Concepts of Modern Physics" has justly characterized it as an adamantine solid.

In order that we may have a more definite idea of the properties of this marvellous substance, I may mention that in a paper read before this Institute some years ago I attempted a calculation of its probable density.

The calculations showed that the mass of a cubic mile of ether is not less than $\frac{1}{4}\left(\frac{1}{10}\right)^{18}$ of a pound and not more than $\frac{1}{4}\left(\frac{1}{10}\right)^{7}$ of a pound. That is, a sphere whose radius is 95,000,000 miles from the sun (the distance of the earth from the sun) would contain at least 4,400,000 tons of ether. By a somewhat different method, Sir W. Thomson has shown that a cubic mile of ether in the space traversed by the earth contains not less than $\frac{1}{1000} \times \left(\frac{1}{10}\right)^{5}$ of a pound. As pointed out by Prof. Tait the method of Sir W. Thomson gives only the minimum density. It may also be pointed out that the density of the ether is approximately uniform throughout the solar system. As has been remarked by S. Talan Preston in his interesting Essay on the Physics of the Ether, the law established by Clausius as the result of his investigations of the constitution of gases, viz., that "the mean length of path of a particle is in

the same proportion to the radius of the particle (supposing it to be spherical) as the unit volume of space is to the total volume of particles contained in such unit volume" applies to the ether. From this beautiful law many important and exceedingly interesting consequences follow, but I shall not detain you by pointing them out. From the low density of the ether taken in connection with the functions it has to perform, and especially the necessity of the ether particles being able to penetrate with freedom the intermolecular and interatomic spaces it follows that the component particles of the ether must be extremely minute.

The density of the ether being small, and its particles being minute, it follows that in order to produce pressure necessary to effect the rapid and stupendous changes observed in nature, the velocity of the component particles of the ether must be correspondingly great. Green, in his masterly treatment of the subject, has exhaustively worked out the wave theory of light on the hypothesis that the medium is continuous and homogeneous and nothing of moment has been added to what he has done. But, as is well known, his results do not correspond with observed facts, so that his explanations are unsatisfactory and incomplete. The Undulatory Theory of Light as developed by him thoroughly explained dispersion and absorption, but did not explain reflection and refraction at plane surfaces, and what has aptly been called the hopeless difficulty of double refraction in crystals, stands in the way of the final acceptance of the theory as at present developed.

No explanation of these difficulties has yet been given which can be regarded as complete or satisfactory, and their solution is the work of the future.

It is quite obvious that their successful solution will throw a flood of light on the whole question of the real nature of matter.

THE BŒOTHICK INDIANS.

BY ALAN MACDOUGALL, M CAN. SOC. C. E.

(Read 14th February, 1891.)

This powerful but peaceful nation has been completely destroyed by the white man. The earliest notice of them is in Hacluyt's account of the discovery of Newfoundland by Cabot in 1497, who says of them: "The inhabitants of this island use the skins and furs of wild beasts for garments which they hold in as high estimation as we do our finest garments. In war they use bows and arrows, spears, darts, clubs and slings."

Hayes, who was second in command to Sir Humphrey Gilbert, about 1583, says, "the savages are altogether harmless." Capt. Richard Whitbourne, writing in 1622, describes them as "ingenious and tractable, full of quick and lively apprehension, willing to assist the fishermen in curing fish for a small hire."

This race was cruelly exterminated by the French, who imported the Mic-Macs from Nova Scotia to make war upon them.

In 1769, the British government took an interest in the nation and issued a proclamation prohibiting their being molested and killed. Rewards were offered for the capture of an Indian; in 1804, a woman was captured, treated kindly, loaded with presents and sent back to her tribe, which she never reached; a strong suspicion is entertained that she was murdered by the man to whose care she was entrusted.

In 1810, Lieut. Buchan, R.N., was commissioned by the Governor, Sir Thomas Duckworth, to discover and bring about friendly relations with the Indians. He cruised up the bay of Exploits and at length came on an encampment. He prevailed on two Indians to come on board his vessel; but to effect this, he had to leave two of his marines with the Indians as hostages. His object in taking them on board was to send back by them presents for the Indians. On his return to their encampment he was horrified at finding the headless bodies of his men. It is supposed the Indians got alarmed at the delay and feared he was returning with reinforcements to capture them. The Indians had fled from their camp after the murder; the hostages escaped from Buchan and were never again seen.

In 1819, a party of furriers captured an Indian woman at Red Indian

Lake, after shooting her husband and another Indian. She was brought to St. John's and called Mary March, after the month in which she was taken, treated with great kindness, and in the hope of conciliating her tribe and opening communication with them, she was loaded with presents and sent back to her people. She died on the voyage, having been a sufferer from consumption; the party in charge of her placed her body in a coffin, wrapping muslin around it and left it on the margin of a lake so as to be found by her people, who conveyed it to Red Indian Lake, where it was found by Cormack. The manners of Mary March when in St. John's were very pleasing. There was a quiet dignity about her which induced the belief that she was a chief's wife. She had been dead for several years when found by Cormack.

Four years after the capture of Mary March, three other red Indian women were captured near Twillingate and brought to St. John's. These were the last of the tribe seen alive. They were a mother and two daughters. The mother and one daughter died in a short time, the other lived for six years, learned English and became a useful servant, but died of consumption, a disease, as she said, fatal to many of her tribe. Her name was Shanandithet. She had a wonderful talent for drawing. Soon after her arrival in St. John's a piece of paper and a lead pencil were given to her, and in a few strokes she drew a deer perfectly, and what was more remarkable began at the tip of the tail.

In the museum are several hand sketches, showing the route of Buchan's expedition in 1810, the massacre of the marines, and the flight of the Indians, which were drawn by Shanandithet who was with the tribe at the time. The sketches are remarkable for their accuracy in giving the numbers of Indians and whites. They show where the marines were killed and the route of the fugitive Indians. The papers are very interesting. It is the earnest hope of the writer that Mr. Howley may soon be able to give a detailed history of these expeditions as gathered from the various monographs under his charge.

Cormack, the traveller who crossed the island in 1822, made a final effort in 1828 to discover the remnant of the red Indians, which were supposed to be in existence, in order to open up friendly communications with them. He and his party penetrated to Red Indian Lake, the headquarters of the Bœothicks, but could not find a single person. They found numerous relics of the race, such as clusters of wigwams, storehouses for venison, canoes, etc. In one of the burial huts they found two bodies wrapped in deer skins on the floor, one was the body of Mary March, which was in a white deal coffin, neatly shrouded in white muslin. Beside the bodies were two small wooden images, representing husband

and wife, and a doll, representing a child; also arrows, a quiver, fire stones (iron pyrites), and other things.

Of their customs and habits a few words must suffice in this place. Their winter mamateeks, or wigwams were conical. Their frames were of poles covered with skins or birch bark, stoutly constructed, though they looked very light. Several had withstood the storms of over thirty winters. They were made to accommodate from six to eighteen persons. The fire was in the centre; round it were a number of holes, one for each person, in which the occupant sat, and it is supposed slept. For increased comfort the holes were lined with moss.

The remains of a vapour bath were also found, the construction was ingenious; large stones were heated in the open air by burning stones round them, the ashes were then removed, a hemispherical frame work, closely covered with skins to exclude the external air was fixed over the stones. The patient crept in under the skins, taking with him a birch rind bucket of water and a small dish to dip it out; on pouring water on the hot stones he could raise the steam at pleasure.

They produced fire by striking together two pieces of iron pyrites, a custom peculiarly their own, and not known to exist among other tribes.

They had four modes of sepulture which varied according to the rank of the deceased. One of the repositories resembled a hut 10 feet by 8 or 9 and 4 or 5 feet high in the centre, floored with square poles, the roof covered with rinds of trees and in every way well secured inside against the weather and the intrusions of wild beasts. Another resembled that of our own Indians, the body was wrapped in birch bark and with the property of the deceased placed on a sort of scaffold about 4½ feet from the ground. The scaffold was formed of four poles about 7 feet high, fixed perpendicularly in the ground, to sustain a floor 5 feet 6 inches long by 4 feet broad, the floor was made of small square beams laid close together horizontally on which the body and property lay. A third method was when the body was bent together and wrapped in birch rind and enclosed in a sort of box placed on the ground; the box was made of small square posts laid on each other horizontally and notched at the corners to make them fit closely; it was 4 feet long, 3 feet wide, 2½ feet deep, well lined with birch rind to exclude the weather; the body lay on its right side. The last and most common way was to wrap the body in birch rind and cover it over with heaps of stones on the surface of the ground in some retired spot. Sometimes the body thus wrapped was put under the surface a foot or two and the spot covered with stones. In some places where the ground was soft and sandy the graves were deeper and no stones were placed over them.

They were great hunters and fishermen, and had an ingenious method of trapping deer. They constructed a long fence of timber by chopping down trees, leaving openings at certain spots for the deer to enter. The fences opened out into large "corrals" or enclosures, or led to the lakes, in both of which the deer were slaughtered. Some of these drives are forty miles in length, and can easily be traced at the present day.

The most interesting remains in the museum are two skulls and several of the parts of two bodies, a mummified body of a boy, and an almost complete skeleton of a man, along with a fine collection of bone ornaments.

These Indians do not appear to have been great stone workers. A few examples of cults, hoes, scraping tools for hide dressing have been found. They did not use pottery. Their culinary utensils were of birch rind, from the size of a teacup up to a two-gallon pail. This practice is still in use among the Mic-Macs. For light they appear to have used soap-stone lamps of rhomboidal shape 5 inches long on major axis, at one end of which is a small notch in which the wick lay, the oil being obtained from the seal and fat of the deer. It is surmised they used these lamps in a similar manner to the Esquimaux of the present day Of arrow heads there is evidence of the same shapes and materials as those used by the western Indians. Some patterns, apparently of later date, are of slate, with very keen, sharp edges, and one of iron with a razor edge on it. These are made at the angle of 45°, a marked difference to the usual equilateral triangle.

The bone ornaments are very interesting being the first which the writer has met with. There are two styles, one used for ornamenting the hair, the other the dress; they are all well shapen, elaborately figured, and on none are the figures or patterns duplicated. The form of pattern is a right angled triangle, in which there is either one or two divisions. Each style of ornamentation is separate, the double division does not appear on the single division specimens. The hair combs are chiefly two-pronged, although there are a good many three-pronged specimens; they range from 2 to 3 inches in length, are not rudely or coarsely carved, and present a variety of patterns. The small tooth comb, of which there are several examples, are like those of the Esquimaux, the teeth are from ½ to ¾, of an inch long. On some large pieces of ivory evidently intended for dominoes, the carving takes the shape of the letter H. This ornament runs through many of the specimens. All these ornaments have been cut

out of the bones and tusks of walrus, deer and the seal and are dyed a dark sienna color. They were worn as a fringe to the upper garment, and sometimes as a deep necklace.

The body of the boy is an interesting relic. It was found in 1886, and exhibited at St. John's in October of that year. The body was wrapped in deer skin, which fitted it closely. Attached to the skin were an ornamental fringe of the skin, thirty-two ornamental bone objects similar to those described, and some bird claws. This was enclosed in birch rind, closely and beautifully sewn. In the grave were found a small wooden image, a doll dressed or covered with birch rind, a bow, some arrows, beautifully polished arrow-heads, two pairs of moccasins, a rind basket containing some smoked salmon, and several dried trout wrapped in separate parcels. The preservation of the skin is the most interesting question. It covers the whole body except the skull, is of dark color, and appears like soft, tanned leather. The body is bent up, and was on its left side when found.

In September, 1888, the skeleton of an Indian was found by Mr. Jas. Templeton, near Comfort Head. When found it was in a bent-up position, the chin resting on the knees, and was held in that position by a rope. The arms were at the side, bent at the elbows, so that the arms crossed the legs. The head had been covered with deer skin. The body lay on its right side, the head to the north. Broken arrows were placed across the body, the ornaments put between the doubled up legs and the body. It is supposed to be the body of a medicine man, from the narrow chest and contents of a medicine bag, which were a number of carved bone charms, strings of wampum, a brilliant piece of iron pyrites, and several bird skulls. The coffin had not been sewn. The birch rind had been put on the bottom and turned up over the body, with a few stones placed on it to keep it in place.

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SURNAMES AND PLACE-NAMES OF THE ISLE OF MAN.

By Rev. Neil MacNish. B.D., LL.D.

(Read 21st February, 1891.)

Such is the name of a book which has recently been published, and which contains very useful information, not for Manxmen merely, but also for Celtic scholars everywhere. "My aim in the following pages," the author writes, "is to give a complete account of the Personal names and Place-names of the Isle of Man." The author of the book in question, is Mr. A. W. Moore, M.A., a gentleman of scholarly attainments, who has devoted much attention to the literature and topography of Man, and who has earned for himself an honorable reputation owing to his patriotic efforts to revive and perpetuate whatever is of value in the history and traditions of his native Island. Mr. Moore is a member of the House of Keys, and resides at Cronkbourne, a name which reveals its Gaelic lineage at a glance. In January, 1885, he started a quarterly journal of matters past and present connected with the Isle of Man, to which he gave the modest name of "The Manx Note Book." Mr. Spencer Walpole, the present Lieutenant-Governor of Man, wrote an introductory notice, wherein, among other things, he remarked :—"Let it not be said that Man is too little, and that Manxmen are too few for such a publication. The Isle of Man can at least boast that it has preserved its independence unimpaired, and that it still possesses the old legislature which had its origin before the Battle of Hastings. Fifty thousand people still retaining their old laws and their old customs in the centre of the United Kingdom is a spectacle as unique as it is notable. Their annals necessarily possess a peculiar interest to the antiquarian and the historian." So far as the articles of the Note Book and the printing of this book are concerned, the expectations of its readers were more than adequately satisfied. Mr. Moore, however, unhappily found that he was incurring a heavy pecuniary loss in publishing the Note Book; and hence, much to his own regret and to the regret of his numerous friends, he was reluctantly led to discontinue the publication of it with the twelfth number, which appeared in October, 1887. The Lieutenant-Governor was asked to write what he termed the Epilogue of the Note Book. He thus concludes his Epilogue :—"And so far as artistic merit cannot compensate for a defective balance sheet, the time has come for closing this

experiment and for saying farewell. Yet, in thus bringing his labors to a premature conclusion, the editor of this Manx Note Book may have the satisfaction of reflecting that no good sound piece of work ever perished altogether. The Manx Note Book disappears, but its old numbers will be treasured by their possessors, and perhaps some people, when they are trying to complete their sets, will regret that their active admiration was too late, and that they did not bestow on the Note Book while it was still alive the support which might have averted its doom."

Though all lovers of Celtic literature have cause to regret that Mr. Moore, whose knowledge and enthusiasm and resources are abundant, did not receive generous assistance in connection with the Note Book; Manxmen can compare very favorably with their Irish and Scottish cousins in their desire to rescue from oblivion and to perpetuate whatever is of greatest value in the prose and poetry and folk-lore of their Island. There was formed in 1858 a society bearing the designation, "The Manx Society for Publication of National Documents of the Isle of Man." Up to 1886 twenty-nine volumes were published by that Society. In the October number of the Manx Note Book for 1886, an account is given of the foundation of the Manx Society, of the work which it undertook to accomplish, as well as of the work that still remained to be performed. An account is also given of the financial position of the Society and of the appointment of four new members of the Council. As Mr. Moore is one of the four, it may be fairly hoped that he will exert himself in the endeavor to carry on to a larger extent the laudable work for which the Society was organized.

There is unfortunately too much reason to justify the accusation, that Celts are fond of contenting themselves with sentimental affection for their language and literature; and that they are somewhat tardy in befriending those scholars who are anxious to perpetuate the language, and to keep the flame of love for the language of their fathers alive and burning in the hearts of the children of every generation that appears on the scene. The Irish Gaels, who have a magnificent heirloom in the form of a very ancient and copious literature, have in recent years been exerting themselves, with a large amount of warmth and energy, in the interests of all that is distinctive in the government and institutions of their country.

It cannot fail to occasion surprise that, while so deep and widespread a feeling exists among Irish Celts for the independence of Ireland, there are few among their leaders who can speak the language of their forefathers. Though they cannot be accused of having an undue affection for the Sassenach, they have chosen to abandon their native language,

which is Gaelic, and to adopt the language of those whom they are taught rightly or wrongly to regard as otherwise than friendly to themselves and their country. There was started some years ago in Dublin, in the best interests of Irish, a journal bearing the designation, "Iris Labhar na Gaedhlige, The Gaelic Journal, exclusively devoted to the preservation and cultivation of the Irish language, founded, conducted and published by the Gaelic Union." The Gaelic Union had in contemplation the very excellent object of encouraging the study of Irish in the schools of the country, and altogether of infusing fresh vitality into the attention which the language and literature of Ireland ought to receive from Irish Celts. Though the aims of the Gaelic Union and of the Journal were patriotic in an eminent degree, it must be confessed that the support which in all fairness might be expected, has not been extended either to the Gaelic Union or to the Gaelic Journal. In an article which appeared in one of the numbers of the Journal for 1889, the editor adverts in doleful terms to the prospects of that periodical. "The Gael, a Monthly Journal Devoted to the Cultivation and Preservation of the Irish Language and the Autonomy of the Irish Nation:" Such is the designation of a journal which has been published in Brooklyn, N.Y., for the last ten years. It has to be said in favor of that journal, that it is ably conducted, and that it is rendering even on a foreign soil excellent service to the language and literature of Ireland. The Welsh easily claim the palm among the Celts for intrepid devotion to the language and traditions of their forefathers. So deeply seated is the affection of the Welsh for their native language, and so beneficial is the influence of the Eisteddfods which are now held annually, that the prediction may be hazarded that the future has nothing which is not hopeful and assuring regarding the perpetuation of Welsh in all its rugged grandeur in the Principality of Wales. Through the heroic efforts of Prof. Blackie, in whose veins, as he is fond of asserting, there is not a drop of Celtic blood, a Celtic chair was established in the University of Edinburgh a few years ago. To him largely pertains the praise which results from knowing, that throughout the Highlands of Scotland, and in those cities where Gaels reside in large numbers, Societies exist for the avowed object of honoring and continuing the study and knowledge of Gaelic, and of the traditions of the Highlands. A movement which promises fairly to lead to important results, is now on foot for instituting in the Highlands of Scotland annual Eisteddfods after the example and in the spirit of the Eisteddfods which are annually held in connection with Wales, and which have already done incalculable service in the way of continuing and developing all that is best in the poetry and prose, in the music and traditions, of the Welsh.

Prof. Rhys, of Oxford, contends that the Isle of Man has proved the meeting-place for Ivernians, Goidels, Scandinavians, and Englishmen. Mr. Moore divides the history of Man into three parts:—

1. When it was inhabited by a Celtic people exclusively.
2. The period of the Viking invasions and the establishment of Scandinavian rule.
3. The period during which Man came under English dominion.

It is to be regretted that he employs the term Celtic to designate the Goidelic branch merely, and not the Cymric as well. The term Celtic is usually and wisely made to perform the comprehensive duty of embracing all the branches of the Cymric and Gaelic families of the Celtic language. Mr. Moore has been at great pains to study the meaning and origin of the Scandinavian names of places that occur in Man. He has had the valuable assistance of the late Dr. Gudbrand Vigfusson, of Oxford, who was a Norse and Runic scholar of great ability. It is found that in nearly every case Scandinavian names are Celticized, *i.e.*, they have received the prefix Mac—a prefix which was almost universal in the sixteenth century. There is an old distich wherein the quantity of *o* in duobus is changed:—

Per Mac atque O, Tu veros cognoscis Hibernos;
His duobus demptis, nullus Hibernus adest.

i.e.

"By Mac and O, you always know
True Irishmen, they say,
But if they lack both O and Mac
No Irishmen are they."

It does not appear that *O* ever took root in the Isle of Man—though *Mac* was widely prevalent. As any Scottish Gael can determine for himself, *Mac* indicates *son*, while *O ogha* indicates grandson or descendant. MacNeill and MacDonell are forms which pertain to Scottish Gaelic, while O'Neill and O'Donell are characteristic of Irish. *Mac* is made to do duty in presenting in an English dress the names of both sexes in Gaelic, *e.g.*, John MacNeill, Mary MacNeill. *Nic*, which is a contraction for *nighean*, daughter, is used in Gaelic to designate females, *e.g.*, Mairi Nic Eallair.

It is somewhat anomalous that Mac should be made to represent both sexes in English. Those Gaels who aim at transforming their names entirely into English, convert *Mac* into *son*, and append son to their names, *e.g.*, Anderson, Johnson, Stevenson. Little do those who are in the habit of eliminating *a* from *Mac*, and of writing *Mc*, reflect that

they are leaving out the essential letter in *Mac*, and that *M* or *c* could with far greater impunity be omitted. Indeed, in certain parts of Scotland *M* or *Mh* in *Mac* or *Mhac* is silent in colloquial conversation, and *ac* alone is audible, *e.g.*, Iain *ac* a' Phearsuinn.

Mr. Moore avers that surnames in Europe may generally be divided into four classes :

1. Those taken from the personal names of an ancestor.
2. Those taken from trades and occupations.
3. Those which originally indicated place of birth or residence.
4. Those which were originally descriptive of a person's appearance or character or residence.

It has been ascertained that of the surnames which are now in use in Man, 68 per cent. are purely Celtic. Any man of intelligence can understand, that in the early days of human civilization when books were largely, if not entirely, unknown, the power of observation of the people of those days was very acute and accurate ; insomuch that the names which they gave to rivers and mountains, &c., had as their basis an unmistakable similarity or foundation in nature itself. Mr. Moore has, therefore, abundant reason on his side when he asserts, that those who gave the names, so far as places are concerned, considered such names to be accurate descriptions of the localities to which they are applied, and that they are never mere arbitrary sounds, but have a rational significance. In acknowledging the authorities that aided him in the preparation of his book, Mr. Moore, among other books, mentions Cleasby & Vigfusson's Icelandic Dictionary, and the Annals of the Four Masters. The latter book bears the designation of the *Annals* of the Four Masters, because four men were prominent in the preparation of it. The chief of those men was Michael O'Clery, than whom no lover of his country has any where to present a finer exhibition of cheerful devotion to duty, of large contentment with poverty, and of patriotic affection for all that was great and good in the annals of his people. The work in question was begun in Dun-na-ngall, or Donegal, on the 22nd January, 1632, A.D., and was finished on the 10th August, 1636. It has been truly said, that no other nation has such a monument of historical learning as the Annals of the Four Masters contain in connection with the history of Ireland. It is stated in the book in question "that *Giolla*, especially among the ancients, signified a youth, but was generally a servant ; and hence it happened that families that were devoted to certain saints, took care to call their sons after them, prefixing the work *Giolla*, intimating that they were to be servants or devotees of those saints, and it will be found that there are few saints of celebrity from whose names those

of men were not formed by the prefixing of *Giolla*." Among English writers in our own day, the word Gillie passes as current coin.

There are many Gaelic and Manx surnames which are formed from Giolla, *a servant*, and the name of a saint, *e.g.*:—

GAELIC NAMES.

MacLean, Mac Ille Eoin, or Iain, the son of the servant of John, or Saint John.

MacLennan, Mac Ille Fhinnein, the son of the servant of Finnan, or St. Finnan.

MacLellan, Mac Ille Fhaolain, the son of the servant of Faolan, or St. Faolan.

MacCallum, Mac Ille Chaluim, the son of the servant of Columba, or St. Columba.

Gilchrist or Mac Gilchrist, Mac Ille Chriosda, the son of the servant of Christ.

Kilpatrick, Mac Ille Phadruic, the son of the servant of St. Patrick.

Gillespie, Mac Ille Easpuig, the son of the bishop's servant.

MacAndrew, Mac Ille Aindreis, the son of the servant of St. Andrew.

Jamieson, Mac Ille Sheumais the son of the servant of James.

MANX SURNAMES.

Kissack, Mac Guilley Isaac, the son of the servant of Isaac.

Quane, Mac Guilley Shane, Johnson, or the son of the servant of John.

Mac Vorrey, Mac Guilley Vorrey, the son of the servant of Mary-Morrison, Murray, Currie.

Mac Mychel, Mac Guilley Michil, the son of the servant of Michael. Carmichael.

Fayle, Mac Fayle, Mac Guilley Phoil, the son of Paul's servant, Mac Phail.

Mac Faden, Mac Ille Phaidin, Little Patrick's son.

Bridson, MacGuilley Brighde.

Mr. Moore gives a list of surnames that are derived from personal names of purely native origin, *e.g.*:—

Quarry, MacGuaire, Guaire's son.

Quine, MacCuinn, Conn Counsel.

Connelly, MacConghalaich (congal conflict).

Cannell, MacConail, Conal's son.

Mr. Moore is incorrect in his contention, that Domhnall is the diminutive of the root *Dom* in *Dominus*, master. The common derivation of Domhnall or Donull, *donn*, brown, and *suil*, eye, is far preferable. It is also incorrect to derive Dughall from *dubh*, black, and *Gall*, a Lowlander, inasmuch as stress is laid on the first syllable *Dubh*. In the second syllable *suil* is clearly present.

Kelly, MacCallaigh, Callach, war strife.

Moore, O'Mordha, mor great.

Curphey, Murchie or MacMurchy, MacMurchada, Muir, sea, Cathaide, warrior.

Kneal, Niall, champion.

Colvin, Calvin, Calbhin, call, bald.

Coole, Cooil, MacCumhail, Comhal, Courageous.

MacNameer, MacNamara, MacConmara, cu dog and mara, sea.

MacRory, Ruaidhri, ruadh righ, red king.

'MacDeean, MacPherson, and MacOspagie, Dean's or Deacon's son, Parson's son, and Bishop's son, are the strongest theeves that be" Such is a citation that Mr. Moore makes in connection with Celtic surnames from trades or occupations Of such surnames these are examples :—

MacTaggart, the son of the Priest.

Ward, Mac a' Bhaird, the son of the Bard.

Tear, MacIntyre, Mac an-t Saoir, the son of the Carpenter.

Gown, Smith or Smithson, Mac a' Ghobhain, the son of the Blacksmith.

Kerd, Caird, Ceard, an artificer.

Gill, Giolla, a young man. Gill in Scottish Gaelic is to be derived from *Gall*, the full name being Mac a' Ghoill, the son of the Lowlander or Stranger.

MacPhearsan, MacPherson, the son of the Parson.

Mac y Chlery, Mac a' Chleirich, the Clerk's son.

When Great Britain and Ireland were subjected to the rude invasions of the Northmen, the Danes made inroads on the eastern coast, and the

Scandinavians, properly so-called, made their incursions into the western parts, and therefore, into the Isle of Man and the Hebrides. So strong and stable and resolute was the Celtic population of the Isle of Man, that the Scandinavians who settled there, adopted the prefix *Mac*, and thus became in name part of the Celts among whom they lived. Of such names these are examples :—

Castell, a contraction of Mac as Ketill, the son of the Kettle. Mac Askel, Makaskil, Caskill are other forms of the same name.

Corkill, a contraction of Mac-por-ketill, the son of Thor of the kettle. Thorr, the God of Thunder, the Keeper of the Hammer, the destroyer of evil spirits, the son of Mother Earth, was the favorite deity of the North. MacTorquil, Mac Corquodale, MacCorkyll, are other forms of the same name.

The name MacLeod, which is so common in Scotland, is of Scandinavian origin. Corlett is the Manx form of the same name. Ljot, which corresponds to Leod, means *people*, and therefore MacLeod signifies the son of the people. It appears that the MacLeods of Scotland have always claimed a Scandinavian origin. The MacLeods of Lewis not only quarter the Manx trie cassyn (three feet) but also use the same motto, "Quocumque jeceris stabo." In the names of some of the Western Isles of Scotland, there are indelible evidences of the presence and power of the Scandinavians. Lewis, Barra, Scarba, Jura are not Gaelic but Scandinavian terms. Such personal names as Norman or Tormoid, Lewis, Godfrey, Farquhar, Ranald, are Scandinavian and not Gaelic at all. When MacAulay incurred the odium of the Scottish Gaels for his severe and unnecessary strictures on the method of life which their ancestors pursued, it was not commonly known that the name MacAulay is a shortened form of MacAmhlaith, Anlaf's or Olaf's son. Olaf was a royal name in the Isle of Man. Though MacAulay's great-grandfather was minister of the small Isles, as they are termed among the Hebrides, it is possible to find an explanation of the historian's antipathy to the Gaels of Scotland, in the re-appearance in his person of the hostility which his forefathers bore, or had cause to bear, towards the rightful owners of the soil. The Gaels of Eastern Ontario are unconsciously doing homage to the Scandinavian origin of the term Ranald; forasmuch as in Gaelic, as well as in English, they gave prominence to the vowel *a* and not to *o* in the first syllable. Clan Ranald, Clann Raonuill, Raonuill, Raonull: in such terms, deference is properly paid to the etymological meaning of the Scandinavian appellation. Raghnall, the Celtic form of Ragnvaldr, is compounded of ragn the God and valdr, ruler. MacRannall, &c., MacRaghnaill, Reginald's son, are other forms of Raghnall.

It appears that after the year 1333, many of the distinguished Anglo-Norman families that settled in Connaught and Munster became Hibernicized, Hibernis ipsis Hiberniores, spoke the Irish language, and assumed surnames like those of the Irish by prefixing Mac to the Christian names of their ancestors, *e.g.*:—

Gale, Mac an Ghaill.

Quillam, MacWilliam.

Kinry, MacHenry.

Nicknames from father's or mother's Christian names are very common in the Isle of Man. Mr. Moore inserts a certain poem which is somewhat amusing:—

"Now, I'll be bail his name is Quaile,
I see it in his face.
As sure as life, exclaimed his wife,
He's something to that race.
Yes, you are right, good dame, said I,
That is my father's name,
Though not the one that I go by,
Nor like unto the same.
I am called by all both great and small,
Bill Homnais-Beg-Tom Moar."*

*Bill, the son of little Tommy, the son of big Tom.

So far as place-names that are of Celtic origin are concerned, Mr. Moore has found that—

Cronk, Cnoc,	occurs as a prefix	76	times.
Ghone, gleann,	" "	39	"
Creg, Creag,	" "	36	"
Keeill, Cill,	" "	34	"
Chibher, Tobair,	" "	21	"
Balla, Baile,	" "	400	"

As my review of Mr. Moore's book has already extended to an undue length; and as in a paper which I had the honor of sending a few years ago to the Canadian Institute, I discussed the topographical names of the Isle of Man, I shall not now make any minute references to the very instructive portion of his book, which deals with the place-names of his native Island. Scottish Gaels will not be readily disposed to believe that the well-known and expressive word Mull, Maol, Moyle, which occurs in the Mull of Kintyre, the Mull of Galloway, Mull of Oe, etc., is of Scandinavian origin, and is not after all the pithy Gaelic word Maol, bare or bald. According to Mr. Moore, Mull is the Scandinavian *Muli*, a muzzle or snout, a headland or jutting crag.

Vik is a Scandinavian word that signifies a small creek or bay. Vik is to be recognized in Wick, and in the last syllable of Keswick, Greenwich; and in the forms of *aig* or *ag*, it is present in Greenock, Gourock and many other names in the topography of Scotland. Scottish Gaels who are continually in the habit of employing the term *sgireachd* for parish, are not generally aware that sgireachd, Manx Skeery, is a Scandinavian word, and that it is derived from skera, to cut or divide; the reference doubtless being to the division of Man and of Scotland into what has been long known as parishes.

It might be supposed, that as the Gaels occupied the Isle of Man and the Hebrides long before Danes or Scandinavians began to visit those places, the word to denote a rock in the sea would be Gaelic. It seems, however, that sgeir, the word in question, is Scandinavian.

Mr. Moore has rendered very important service to all who take an interest in the Isle of Man; and to all who find pleasure in examining the records of whatever kind that yet remain to throw light on the days and traditions of Celts everywhere. Mr. Moore's book cannot fail to find a very honourable place among the comparatively few books that are of highest value and that are most highly prized, in connection with the early monuments and character and varied developments of the several divisions of the great Celtic family. The wish is to be devoutly cherished, that some Celts with a large measure of the refined taste and scholarship, and ability and patient enthusiasm of Mr. Moore, will speedily appear to render to their own division of the Celtic family—where such a service is still very much needed—such excellent service as Mr. Moore has rendered to the Isle of Man—a service which ought to endear him to Manx men everywhere, and to make every intelligent and patriotic Celt very grateful to him.

ART IN CANADA TO-DAY.

By J. W. L. Forster.

(Read January 31st, 1891.)

Everything that grows to-day is from seed planted yesterday. Canadian painters have inherited from the pioneers of the profession in this country the legacy bequeathed by our back-woods-men to their sons—honesty and industry, and a hard but fair field for both. During the later years of colonial life Canada has contributed many brilliant names to the art rolls of other lands—the Smillie Brothers, LeClear, Woodward, Rattray, Sandham, Fraser, Walker, Shannon, Peel, Herbert and many more; but in the meantime our own field has been occupied by foreigners.

In Western Canada the names signed upon pictures during the last fifty years have been legion: pilgrims each, as all our fathers were, yet they have helped to plant a stem in the soil of our country from whose vintage we drink to-day. The great majority of visiting artists were British, as their patrons were mostly men whose education and taste were of that careful, academic school. For a time the patronage of art was liberal, but this passed away with the legacies that sustained it, or with the men whose taste and liberality had encouraged the advent of artists of note. But those early days brought to their sons the demands of a busy colonial life, and little opportunity for the culture of the esthetic, and so one by one the artists—birds of passage—disappeared. Paul Kane, the first distinguished Canadian, Sawyer, Fowler, Creswell, Berthon remained. Of these Mr. Berthon's hand alone remains to do honor to the Toronto Law Society in portraits for Osgoode Hall of our distinguished jurists. The Toronto Law Society, inheriting, as many of its members do, the blood and the traditions of the founders of our local commonwealth, has kept alive the spirit of a generous age.

The first, or Upper Canada Art Society, was formed in 1841, the late Mr. J. G. Howard being its chief promoter. It held its first exhibition in the Parliament Buildings, and amongst the pictures shown were a number of valuable paintings by British painters. The Electoral Division Society next assumed the patronage of the fine arts, and during its existence competitive prizes were offered for both professional and amateur artists. James Armstrong was its most active head, the late Col. Denison being its first president. This society merged into the Industrial and

Arts Association, which for years held the gauge of professional merit in the art of the country. In 1873 was formed the first distinctly professional group, known as the Ontario Society of Artists, and which, during these eighteen years has placed annually before the people of Canada the best work of our artists. Two years before that date the Art Association of Montreal was organized, and in 1880 H.R.H. the Princess Louise and the Marquis of Lorne inaugurated the Royal Canadian Academy.

Annual exhibitions of meritorious pictures, aided by an Art Union successfully promoted by the Ontario Society of Artists, under the presidency of Hon. G. W. Allan, have contributed much toward an awaking interest in our country's art; but equally potent has been the influence of successes achieved by our younger painters in the capitals of Europe in turning the eyes of the people to what is being done at home.

The art of Canada to-day is a mingling of elements. We refrain from mentioning any names of living men, not wishing to discriminate amongst our confreres in any way, although you will not be slow to observe one very natural division, viz.: Belonging to the professional society mentioned are fifty members, of these a half-dozen, certainly not more than ten, are native Canadians. The influence of the old world may be seen in the work of many who cherish still the precepts of their masters. Yet it is due to those who have adopted Canada as their home to say they are as Canadian in the faithful reproduction of the pure glories of our climate as those who first saw the sun in our own sky. Our native artists, who have studied abroad, are very much inclined to paint a Canadian sky with the haze of Western Europe, and our verdure too as though it grew upon foreign soil. Our art is not Canadian.

The French school to-day rules the art of Europe. No stronger evidence of this is required than the catalogue of the Great International Exhibition held in Paris in 1889. The British is the only school distinct from it. Canada furnishes the arena in which the forces of these rival schools contend; and while the restless dispute continues with little sign of truce, we may at least expect more universal interest in the true ideal to which our painters are looking. When a more intelligent conception of the aim of art is possessed by our younger men especially, it may be discovered that both are near a pure and high ideal, and that rapprochement, not rivalry, would best serve the occasion; and the union might reasonably be hoped to produce a purer, higher ideal than any yet reached. Material is certainly not wanting, nor motif for art of the grandest order.

The first requisite is for a stronger national spirit. Events are slowly developing this; and the signs are full of promise in this direction. The

second great need is for a museum equipped with well-chosen specimens of the world's art. Our Government and citizens are establishing schools of industrial and fine art, yet when we would point our pupils to examples of pure art, lo! there are no ; and when we would know what art has been, in order to discover what art may be, we must go as exiles and pilgrims to foreign cities, where there is no Canadian air to clear the atmosphere of false traditions, or blow aside the prejudices of antique philosophies: philosophies true enough in themselves, but not adapted to the newer civilization of this continent. We want their history with our hope, their experience with our ambitions; and a museum that gives the best of their art history and achievement will greatly strengthen our hope and give rein to our ambition.

A third need is for capable and generous criticism. There are many men whose discernment and sympathies fit them eminently for the roll of art critic; but as yet journalism has not opened wide the door to advancement in such a specialty. In the meantime, while we wait the advent in Canada of an Albert Wolfe or Hammerton, we declare the unprejudiced impression on the mind of the public to be the fairest test of a picture's merit. No questioning will cast a reasonable doubt upon the claim of an experienced purchaser to first place as connoisseur and critic, freed as he is from the narrowing influences of specialities, which impose limitations upon the judgment of the professional artist. But this question we leave for fuller discussion in a later paper: suffice it for us Canadians in our observation of the nature whose lavish wonders greet the eye everywhere, and of the representations of that nature in pictorial art, we give our independent judgment the encouragement it deserves. False taste will thereby be corrected, and art that is true art greatly encouraged.

BONE CAVES—WITH ESPECIAL REFERENCE TO PRE-HISTORIC MAN.

By Arthur Harvey.

(Read 19th January, 1891.)

This paper, read at a meeting of the Biological Section, was divided into the following heads :—

1. The cosmogony of the Assyrians, Egyptians and Hebrews compared with that of the Greeks and Romans and of our own time.

2. Various divisions of prehistoric time.

3. Description of cave explorations, and among these :—*(a)*. The Roset cave, by M. Caravin Cachin, translated from the Proceedings of the French Association for the Advancement of Science, 1889. *(b)*. Notes of papers, in the same volume, by M. Theophile Habert, of Troyes; by M. le Dr. Pommerol, of Gerzat, Puy de Dôme; by M. G. Chauvel and Mr. Adrian de Montillet. *(c)*. The bone caves of Gower, by Mr. John Roberts, Swansea (Wales) Institute, 1888. *(d)*. The cave of Gabrovizza, by Dr. Carlo Marchesetti, translated from the Atti del Museo Civico de Storia Naturale, Trieste.

4. The artistic talents of prehistoric man by Dr. Lazarus Popoff. Translated from a French version of the Russian original.

5. The similarity between the habits of stone age men in Europe and (the Indian) in America.

6. Correction, from American analogy, of some current European ideas on this subject.

7. General view of the number, condition and movement of the population in the stone age.

8. Protest against the use of the name "cave-dwellers."

The paper dealt with the last four heads as follows :—

Attention is at once arrested by the remarkable similarity of all the relics of prehistoric man in Europe to these articles which were in daily use among the Indians of this continent when the white man burst upon the American stage. Of these Indian tribes we have survivors, and of their implements of flint, greenstone or diorite, jasper, shell, bone and wood we have in our museum a fine collection. We find lances and

spears, knives, scrapers, drills, axes, borers, pottery, almost identical in shape and size with the European specimens described by the distinguished men above quoted. Even to the ornaments on the bowls this similarity extends. The European manufacture was perhaps a little further advanced. Our whole system of Natural History belonging, indeed, to a somewhat older period than that of Europe, it is not to be wondered at that our indigenous men should have been of a somewhat more primitive type, so that when they came into contact with the European, our aborigines should be inferior in the struggle.

But this striking similarity, extending even to habits and customs, *e. g.*, the cracking of bones for their marrow, the wearing of ornaments of shell, the mixing of red paint for the body, the burning of pottery in the open fire, must surely go further, and one is led to ask if the savants of Europe are justified in applying to these prehistoric people—palæolithic or neolithic; Mousterian, Solutrean, Magdalenian, Robenhausian or others—the general designation of Troglodytes. It is certainly hard to understand with what justice Mr. Caravin Cachin should call the gentleman who is said to have heated flints in fire until some splinters flew off, and then to have further, by knocking off some pieces, made them into cutting implements, an Anthropopithecus. As for the form of the skulls which have been found, it seems now well established that those which appear to be of palæolithic date are long, those of neolithic date a good deal mixed, but usually short; the former being somewhat the larger in cubic contents. People have been led astray and are yet held captive by the old poets, by old legends or traditions, telling of antres vast and the ogres which lived in them. On reflection one must perceive that Europe was inhabited in prehistoric times by a population at least as numerous as was America at the time of its discovery, say by millions, and that this population was in places agricultural, in others pastoral, in others depending principally on the chase; just as we find the Indians to have been here. Those tribes had their wars, feuds like those which existed among our Indians, and they must occasionally have had great chiefs, who would extend their sway over large areas, as some Indian races did, and some of their European successors do to this day. Perhaps incursions would be made by migrating tribes from one land to another, from Asia or from Scythia, as has often been the case in historic times. It seems certain, from the intimate analogy between the aborigines of Europe and of America, that there were considerable movements of population there, every few centuries; race succeeding race, for thousands of years. This view is confirmed by the differences of the types of skull—the long heads or more primitive people having been displaced by suc-

cessive waves of short heads. Languages, too, would follow the analogy of our continent. We may fairly allow to several an area equal to that occupied by, let us say, the Chippewa and its correlated dialects, which would permit of several languages in Europe, as distinct as those of different families of Indians here. The Celtic language is surely a survival of one of these prehistoric tongues, and how much stronger language often is than race may be gathered from the many-complexioned varieties of men who speak a Celtic tongue to-day. The active competition between the races inhabiting Europe in lithic times would naturally produce somewhere a breed of men more powerful than the rest —certainly north of the Alps and the Carpathians, and probably not far from the East German land, ever the breeder of heroes—which would master Europe by degrees and spread even beyond the Caspian, then a most extensive sea, to India. Thus arose the people we call Aryans.

The idea that Europe was a completely afforested country at all times seems an assumption. The aborigines knew the use of fire. Were there no forest fires there as here? Were there no organised methods of making a prairie and of keeping it burned? What mean the ox, the horse, the sheep, if there were no champaign country? It does not even need man to remove the forests. Who can tell what the climate of Europe was in respect to drought when the Caspian was a huge sea extending to and beyond the Aral, including the valley of the Oxus and other Asiatic valleys? Northern Africa, perhaps in consequence of the change in winds which the shrinkage in Asiatic water-areas has caused, is slowly drying up; the great desert is much more arid than it was in Roman times: this may indeed have been the moist region, parts of Europe the dry one. We know that some countries, formerly afforested, are bare to-day—Ireland, parts of France and Italy, perhaps portions of Spain. Some of these have become almost treeless, entirely through the ravages of goats and sheep, especially the former. There must always have been chamois to destroy the forests of one mountain district after another—themselves dying away or migrating as they dimished their own food supply. *En passant* let us observe that no writer on the cave animals of Europe takes any account of a most important point, the probable annual migration of the larger mammals. Winter and summer alternated in these early times as they do now, and, just as the buffalo migrated according to the season, and the deer in Minnesota and Wisconsin still do, being found hundreds of miles further south at one period of the year than at another, so the northern types found in the caves may have been killed or may have died there during their winter migration to warmer climes, and *vice versâ* with southern types.

Long ago, in a paper read before a section of this Institute, the writer combatted the notion that at any epoch one great ice sheet was moving steadily, over mountain and valley, from Muskoka into Pennsylvania, Ohio and New York; holding that when there was perennial ice on our hills it could only follow the slopes. This view has come to be acknowledged, and authorities will now allow some glacier ice to have moved even northward into the prehistoric St. Lawrence, and so on. There now exists in his mind a doubt whether at any time there was a general glacial epoch in the sense the term is used, viz., a reign of cold over the Northern Hemisphere. There has been, it rather seems, a transference from one centre to another of the locality at which precipitation and congelation enough takes place to form glaciers and sheets or caps of ice. If the chief examples are in America to-day, they may at another epoch have been in Europe, and at yet another in Asia. At no time, one begins to think, was there more ice and glacial action over the Northern Hemisphere as a whole than there is to-day. These changes of cold-centres, which are closely connected with changes of areas of evaporation and of aërial humidity, to account for which no nutation or libration of the earth's poles is needed, may have been quite rapid, sufficiently so to have influenced within the time of prehistoric man, the local distributions of types of animals.

One of the most interesting and noted pictures in the Paris Salon of 1889, exhibited in London in 1890, represented a prehistoric man, naked but for a shawl of skins, coming back to his cave with some trophies of the chase. He was meeting at the cavern mouth a fearful sight: his wife (a lovely shape, just like a Paris artists' model of to-day), lying dead at the entrance, and a lion carrying off in its mouth one of his children. This embodied on one canvas many of the ideas European writers have encouraged. We may be certain, however, considering the habits of our Indians (1), that prehistoric man lived in reasonable safety from wild beasts, which would then, as now, rather flee from than attack the haunts of men. Fires, lances, arrows were surely effective for defence and protection. (2). Man of the stone ages was certainly clothed, as a protection against cold; the scrapers and knives were to tan or dress his furs; the drills, needles and other such implements were used to make his covering. With equal certainty he would have garments which would be convenient and would not hinder him in going through the forest, across the plain, or over the mountain slope. (3). The woman was not of the type of the fair skinned Venus de Medici, with delicate fingers unused to toil. (4). The children were not as lovely, except in their parents' eyes, as Raphael's cherubs. With this let us leave the artist.

Lastly let us finish our protest against the appellation given to these men of Troglodytes or cave-dwellers. In a few parts of Europe caves are numerous. In those localities they may have been used as dwellings, for caves can be made very comfortable habitations. They are so equal in temperature, have such lovely views before them, are so secure from fire, flood and cyclone, give such facilities for cleanliness and drainage, that people hold to them as eligible dwellings to this day. We could now multiply cave dwellings almost at will, for we have tools of iron, but the men of the stone ages could not, they had to be content with natural caves, and there never were enough to have served more than the merest fraction of the population. You cannot house the increasing numbers of our forefathers unless you allow them to live under coverings of bark or of skins, probably moveable like those of the Khirghiz, the Esquimaux, the Indians, the South Africans. A spot near a cave was doubtless thought a good place to encamp, the mere shelter of an overhanging ledge would mean comfort, and happy must have been the family in Quaternary times who could establish a right of possession, either for a single season or for several. For a residence of a few weeks at a time, such caves were doubtless convenient; so they would be now for a party of pot-hunters. But if anybody says our ancestors lived continuously and exclusively in caves both dark and wet, on floors reeking with the foulest of smells, which would revolt his senses and destroy his body—let us hesitate to believe him. Was there no rheumatism or phthisis to be feared—no typhoid or malarial fever to be avoided? Possibly the caves may have been used as store houses for a settlement or a group of families encamped near by. During a period of rain or snow or tempest, work could be carried on there, they would be as stores where fuel could be kept dry, and, in summer, carcasses of animals would keep, better than outside. Perhaps the fires were for smoking and so preserving some kinds of meat. During continuous rains the cave might be the temporary kitchen for several families or the whole. This view raises man in all prehistoric epochs, of which we have relics, to a higher plane than that usually assigned to him—so much higher, indeed, as to lead to the belief that in tracing with reasonable accuracy the habits of these ancient tribes, we can find guidance in the local customs of several isolated European districts in this very year of grace—survivals probably from the remotest epochs.

THE OCCURRENCE OF GOLD AND SILVER IN GALENA AND IRON PYRITES.

By R. Dewar.

(Read 29th November, 1890.)

Galena occurs principally in the Silurian and Carboniferous ages. In America deposits occur in the Lower Silurian, Canadian period, and Calciferous epoch, and in the Trenton period, and Trenton epoch. In the Upper Silurian, the Niagara period, and Medina epoch, Carboniferous age, Subcarboniferous period in Missouri. In Europe in Lower Silurian, in the Lower Llandeillo, in Shropshire, in Caradoc formation, in Montgomery and Cardiganshire, in Stage D of Barrande at Priyibram, in Bohemia, in Granada, Jaen, and Sierra DeGador, at the foot of the Sierra Nevadas in Spain.* The deposits at Leadhills, Lanarkshire, Scotland, are also of the Lower Silurian age. Devonian in Devon and Cornwall, in England; Lower Devonian in the Hartz at Andreasburg, and Clausthal; Upper Devonian at Vedrin, in Belgium.

In Carboniferous age, Subcarboniferous period, in mountain limestone in Cumberland, Durham, Northumberland, Yorkshire, Derbyshire and Flintshire, in England; and in county Wicklow, Ireland.

The only deposits of any importance which lie outside of the palaeozoic time are those of Bleiberg and Baibel in Carinthia, Austria, which are supposed to occur in rocks of the Muschelkalk age.

Iron pyrites is found in rocks of all ages from the oldest to the most recent formation.

Galena and iron pyrites are very often found associated with one another.

Both of these sulphides have in some instances been deposited from solution as is attested to by their being found in indurated clay, and in nodules of chalk in clay ironstone from the coal measures; pyrites is even found as galena is, quite commonly as sheets or coatings between the layers of bituminous coal and also on anthracite, as well as pseudomorphs of both animal and vegetable origin.

Galena is found in granite, sandstone, argillaceous and limestone rocks. Its matrix is generally either quartz, fluor spar, baryta, or calcite.

*De Verneul thinks this formation is Triassic.

Galenas occurring in the older crystalline metamorphic rocks are more auriferous and argentiferous and continue to a greater depth than those occurring in limestone, for instance, the galena from the mountain limestone of Cumberland, Derbyshire, etc., although it contains silver is not to be compared with that from Devon or Cornwall, which occurs in metamorphic clayslates or killas; formerly some of the veins in Cornwall produced from 80 to 140 ozs. of silver per ton of ore.

Philips gives in 1874, the statistics as 4,098 tons of lead containing 207,700 ozs. of silver for Devonshire. Before proceeding further, I may say that there is not in existence either galena or iron pyrites in which either gold or silver does not exist. I should mention that I would have incorporated the results of a number of tests made by me for those metals in both these minerals, but Percy has in his Metallurgy of Lead a table, which shows the results of his research in this direction which I do not propose to improve on. When I speak of the presence of these metals, they may either be there as mere traces or may be in such large proportion as to warrant their working; for instance Philips makes mention of the Morro Velho Mine in the province of Minas Geraes, in Brazil, as being the largest and most prosperous in that country up to the year 1863, it having produced since the year 1839, a net profit of one million sterling to its proprietors, but at that time was stopped by the combustion of the timber work, supposed to have originated from the oxidation of pyrites, the workings being on auriferous pyrites. At the present time, quite a portion of the annual production of gold is obtained from pyrites. Veins of pyrites are generally oxidised to a great depth, although in some places they are found normal with merely a surface oxidation; the results are generally Ferric Oxide, Fe_2O_3. Hydrogen Sulphides, H_2S, and Sulphur Dioxides SO_2, the excess of these products of oxidation is carried away by circulating surface or subterranean waters, and leaves with the matrix some of the ferric oxide and the greater part of the gold. A good illustration of those facts is the Mount Morgan Gold Mine in Australia, where the ore, if it may be so called, is a siliceous sinter containing gold in a very finely divided state, which has resulted from the oxidation of pyrites, which is proved by the matrix being a siliceous sinter, as the intersticial or honeycombed appearance of same is due to the crystals of pyrites which once filled same having oxidized. In the Lake of the Woods, in Ontario district, especially on the margin of the lake and also in the lake itself, there is a ferruginous earth, which contains considerable gold and which is said to exist in considerable quantities. The gold exists as nuggets as well as in a finely divided state, this also, I believe, has originated from the decomposition of iron pyrites.

Now the gold and silver may have existed in different states preceding the Palæozoic time. It is to be supposd that these metals would be among the first of the elements to condense on the now solid earth's surface or at least long before the gases which are the constituents of water, had reached a temperature favorable for their combining to form that liquid. Now, then, the water when it condensed on the earth would be at a temperature of 100° C. This would certainly take in solution alkaline sulphides and carbonates, provided they were present, and we have grounds to believe that they were. This would attack and dissolve any silica or quartz that it came in contact with, and also in turn attack and dissolve gold. Again, were fissures to open into these seas and mineral or rock matter, we may say gold in a molten state to issue therefrom. The gold would be caused to fly into thousands of small particles which would flatten into sheets when coming in contact with solid bodies, failing to do this, into, small spherical bodies. The gold in this state would be more easily attacked by the foregoing solution; this solution would also dissolve other metals and minerals such as fluor spar and baryta.

I am not exaggerating when I say that it was possible for free chlorine to be present in large quantities in those waters, this, which is the greatest solvent of gold, would certainly attack all it came in contact with. The principal solvents of silver would be chlorine and sulphur solutions. Or, another theory which may either be taken in conjunction with foregoing or independent of it, is, that these metals may have still remained in the metallic state and have lain under superimposed bodies of rock; then during hydrothermal activity, the gold, silver, lead and siliceous rocks would become melted; some of the gold would combine with the silica to form silicate of gold which is a soluble salt, also if a body of sulphur was present, it would combine with the silver, lead and gold to form sulphide. This, then, may have cooled and lain until further subterranean movements caused a fissure to open, or the fissure may have been open during the hydrothermal activity when the fused or liquid masses carried along by aqueous or other vapors would be attracted towards the fissure, as it would be a vacuum compared with the surrounding body of rock and would be deposited on the walls, forming a vein of segregation.

In support of the foregoing, according to Daubree, Lenormant and others, water under pressure at 204° C. will reduce to a pasty condition almost all ordinary rocks. Daubree has shown that all siliceous rocks in the presence of small quantities of superheated water (say about 10%, which is equal to water of sedimentation), become pasty at 204° C., and

426° C. become fluid. Under normal conditions these rocks require from 1371° C. to 1649° C. to liquefy them. If any alkali were present the figures would be considerably reduced. This is termed hydrothermal fusion.

Further, by fusing lead and sulphur together we can make artificial galena, the same is true of silver. We also are able to form silicate as well as sulphide of gold in our laboratories. That silicate of gold exists in nature I was first led to believe by finding that metal in quartz, which, before treatment, had not the least appearance of containing it, and I subsequently found that my results justified me in believing that I was right in my conclusions, and last but not least, as I have before mentioned, that galena veins are very rich in one stratum, but on entering another, provided it has a different composition, they become very poor, thus sustaining my theory that the entire vein matter was originally incorporated in that stratum of rock which forms the wall rock of that part of the strata which has the greatest body of metal.

Again, the gold may have been reduced by erosion to small grains and in time become disseminated through the debris of its disintegrated matrix, thus forming stream gold of which we have examples in our placer mines of California, Australia, Siberia, and other places. Now, were ferrous or ferric sulphate, Fe. SO_4 and Fe_2, 3 SO_4, to percolate through this gravel they would certainly dissolve a large portion of the gold, thus preparing a solution for the formation of auriferous iron pyrites. For the origin of the ferrous and ferric sulphates we have iron pyrites, which is ferric sulphide Fe. S_2, which would lose half its sulphur at a white heat forming ferrous sulphide Fe. S; this, when heated in air would form the sulphide, or else these changes might be brought about by atmospheric agency, as I have mentioned in a foregoing part of this paper.

We will now consider those deposits of galena which occur in non-metamorphic rocks, which are principally in limestone, a good illustration of which are the lead regions of Missouri and Wisconsin, which are not, properly speaking, veins, but have been formed by surface solutions containing the galena and accompanying minerals, namely, calcspar, baryta and chert in solution. The solution was probably an alkaline carbonate or sulphide, as these are the natural solvents of the foregoing minerals. As I before said, these deposits are not to be compared to those which occur in the older metamorphic rocks as regards the amount of silver or gold they contain, but are invaluable as lead producing deposits.

Taking it for granted that the principal body of metal was buried

under superimposed strata of deposited sediments or igneous rock matter, then it is apparent that the material for the nonmetamorphic superficial deposits would have to be drawn from the already formed veins of segregation, and I know of nothing that would influence me to view this negatively as native lead when found, or, properly speaking, as far as has been found, up to the present, has resulted from the decomposition of galena which is undeniable.

To proceed, the galena was not leached from the older veins nor yet carried in solution as sulphide of lead by alkaline sulphide or carbonate solutions, simply for the reason that it is not soluble in those solutions as some geologists would like to believe. Gold is the only sulphide of the metals we are treating of, that is soluble in an alkaline sulphide. Then what possible state would be the most convenient? I have come to the conclusion that the following would be possible, as well as soluble, under the conditions which I shall hereafter give, namely: the lead as chloride, sulphate carbonate, or in metallic state the silver as metallic or chloride, the gold, the chloride, metallic sulphide or the necessary solvents would be alkaline, chlorides, hyposulphites and carbonates; the sulphate of lead and chloride of silver would be soluble in the hyposulphite, the chloride of gold and chloride of lead would be soluble in water; but you will ask me where is there a possibility of any of these solutions existing as well as some of those salts, especially the chloride and hyposulphite solution? Allow me first to remind you that three-quarters of the earth's surface is submerged under what may be called a solution of an alkaline chloride, and as to the hyposulphite solution, active volcanoes always produce sulphur dioxide, Si. O_2, water in the vicinity of those is generally charged with this gas, which combines with it to form sulphurous acid; this again would combine with another atom of sulphur, providing it were present with the necessary heat to form hyposulphurous acid. The following equation would show reaction :—

$$SO_2+H_2O+S=H_2S_2O_3,$$

or the oxygen could be replaced by sodium—

$$=Na_2S_2O_3$$

This may seem a rather complicated process and might be thought unpractical, but when we take into account the vast amount of action exhibited by sulphur springs, we cannot help admitting it to be possible. A good illustration of those springs is one described by Dr. Beck, as existing at Manilus, in the State of New York, which is, according to him, one mile and a half long, half a mile broad, and 168 feet deep; a spring like this would furnish material, allowing us to dispense with the volcano. A spring such as this possibly existed at the bottom of a silurian or carboniferous sea. We have an example of such off the coast

of Florida, with the difference that it is a fresh water spring. As for the salts, galena is oxidized from the sulphide to the sulphate and further to carbonate by atmospheric agency and surface water containing carbon dioxide. In the first place the gold would exist as sulphide in the galena; on decomposition it would be converted into the terchloride by chlorine, as also would the lead and silver to their respective chlorides. But the enormous power of carbon dioxide, assisted by heat, has been overlooked in works on chemical geology, or rather the power, especially of alkaline carbonate. The carbonate of lead being soluble in an alkaline carbonate would be carried along by currents until, perhaps, passing where the waters of a sulphur spring emerged into the sea, or lake, or perhaps the spring burst from the bed of same, these waters being charged with hydrogen sulphides, that gas, or rather solution of gas, would decompose the carbonate as follows:—

$$Pb.\ CO_3 + H_2\ S = Pb.\ S + H_2\ CO_3,$$

thus forming carbonic acid and sulphide of lead. Then the process involved taking the hyposulphite solution as agent would be as follows: The silver having been converted into chloride would be dissolved by the sea or lacustrine hyposulphite solution, it was also possible for a spring of fresh water, such as I have mentioned, to have existed in those seas or lakes; hence, were this solution to pass through this pillar of ascending water, or at least some of it, to be mixed with this solution, then the silver would be precipitated as sulphide, the reaction is as follows:—

$$Na_2S_2O_3 + Ag.Cl. = (Na.Ag.)S_2O_3 + Na.Cl.$$
$$(Na.Ag.)S_2O_3 + H_2O = (Na.Ag)S + H_2SO_4.$$

This may then have come in contact with chlorine, decomposing part of the solution which would again be reduced to silver chloride, and carried along in suspension. In proof of this we have the deposits in Peru of chloride of silver occurring in amorphous masses of sulphide of silver; the chloride of silver also occurs in Peru in the ferruginous rocks called pacos, called in Mexico colorados, and in Cornwall by the Cornish miners, gossan; the chloride of silver of Huelgoet in Brittany, is similar to this, occurring in cavernous hydrated oxide of iron. This pacos is said to have resulted from the oxidation of iron pyrites. Now, it is quite apparent that this chloride was not carried there by the solution containing the constituents for the formation of the iron pyrites, that is in solution, but it is possible that it was carried there in suspension, or that a hot alkaline chloride solution may have had it in solution and coming in contact with the solution, destined for the formation of the pyrites which we may say was cold, or at least at a lower temperature than it; the silver chloride

would be precipitated. Then the vein matter being formed it may have been deposited on the bottom of one of these seas or lakes or the solution carrying along in suspension or solution the vein matter may have issued from the lake by some outlet and may have passed through some fissure which contained detritus. It is certain that a great part of solution would be left to form a vein. We have such veins in the vicinity of Zellerfield and Clansthal, in the Hartz, the gangue being made up of a breccia of country rock which is a clay slate cemented together by baryta, calcite, quartz and carbonate of iron, it is veins of this description that the galena occurs in at that place. In conclusion, allow me to say that we are too quick at condemning processes which, perhaps, seem impracticable in our laboratories, but we should not forget that we are comparing the finite with the infinite; we must remember that when our Creator, God, had the power to resolve this universe, of which we form a part, from a void; he certainly had the power to form laws, the beauty of which our feeble conception can scarcely grasp, and that these laws operated at his will. Man is slowly gaining an insight into those laws and is making them his servants in the metallurgical treatment of the treasures of the mine as well as in other branches of science, instances being the chlorination and hypo-sulphite processes. The vast extent of these processes carried on by nature is better understood when we take into consideration such deposits as for instance at Huelgoet in Brittany, where, although the principal ore is an argentiferous galena, yet the deposit which I before mentioned yields 30 oz. of silver per ton as chloride, and the pacos of Peru, although having been worked for two centuries, at the beginning of this century had not been penetrated to a depth of 100 feet.

NOTE.—In confirmation of the statement in regard to sulphide of gold in this paper, I may say that three days after reading same I was examining a piece of quartz containing pyrites, when, on turning the quartz in my hand, I noticed a dark powder in a crevice which appeared to be plumbago, but on close inspection, and on making an analysis, I found it to be a ferrous sulphide Fe, S, containing sulphide of gold; the pyrites proved to be iron pyrites containing arsenide of nickel and traces of gold; the vein from which it was taken had walls of diorite.

REFORMS IN TIME RECKONING.

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(Read 21st March, 1891.)

It is only within the last fifteen years that special attention has been directed to the unsouud principles, the untenable theories, and the curious old usages which still in many quarters prevail with respect to time, its measurement and notation. In spite of the advance in science in other directions, which makes the incongruities in question the more remarkable, we have remained until now rooted in observances which cannot be defended on any rational or scientific ground. We do not suppress our ridicule at many ancient customs which at the present day appear to us absurd ; nevertheless we remain blind to the fact that some of our practices in the reckoning of time, are not less irrational, and are based on theories which cannot be sustained.

The three great divisions of time, with which we are most familiar, are the year, the month, and the day: the latter is the smallest measure of time revealed to us in nature, and is dependent upon the diurnal rotation of the earth. Although the subdivision of the day is of extreme antiquity, at one period in history hours were unknown. The word hour is not found in Plato or in Xenophon. It is first met with at the period of the Macedonian rule at Athens. In the early literature of Greece, the Hours (Horai) are mentioned, not as the divisions of the day, but as the goddesses of the Seasons, as maidens of beauty bearing the products of the earth, and attendant upon Venus as she rose from the sea.

With a primitive people, the crowing of the cock was a means of making known the early dawn ; and the position of the sun in the heavens enabled mankind to estimate the passage of time during the hours of sunlight ; the progress of night was determined by the position of the stars. By such rude means a rough approximation was obtained of known intervals during the passage of night and day.

The separation of the day into two series each of twelve hours took its origin long before the Christian era. The Arcadians counted the night from sun-set to sun-rise by a subdivision of twelve parts determined by the observed stars or groups of stars which appeared at

intervals in the eastern horizon, and the intervals were thus denoted with proximate accuracy. By analogy the day from sun-rise to sun-set was similarly subdivided; hence the division of the diurnal period embracing day-light and darkness, into two portions, each of which was subdivided into twelve hours. The modern practice differs from ancient usage only in the initial points of division. We reckon from mid-day and midnight instead of from sun-rise and sun-set. The ancients had an absolutely distinct reckoning for the night, and another for the day, and they employed for the duty of observation during these periods two distinct classes of watchers.

Both in Greece and Rome "gnomons" were erected in open ground for the public benefit, the length of the shadows of which denoted the several hours. Magistrates were charged with the duty of watching the shadow, and announcing in a loud voice the moment of mid-day, morning, and evening. A few persons of wealth maintained their private gnomons with slaves to watch the progress of the shadow, and at intervals to announce its length. It is generally supposed that the great obelisks of Egypt, examples of which still remain, were the clocks of the ancients. One fact was early noticeable, that the gnomon or obelisk, whatever its length, and whatever the season, cast its shortest shadow at an invariable period of the day, and thus mid-day naturally became established at an early date as an important point of time.

An advance was made in the art of measuring the passage of the sun by the introduction of sun-dials, by which a greater degree of precision was obtained. Herodotus tells us that the concave dial and the ordinary sun-dial were brought from Egypt, with the division of the period of direct sunlight into twelve parts, all of which "the Greeks learned from the Babylonians."

Obviously the hours, being each a twelfth part of the two intervals between sun-rise and sun-set, varied in length in the different months. Throughout the temperate zone, hours determined on this principle would constantly vary. In one half the year the hours of the night, in the other half those of the day, would be the longest. Only twice in the year, that is to say, at the equinoxes, would the hours be of uniform length. In some parts of the temperate zone the hours in summer would be, under this system, double the length of the hours in winter, and *vice versa*. As the reckoning began with sun-rise and sun-set, these epochs coincided with the twelfth hour of the previous half-day. Mid-day and midnight each would be the sixth hour of the respective days and nights.

Gradually mechanical contrivances were introduced to overcome the

impossibility of observing the time by the sun or stars during cloudy weather. The first mechanical means employed was the flow of water, drop by drop. Mechanisms of this kind named by the Greeks clepsydras, were of various forms; in one class the flow of water was weighed, in another the volume was measured. The clepsydra was introduced into Egypt at the time of the Ptolemies; from thence it found its way to Greece and Rome.

In these mechanical movements, and in others which followed in later years, it became necessary to introduce complicated contrivances to mark the variable length of the hours as the seasons advanced. Such is the invincible power of habit that it exacted a continual change in the movement of time-keepers in order to secure a notation of the unequal hours. To denote these ever-varying intervals by machines of regular motion, demanded all the inventive powers and skill, which the pertinacity of human ingenuity could call forth, to meet this requirement. It will readily be understood that the ancient water clock was a great and cumbrous contrivance, possessed only by royal personages, or men of large wealth, and was regarded by the people of that age as a product of much intellectual culture, and an evidence of the advance of civilization.

In the cloisters, the monks contrived to denote the passage of time by the consumption of oil in lamps graduated for the purpose; elsewhere by the burning of candles, upon the wicks of which were placed a series of knots at calculated intervals to mark periodic duration. In course of years sand glasses were introduced, some of which were regulated to be reversed at the end of each half-hour; in which case it was indispensable to have watchers continually in attendance to turn them forty-eight times during the twenty-four hours.

The great defect of all these contrivances was, they had no principle of continuity, and incessant watchfulness had to be observed. An effort was therefore made to supersede the dropping of water, the consumption of oil, the running of sand, and the burning of tapers, by having recourse to suspended weights, and the introduction of wheelwork which should move with regularity, and chronicle the hour. In 1288, one of these machines was installed at Westminster Hall, which drew forth the admiration of the people of London. Half a century later a similar mechanical combination was erected at Dover Castle; about this date wheelwork clocks were placed in the Church of St. Gothard, at Padua, and at different points in Europe.

In every one of these complicated mechanical contrivances the exigencies of "use and wont" had to be taken into account. Public opinion

of those dates would not countenance the adoption of hours of uniform length throughout the year. It was exacted that hours of the day and night should remain distinct, and should vary with the change of seasons. So late as the fifteenth century this strange usage of counting the passage of time by hours of unequal length remained in force. Gradually its absurdity became apparent, and the practice was introduced of allowing the clocks to continue their movements at the same rate night and day, commencing the reckoning as before at sunset.

Although the hours were no longer required to be variable in length, the commencement of the day at sunset continually varied with the seasons. The necessity therefore remained of moving the hands of the clock forward or backward nearly every day, or as it frequently happened the assumed error was allowed to accumulate until it reached a quarter of an hour. The total error in the latitude of Greenwich in any half year was about four hours and a half; an error which was reversed each half year, as the seasons changed. The same practice prevailed generally throughout Europe, and the total discrepancy was greater or less than four and a half hours according to latitude.

This continual adaptation of the hands on the dial was known as "the leap of the clock" (*sauter l'heure*), and however perfect the mechanical arrangements, it was in vain, under such a system, to look for precision or uniformity of reckoning.

The incessant interference, the daily application of thumb rule to move the hands sometimes forward, at other times backward, an operation termed "regulating the clock by the sun," to meet the daily changing period of sunset, required so much attention that the ingenuity of skilled men was directed to obtain some means of effecting the changes automatically. M. Houzeau, in a lecture before the Royal Belgium Geographical Society, March, 1888, remarks on this point:—"Never was human ingenuity expended upon any subject so irrational and of such little merit. But habit which had lasted for centuries was at stake, and habits never reason, they exact" Towards the end of the last century these wonderful machines with automatical complications for pushing forward or retarding the hours were objects of admiration in most of the capitals of Europe, and so late as 1806 an honorary distinction was conferred by the French Emperor Napoleon I., on the inventor and maker of a clock possessing the proper increment needed to change with accuracy the hands on the dial every day at all seasons.

Some years before this date, the question was being asked, what advantage results from having a daily change in the initial point of the hours, why not have uniformity, summer and winter, as well as

night and day? The spirit of enquiry eventually resulted in the introduction of what we now call "mean time," but to effect the change was a matter of great difficulty. In the words of M. Houzeau:—"It was a greater revolution than we are now capable of imagining. There was between this uniform time, which we call "mean time," and the time of the people or of the sun, sometimes the difference of a quarter of an hour. Out of this divergence the populations created a scarecrow at which we are forced to laugh. The mid-day by the sun, or the middle of the day, will no longer, they said, accord with twelve o'clock. Tradesmen, day laborers, will be bewildered and their work disarranged. The forenoon will be sometimes longer, sometimes shorter, than the afternoon. Bakers deceived by the clock will no longer be ready in time, and the people will be in want of bread. I in no way exaggerate, but is not this the history of all reforms? And what did the fears amount to? We have to-day "mean time," without the immense majority of our contemporaries having the least idea that any other notation was ever followed."*

The introduction of mean time into common use was only effected after much opposition. It took its origin in Geneva in 1780, and slowly made its way. In London the variable hours ceased in 1792. It required another eighteen years to overcome the old custom in Berlin, and it is difficult to believe that Paris did not renounce the daily alteration of its clocks until 1816.

We smile at these practices, now happily no longer prevailing, which came down from antiquity, and wonder at the persistency with which they were clung to, even after their absurdity became recognized. Another generation may perhaps laugh at those living in this century for adhering to customs not less open to ridicule.

What reason can we give for using the double series of hours, repeating one to twelve in each half of a single diurnal period; a practice which originated in primitive times, the purpose and significance of which have long since been forgotten? Who in this railway age would think of regulating the movement of trains by the shadow of the sun during the day, or by the progress of the stars during the night?

Again there is a general belief throughout Christendom that Sunday is simultaneous over the world. What would the rigid Sabbatarian say if told as a matter of fact that Saturday extends into the middle of Sunday, and Monday begins when Saturday ends? and while this is actually the case, Sunday itself extends from the end of Friday to the first hour of Tuesday, ranging over forty-eight hours? Further, that the same ano-

* Translated from Houzeau, Histoire de l'heure, pp. 182-3.

maly is common to each of the seven days of the week? Again, "local time" is a familiar expression, but it is entirely incorrect. There is no such thing as local time. The expression "local time" is based upon the theory that time changes with the longitude; that each meridian has a separate and distinct time. Let us follow this theory out. Take a hundred or a thousand different meridians. All meridians meet at two common points, one in each of the hemispheres, the poles, so that at each of these points we would have a hundred or a thousand different "local times." This only requires to be stated to establish the impossibility and absurdity of the theory that in nature there is a multiplicity of "local times." Why do we use the terms "astronomical time," "solar time," "sidereal time," "nautical time," "mean time," and so on? Expressions which imply plurality of the conception which we call time? Let us endeavor to make clear that these terms are misleading, by asking what time actually is.

It is less difficult to say what it is not, than to define what time is. This much we know, it is neither fluid nor solid; it has no body or spirit; it is not distinguishable by any of the senses; we can only form a conception of time by its passage; it is nevertheless a reality with an infinite past and an infinite future. Continuity is its chief attribute; it may be likened to an endless chain composed of an infinite number of links, each link inseparably connected with its fellow links, while the whole moves onward in unalterable order. Unlike material bodies, time cannot be divided into separate parts, to constitute two or more distinct portions or classes of duration, in the sense in which solids and fluids can be divided; it may be likened to a stream diffused throughout space, which uninterruptedly flows uniformly onward, and more than one such stream is inconceivable. If time cannot be divided into separate parts, it may be divided in another sense, but the divisions are not interchangeable; it is not possible for any one division to be displaced, or any two divisions to be transposed; divisions of time cannot like books in a library be classified and arranged in separate shelves, or be changed from place to place; they cannot as soldiers in a regiment fall out of position in the ranks; all divisions and sub-divisions of time remain in an unbroken line, they advance in single file, never to pass out of consecutive order. Time remains uninfluenced by matter, by space, or by distance; it is universal and essentially non-local. There is only one time, and its divisions can never be found side by side; they only follow one another. Different times, so-called, are merely divisions of the one time; they do not co-exist, but are parts of an inseparable whole. Time is an absolute unity, the same throughout the entire universe, with

the remarkable attribute that it can be measured with the nicest precision.

If we accept the cardinal idea running through this definition that *there is one time only* we will find ourselves on solid ground, and we may proceed to build up on the fundamental principles of unity and unbroken continuity a scheme of reckoning to meet all reasonable demands which may be made upon it, in this and succeeding generations. The problem would be easier of solution were there no existing customs to overcome, and we had to begin *de novo* to establish the best means of accomplishing the desired purpose.

As we are circumstanced in the world's history, we have to accommodate the reform of to-day to such of our inherited usages as are not at variance with essential principles, or do not materially affect their application. If, for example, circumstances admitted, we might with advantage introduce the decimal system as a notation to be followed, but we already use the duodecimal combined with the sexagesimal division, and force of habit seems to require, that we should, as far as possible, adhere to the existing system in this respect, at least so far as it is not at variance with sound principles and the general convenience. It is obviously indispensible that we should refrain from any meddlesome interference with confirmed usages, or suggest changes not manifestly called for.

The advance of civilization during the past half century has produced entirely new conditions in human life. Steam and electricity applied to communication by sea and land have done much to obliterate distance, and bring all nations, so to speak, within one neighborhood. Through force of circumstances, therefore, we are obliged to take a comprehensive view of the entire globe in considering the question of time-reckoning. It is no longer possible to limit the subject to a narrow and sectional aspect. The progress of the age demands that we should not confine our view to one limited horizon, to one country or to one continent. The problem presented for solution to the people of both hemispheres is to secure a measurement of the one universal passage of time common to all, which shall be based on data so incontrovertible, and on principles so sound, as to obtain the acceptance of the generations which are to follow us.

To effect any measurement there are two essentials; first, a starting point or zero; second, a scale or a unit of measurement. The Washington Conference of 1884 has determined both a zero and a unit. The zero is the instant of mean solar passage on the anti-prime meridian

which is 180° from the meridian of Greenwich. The unit is the smallest and most available measure of time which nature presents to us; the period occupied by a single rotation of the earth on its axis, and is denoted by two successive solar passages on the zero meridian.

The "universal day," as defined by the Washington Conference, is actually the time unit, but the term "day" is unfortunate and misleading.* A "day" is always associated with sunlight and darkness, and is in fact a local and superficial phenomenon. Every separate meridian which can be laid down on the surface of the globe has its definite day with the accompanying and distinct sun-rise and sun-set in each case. It is important to disassociate the normal unit, the standard measure of time for the world, from our ordinary conception of the day. In order to do so and make clear the fundamental idea of unity of reckoning, it will answer our purpose to find a point of reference equally related to the whole globe. The centre of the earth is this one point identical in relation to every spot on the surface. If we could directly communicate with a standard chronometer at the centre to regulate clocks in all latitudes we would have the means of obtaining the perfect unification of time-reckoning the world over. Is there no other point where we could establish a common standard? Is not the axis of rotation which passes through the earth's centre common to the whole earth, and would not any point on this axis furnish the position we are in search of? Let us accordingly take one extremity of the axis, the north pole, and in imagination place ourselves in observation at this point, free from local influences. We would find no sun-rise, no sun-set, neither east nor west, every radius of direction would be identical. We would have nothing given but the position of the meridian establishing the time-zero; from this starting point suppose we divide the horizon into a series of arcs, each of fifteen degrees, making the total number of arcs twenty-four, and through the end of each arc we draw a meridian. The passage of the sun over the zero meridian will indicate the commencement of the time-unit which, according to the usage of centuries, and the decision of the Washington Conference, is divided into twenty-four hours. At the end of the first hour the sun will be over a meridian which may appropriately be termed the *first* hour meridian; at the end of the second hour the solar passage will have advanced to another meridian, which may be distinguished as the

* The question of a proper name for the "time unit" has been considered by the Royal Society of Canada at its May meetings in 1890 and 1891. A time nomenclature committee has been appointed and some progress has been made in this, as well as the question of distinguishing the hour meridians.

second hour meridian; at the end of the third hour it will be on the *third* hour meridian, and so passing over the whole twenty-four.*

This mode of distinguishing the hour meridian, possesses peculiar advantages which will be made plain on reference to the diagram, showing a projection of the northern hemisphere. The figures around the circumference indicate the new meridians numbered as described. The same figures indicate the twenty-four hours into which the world's standard unit measure of time is divided. The motion of the earth on its axis brings each hour meridian in succession to its solar passage, and a complete coincidence is obtained between the hour meridians and the hours of the world's standard. For example, when the solar passage is on hour meridian number 12, it will be 12 o'clock; when on hour meridian number 17, it will be 17 o'clock, and so on for every meridian. Throughout each day the solar passage becomes the index of time common to the world.

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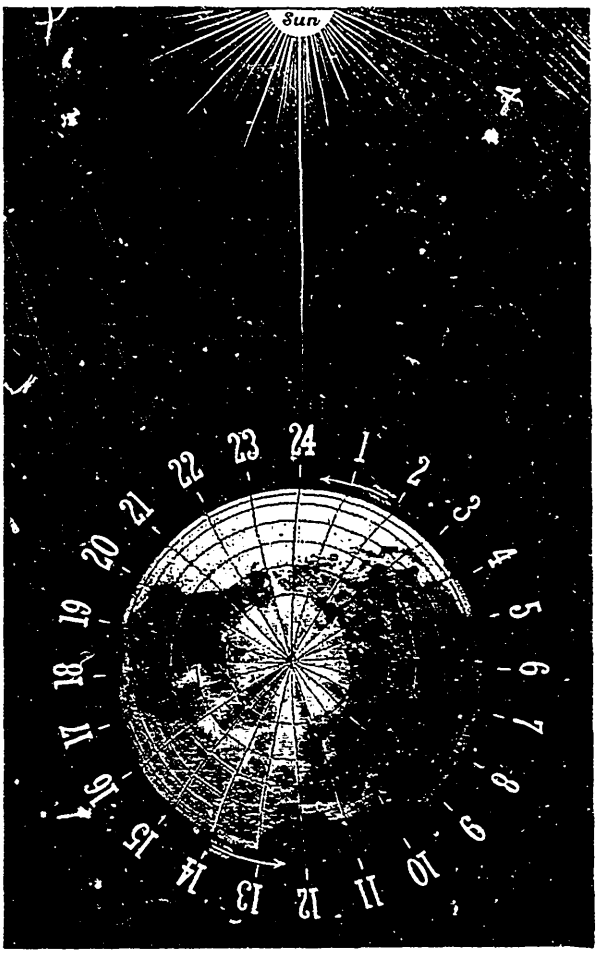
* The time nomenclature committee of the Royal Society of Canada has had under consideration the best mode of distinguishing the hour meridians. This committee reported, May 29th 1891, in favour of using numbers in preference to geographical or other terms, so as to obviate all confusion, numbers having the same precise meaning in all languages and being equally appropriate in both hemispheres. The committee likewise expressed the opinion, which was unanimously endorsed by the society, that the hour meridians should be numbered in consecutive order from the anti-prime meridian as zero, following the apparent motion of the sun towards the west, that is to say as follows, viz:

Anti-Prime Meridian	180°	East and West Longitude	Zero	—0—*Zero.*
Hour Meridian	165°	East Longitude, numbered	One	—1—*Unus.*
"	150°	" "	Two	—2—*Duo.*
"	135°	" "	Three	—3—*Tres.*
"	120°	" "	Four	—4—*Quatuor.*
"	105°	" "	Five	—5—*Quinque.*
"	90°	" "	Six	—6—*Sex.*
"	75°	" "	Seven	—7—*Septem.*
"	60°	" "	Eight	—8—*Octo.*
"	45°	" "	Nine	—9—*Novem.*
"	30°	" "	Ten	—10—*Decem.*
"	15°	" "	Eleven	—11—*Undecim.*
"	0°	Prime Meridian "	Twelve	—12—*Duodecim.*
"	15°	West Longitude "	Thirteen	—13—*Tredecim.*
"	30°	" "	Fourteen	—14—*Quatuordecim.*
"	45°	" "	Fifteen	—15—*Quindecim.*
"	60°	" "	Sixteen	—16—*Sedecim.*
"	75°	" "	Seventeen	—17—*Septemdecim.*
"	90°	" "	Eighteen	—18—*Octodecim.*
"	105°	" "	Nineteen	—19—*Novemdecim.*
"	120°	" "	Twenty	—20—*Viginti.*
"	135°	" "	Twenty-one	—21—*Viginti unus.*
"	150°	" "	Twenty-two	—22—*Viginti duo.*
"	165°	" "	Twenty-three	—23—*Viginti tres.*
Anti-Prime Meridian	180°	East and West Longitude	Twenty-four	—24 or *Zero.*

The Royal Society of Canada has by a unanimous vote recommended that the nomenclature proposed for the hour meridian be brought to the attention of scientific men and sister societies throughout the world, with the view of obtaining general concurrence.



Reference to the diagram will make it clear, that we possess in the earth itself, with the sun as the index, the infallible means of measuring time with precision for ever. The diurnal rotation of the earth is marked by perfect uniformity of movement, and we know of nothing more certain, than its continual recurrence to a given starting point within established intervals. Here, then, we have a great chronometer, which can never fail us, common to the world. Here, provided by

nature is a standard for the measurement of time, which humanity in all places and in all ages may accept.

The direct connection between each locality on the earth's surface and the world's standard chronometer is through the hour meridian. It is plain that when any given hour is indicated by the solar passage, the sun will be vertical over every part of that meridian in both hemispheres. Accordingly, the earth's surface being divided into twenty-four sections or zones, each extending seven and a half degrees on each side of its hour meridian, we obtain the means of establishing universally the one reckoning by the common standard. This has been termed the "hour zone system." By its use, the difficulties which have been referred to are overcome without any violent departure from our inherited ideas, and the exacting customs entailed upon us.

The unity of time is indisputable. Looking forward a few years, unity of notation may become indispensable; meanwhile, the present aim and object is to obtain in all civilized countries uniformity of reckoning. If a common notation were at once attempted throughout the world, it would come into direct conflict with the habits and customs which have everywhere prevailed from the first dawn of civilization. The hour zone system, while furnishing the easy means of transition to one notation, provides a way by which correct principles may at once universally be applied, and uniformity in time-reckoning substantially secured.

The hour zones theoretically extend seven and a half degrees of longitude on each side of the hour meridians, but an arbitrary enforcement of this limitation is by no means essential. The boundary line of contiguous zones must be governed by national, geographical, or commercial considerations, as expediency in each case will dictate.

The principles which underlie the hour zone system are: (1) that on the passage of the sun on any hour meridian it is held to be twelve o'clock (noon) throughout the zone to which that meridian belongs; (2) that the notation in each zone is directly connected with the common standard unit of the world by an established relationship. It is obvious, that if the notation in the several zones be thus connected with the world's standard, there will be a complete and systematic identification in the notation of each of the twenty-four zones. There will be differences, but the differences will in every case be known, the gradations being the invariable multiple of one hour. Throughout the globe there will be complete identity in the minutes and seconds. For example: when the reckoning is described in the tenth zone as 6 hours,

25 minutes, 30 seconds, in the eleventh zone it will be 5 hours, 25 minutes, 30 seconds, in the twelfth zone 4 hours, 25 minutes, 30 seconds, and so on, each successive zone differing in its notation by an exact hour. Thus it will be clear that the system is based on the one reckoning, according to a common standard of measurement and reference. The only departure from complete uniformity will be found in the nomenclature of the hours; but the numbers of the hours being governed by the numbers of the hour meridians, reference to the common standard will at all times be simple and direct.

The relationship established by this system, between the reckoning in each zone or section of the globe, and the world's standard, may for convenience be reduced to the following simple formula:

Let H be the number of the hour meredian, then

(1) In the zone of hour meridian 12 (corresponding with the meridian of Greenwich) the notation of the hours will agree with the world's standard.

(2) In all EAST Longitudes (zones to the east of hour meridian 12) the notation will be in advance of the world's standard.

Hours FASTER = 12—H.

(3) In all WEST Longitudes (zones to the west of hour meridian 12) the notation will be behind the world's standard.

Hours SLOWER = H—12.

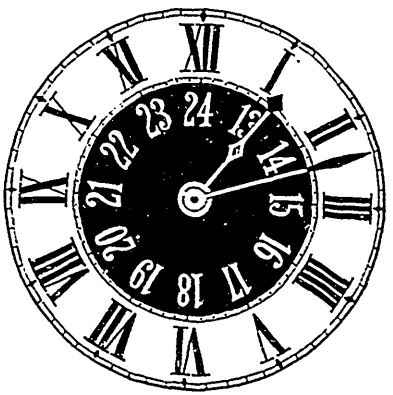
The number distinguishing an hour meridian will be the key to the notation in the zone of that meridian. The world's standard will be the mean of all possible zone notations.

The hour zone system has now been in use throughout North America for seven years, and in the Japanese Empire for two years. In England, Scotland, and Sweden, the reckoning is in accord with this system. In Austria-Hungary, Germany, and Belgium, by all accounts it is on the eve of adoption. Wherever it has been adopted, it has resulted in giving the greatest satisfaction; the hours recorded by the clocks are everywhere indicated at the same moment; the only difference is in the number by which they are distinguished in the several zones, with that simple exception, minutes, seconds, and every sub-division of time are synchronous.

Another important, although secondary, reform in regulating the reckoning of time throughout the world, is to abandon the division of the day into halves, these halves being sub-divided into separate sets of hours, known as *ante meridian* and *post meridian*. The proposal is to follow the recommendation of the Washington Conference with respect

to the "universal day" (the world's standard unit of time), which the representatives of all nations present determined, should be sub-divided into a single series of hours numbered from zero to twenty-four. The old custom of counting the day by halves has no more to recommend it than dividing the month into halves, a custom which prevailed in Europe before the fifteenth century. Each month of thirty days was divided into equal parts; each month of thirty-one days into a first part of sixteen days, numbered one to sixteen and distinguished by the word *intrante*, the second part of fifteen days numbered in reverse order, fifteen to one, and known as *restante*. But the division of the day into two sets of twelve hours similarly named has positive disadvantages. In these days of railways the possibility of error is increased by it, in itself no light consideration. In the printing of time-tables, or the giving and receiving of train orders, a misprint or misapprehension of a single letter may cause a mistake or mishap; while the degree of uncertainty which in some cases exists, may lead to confusion, and confusion not infrequently results in consequences more or less serious.

The twenty-four hour notation, so called, removes all doubt, and assures safety. The change from the old custom is easily effected, and without danger. Experience has established that timepieces now in use can readily be adapted to the new notation by inscribing on their dials the afternoon hours in some such manner as the diagram indicates.



Hours having a lower number than twelve are known to belong absolutely to the first part of the day; those having a higher number to the after part. The new notation has been widely used in Canada for four or five years, being exclusively employed for railway purposes in the Provinces of Nova Scotia, Prince Edward Island, New Brunswick, Manitoba, Alberta and British Columbia, and in portions of Ontario

and Quebec. It has quite recently been brought into use on all the railways within the Indian Empire and in China. Everywhere it gives the greatest satisfaction. According to a report submitted at the last annual meeting of the American Society of Civil Engineers, there is every prospect of the new notation being adopted on all the railways of North America at an early day. The same report points out that while at the beginning of 1890 it was in use on less than 4,000 miles of railway, before the year closed the twenty-four hour notation was permanently adopted on more than 20,000 miles in America and Asia.

If we consider the length of time exacted and the difficulty of effort to effect some of the reforms in time-reckoning to which allusion has been made, we may well be surprised that so much has already been accomplished towards this final reform. Only a few years ago the proposal to interfere with the time honored usage, whatever its necessity, was received with derision. It soon became obvious, however, to men of broad and advanced views, that great changes in time-reckoning and time notation would soon be demanded as requirements of the new conditions of human life. The Congress of the United States intervened, and on the invitation of the President a conference of all nations was held at Washington in 1884, when the subject was first authoritatively considered. Congress is again taking action, by entertaining a measure recently introduced to legalize the changes already effected and contemplated.

In 1878, when an earnest attempt was made to bring the subject of "time reform" to the attention of the British Association for the Advancement of Science, it was looked upon as pure utopianism, and a hearing for it could not be obtained. To-day the British Government, ordinarily conservative in ancient usages, has forwarded to the Governments of every British possession around the globe, the recommendations of the highest scientific authorities in its service "with a view to the adoption of the Hour Zone system in reckoning time generally, and of the 24 hour notation for railway time tables."

There have been other reforms besides those mentioned in the foregoing pages; the most memorable of which were those of Julius Caesar, B. C. 46, and of Pope Gregory XIII., A. D. 1582. The former introduced regulations respecting the division of time which were rendered necessary by the confusion which then prevailed. The latter corrected certain defects which had crept in, in connection with the Julian Calendar, and established new rules of intercalation, regarding the period known as leap year or 'Bissextile." The reform of 1582 took effect in some parts of southern Europe soon after it was decreed, but so

much opposition was offered to it by popular prejudice, that one hundred and seventy years passed before it became law in England; and this reform has not yet reached Russia, where they still adhere to the old style.

The Astronomer Royal of Great Britain has pointed out how different to the past, recent experience has been. In evidence that the claims of truth and utility are now recognized to be above error and confusion, he draws attention to the breadth of view of the managers of the American railways, who were so largely instrumental in introducing the Hour Zone system, a reform calculated to benefit the world in all future ages. In 1886, at the Royal Institution, London, he paid them the well-deserved tribute that "they rose above national jealousies, and decided to have their time-reckoning based on the meridian which was likely to suit the convenience of the greatest numbers, thus doing their utmost to promote uniformity of time throughout the world, by setting an example of the sacrifice of human susceptibilities to general expediency."

A CONSIDERATION OF SEWERAGE SCHEMES.

By L. J. Clark.

(Read 7th March, 1891.)

The title of my paper will lead me to consider the subject under three heads.

I. A general survey of the position of sewage affairs in various parts of the world, particularly in England and Germany.

II. An elucidation of a gravity scheme for Toronto; and

III. Some general defects in sewerage works, and also some weak points in the scheme at present before the city, if time will permit.

A member of the Institute placed in my hands a work on Sewage Disposal, by W. Santo Crimp, assistant engineer of the London County Council, England, with the remark that my tastes ran more in that line than his, and that I might extract something from it that would be of interest to at least some of the members of our society. I have found the book to be one of very great interest, as it contains the very latest information on the subject, having been issued but a few months.

By adopting a schedule relating to the details of sewage disposal, he is able to give the particulars of about forty towns and cities in England in very little space. The information relates, under the head of Sewage Treatment, 1. To *mode* of *disposal*, viz., by precipitation, filtration, irrigation, and direct discharge into large bodies of water. 2. To chemicals used, such as lime, alumino ferric or sulphate of alumina, &c. 3. Annual production of sludge in tons. 4. Disposal of sludge. 5. Tanks, precipitating, continuous or intermittent. 6. Acreage of land used. 7. Years in operation. 8. Closets, whether water closets, pails, privies, or ashpits. 9. Sewage flow every twenty-four hours. 10. Gallons per head. 11. Disposal of manufacturing waste.

Of course all these questions are not fully answered in every case; for instance under the head of Disposal of Sludge, twenty-four answers only are given, as follows:—Given away, 5. Dug into the ground, 5. Sold, 12. Burnt in destructors, 1. Pay for removal, 1.

This throws considerable light on the subject of utilization of sludge for manurial purposes. Many look upon the discharge of crude sewage into large rivers or other bodies of water as being an inexcusable waste;

but the statistics Mr. Crimp has been able to gather do not show that it is possible to obtain much profit from it. He says the manurial value of sludge is now admitted to be very low, and except in a few isolated instances sludge is recognized as a material to be got rid of in the cheapest manner. Furthermore, if it possesses a commercial value, commercial men may be safely relied on to utilize it. They can have the sludge for nothing, in any quantity. Let them take it and deal with it as they will.

Just here let me interject a somewhat novel proposition made with regard to the disposal of the London sewage, viz., by *steamship carriage*. It is intended to convey to sea, in specially designed steamships, the sludge produced from the London sewage. The great advantage of the method is that the sludge will never be seen. Precipitated in covered reservoirs, transmitted from these precipitating tanks to special settling tanks, from thence pumped into the sludge vessel and discharged far from land, the sludge will disappear in the most speedy, cleanly and safe manner that can be devised.

The objections to this system are threefold. 1. Waste of valuable manure. 2. Possibility of nuisance on the coast. 3. Delay in transit by fogs and stress of weather. The first objection has already been answered, commercial men would take care of it, etc. The second objection as to the possibility of nuisance on the coast is a mistaken one. Examine the point closely. Some 3,000 tons of settled sludge, equal to about 150 tons of organic matter, will be discharged per diem, under water several miles from the coast. This will not be discharged at one spot, but be spread over some thirty miles. Assume that the discharge from one vessel holding 1,000 tons, equal to 50 tons of organic matter formed a track when diffused in the water four yards deep by four yards wide, and ten miles in length; what would be the quantity of organic matter in that polluted line of water? Only 16 grains in each gallon. Given a gallon of water containing 16 grains of organic matter situated say, ten miles from the shore, and in a strong tidal way, how much offence will be given, after diffusion, oxidation, the feeding of fish, &c., have acted their part by the time it has reached the coast, if it ever does reach it? I think the objection is satisfactorily answered.

The third objection, delay by fogs and stress of weather is a trivial one. An increase in the capacity of the sludge settling tanks with reserved steam power, which must be provided in any case to guard against breakdowns, will effectually overcome this difficulty. If the whole of the enormous naval traffic of England can be carried on as it is, with almost mathematical precision, surely the carriage of a few

thousand tons of sewer sludge to the channel can be as readily accomplished.

While it is thus clear that in the case of the metropolis the conveyance of the sludge to the sea is the only available remedy, it by no means follows that under other circumstances, and where local conditions are favorable other systems are undesirable. Each case must be dealt with on its own merits, and according to local requirements.

I believe it was at one time the intention of the City Engineer to recommend a somewhat similar scheme for the City of Toronto, for a temporary relief, but no doubt the winter season here would interfere with such a scheme.

Reverting once more to the schedule we learn the average amount of sewage per head daily in these forty towns. It amounts to a trifle less than forty gallons per day. This is of importance, and will be referred to later on, as the size of the sewers should be proportioned to the amount of sewage they are intended to convey.

Under the head of chemicals used, the prevailing materials are lime and sulphate of alumina or alumino ferric. They are found to produce the best results when used in the proportion of 7 grains of the former to 5 of the latter per gallon. The lime is usually applied in the form of milk-of-lime, but better results are produced by using the lime in solution. Great care must be taken to apply just the proper quantity, and have it properly mixed. Machinery more or less complicated is used for this purpose, which it would be quite out of place to attempt to describe in a paper of this nature.

Under the head of acreage I find that on an average one acre of land is required for about 125 persons where sewage farms are established. Thus for Toronto would be required about 1,600 acres, and of course a corresponding increase would be required as the population increased. But even this is considered a low estimate. In Germany 100, and even as low as 75 persons to the acre is recommended. It is admitted by persons in charge of sewage works that the longer land is used for sewage disposal the more it becomes clogged, and the number per acre requires to be reduced.

Comparatively full descriptions of the sewage works of a number of towns and cities of England are given in Mr. Crimp's book, among which are the following: Doncaster, Croydon, Bedford, Dewsbury, Merton, Swanwick, Chiswick, Kingston-on-Thames, Salford, Bradford, Sheffield, Barnet, Coventry, Newhaven, Birmingham, and Dortmund, Germany. In order to arrive at an intelligent view of the case, and to be enabled

to draw conclusions therefrom, it will be necessary to give some of the leading features of a few of them :—

Doncaster, population 26,000. The farm is rented to a farmer at £2 per acre. The farm contains 264 acres. The cost of the works was £50,000. Pumping is required. The expense is £200 in excess of the revenue derived, without including interest or sinking fund on first outlay. Raw sewage applied.

Croydon has a population of 96,000, has two sewage farms, each under the management of a superintendent. The farms contain 525 acres. The sewage is screened but receives no chemical treatment. The cost of the works was £156,000. The annual expense including interest and sinking fund is £7,074 per annum. The sanitary conditions are good.

Bedford has a population of 25,000. The farm contains 223 acres. It is in the hands of a manager who is paid a salary and also receives 1 % commission on sale of produce. The sewage is applied in a raw state; annual deficit £243 ; no nuisance.

Dewsbury, population 30,000. Intermittent filtration is the method adopted. Effluent very pure ; people bathe in it. The farm contains 70 acres, and in favorable years, not too wet, pays its way, not including interest on first cost.

Merton, population 22,500. Farm contains 28 acres ; intermittent filtration practised ; annual expense over revenue £1,550.

Chiswick, population 21,000, has the separate system. Gardeners take the sludge free ; expense £1,572 per annum ; no returns.

Kingston-on-Thames, population 26,000. The sludge is manufactured into a fertilizer by the Native Guano Company, who receive a bonus of £2,442 per annum. This is the A, B, C process.

Salford, population 176,000. Precipitation works. The sludge is burnt ; annual expense, £3,000. No returns. First cost of works, £20,000, not included in the expense.

Bradford, population 200,000. Precipitation with intermittent filtration ; no pumping required ; sludge given away ; annual expense, £3,300.

Sheffield, population 310,000. Cost of works, £65,000 ; yearly expense, £6,000.

Barnet, population 6,400. Sludge dug into the ground ; cost of works, £10,000 ; annual expense, £627 , no returns.

Coventry, population 50,000. Sludge pressed and sold; cost of works, £12,000; annual expense over revenue, £2,810.

Birmingham, population 600,000. Farm comprises 1,227 acres. Total cost of the land and works to the present, £403,695. The sewage is treated with lime and the sludge trenched into the ground. The loss on one year's working of the farm amounts to about £10,000, besides the interest on first cost.

I must not close this list without saying something about the disposal of the Edinburgh sewage; so much has been said about the "irrigated-meadows" as they are called.

The information from here is to the effect that "the great volume of Edinburgh sewage is discharged into the sea (Firth of Forth) direct. On each of the three sewer outlets there is a sewage farm, or as before stated, irrigated meadows. These meadows are owned by private individuals who have always claimed a right to the use of the water in the burns passing through their respective lands; which burns have been gradually converted into open sewers."

They have thus fallen heirs to an almost unlimited amount of sewage; they have no interest in purifying this sewage, in the ordinary sense of the word; they use it without stint, and allow the effluent to leave their lands without any regard to its quality or condition. They pay nothing for it, and the crops, chiefly Italian grass, yield good returns

The corporation has not interfered hitherto with the use or misuse of the sewage. The report goes on to say that it is regrettable that one of the farms, viz., Craigentinny, is not the property of the corporation, as it is remarkably well suited for a sewage farm and adjoins the sea; a large part of it consisting of ground reclaimed from the beach, and mostly drift sand.

With the last part of the report I do not feel inclined to agree. If Edinburgh knows when she is well off she will leave that sewage farm alone. While th private owners of these lands no doubt make money out of them, let them once fall into the hands of the civic authorities and they will speedily become a tax on the citizens, or else Scotch aldermen are made of different stuff from the aldermen we read about—in the States.

The only conclusion which can be drawn from the descriptions of the foregoing sewage disposal works is very concisely summed up in a "report of the Society of Arts" appointed to inquire into the various subjects connected with the health of towns, viz.: "It appears further that the sludge, in a manurial point of view, is of low and uncertain commer-

cial value; that the cost of its conversion into valuable manure will preclude the attainment of any adequate return on the outlay and working expenses connected therewith ; and that means must therefore be used for getting rid of it without reference to possible profit. For health's sake, without consideration of commercial profit, sewage and excreta must be got rid of at any cost."

Under these considerations it is no wonder that Mr. Crimp should come to the conclusion that where it is at all practicable a free outfall into the sea can be obtained, it is the most economical and satisfactory method of disposing of sewage. A description of such sewage disposal is afforded by the works at the town of Portsmouth, England. As I wish to draw a comparison between the works of this town and those I have proposed for the City of Toronto, I will give a somewhat minute description.

The population of Portsmouth is 130,000. The district drained is very flat. The highest and most densely populated portion of the borough is elevated about twelve feet only above the tidal range, while about one-third of the borough is very little above the level of ordinary spring tides. I should have said that Portsmouth is situated on Portsmouth Harbor, but it also has another harbor on the east called Langstone Harbor, into which it discharges its sewage. The dry weather flow is about 4,000,000 gallons. The separate system is partly in operation, but in designing the outfall works provision was made for a considerable amount of rainfall per hour.

Owing to the very flat surface of the land, in order that the sewers should be provided with sufficient fall, the sewage has to be pumped. The main pumping station contains a pair of 150 H. P. compound condensing rotary beam engines, each engine works two pumps by means of connecting-rods, one at each end of the beam. The pumps are each capable of delivering half a million gallons of sewage per hour, when doing full duty. Intercepting sewers convey all the sewage to the well at the pumping station, thence by a rising main. 3 feet 6 inches in diameter and 1500 yards long, it is forced by the pump to large tanks situated near the outfall. I need hardly say that one feature of the scheme is the utilization of the tidal water for scouring the outfall pipes.

There are three storage tanks side by side, having a collection capacity of 4,500,000 gallons, and covering an area of 3¼ acres. Each tank is 160 feet long and 150 feet in width. The inverts of the tanks are segmental in cross-section, with a longitudinal fall of 1 in 150 to the outlet. They are provided with sluices at the upper end in order to

admit of part of the contents of a full tank being discharged into an empty one for the purpose of flushing out deposits. Ample provision is made for ventilation, there being 27 fresh air inlets in the three tanks, while the fumes are collected by a flue 4 feet high and 2½ feet wide and conveyed to the under side of a coke furnace, and passed into a chimney shaft about 100 feet high.

The rapid discharge of the whole of the impounded sewage is an essential feature of the scheme; the outlets are sufficiently large to admit of all the sewage being discharged into the outfalls and thence into the sea, within a period of one hour. The mouths of the outlet-pipes lie just below low water mark. Before definitely deciding upon the point of discharge of the sewage, experiments were caused to be made to ascertain the course that would be taken by the sewage under the diverse conditions prevailing. It was found that the floats were carried many miles out to sea when placed in the tide-way soon after high-water, and the works were designed so as to admit of an exceedingly rapid discharge of the sewage in order to take full advantage of this circumstance. On the arrival of the period when it is desirable to allow the sewage to be discharged into the sea, a small penstock is opened, the escaping sewage operates a turbine, which in its turn sets in motion the machinery by means of which the large penstocks are opened; thus one man can readily open these ponderous appliances, and attend to the tanks as well.

The pumping station and rising main cost £25,000, and the tanks and outfall works £45,000. The annual working expenses at both pumping station and tanks amount to £2,700 per annum.

This brings me to my second head.

I have given the sewage disposal works of Portsmouth considerable space as they afford a good example of a free outfall into the sea or large body of water, and I have always strongly recommended that method of sewage disposal for the city of Toronto. Indeed, it was a consideration of the immense advantage to sewage discharge afforded by tidal waters which led me to devise a scheme that would secure to Toronto the advantage of a tide, though on the tideless waters of Lake Ontario, and those of you who are familiar with my scheme will recognize how fully these have been secured. You will observe that by means of a high-level sewer along, say, Gerrard street, between Yonge and Parliament streets, intercepting all the sewage north of that line and conveying it into a tank situated down near Front street, we secure the benefit of a tide, not ten or twelve feet high, but 32 feet high, or more if we require it. Next, we can have it just when we want it and have

not to wait upon the "tardy favors of the moon." By adjusting the size of our tank, and extending our high-level sewer to the west and thus intercepting more sewage, we can determine the time of filling the tank as we choose, to one hour or less or more. Thus by intercepting 4,000,000 gallons per day, and making the tank to hold half a million gallons, we would have a discharge every three hours, equal to eight tides in the day; even Jupiter with its four moons could not do much better than that. But if we chose, we could have a discharge every hour or every half hour.

Then another feature, considerably emphasized, is a rapid discharge, having 32 feet of head, our discharge would be nearly double as rapid as theirs.

Not having to provide storage for the whole city for 12 hours, say six million gallons, we only need to provide capacity for half a million. By a simple contrivance of automatic flushing apparatus we save the attendance of even a single man. Then last, but not least, we save all the expense and nuisance of pumping. It may be egotism, gentlemen, but I consider I have made a tolerably good substitute for the tides.

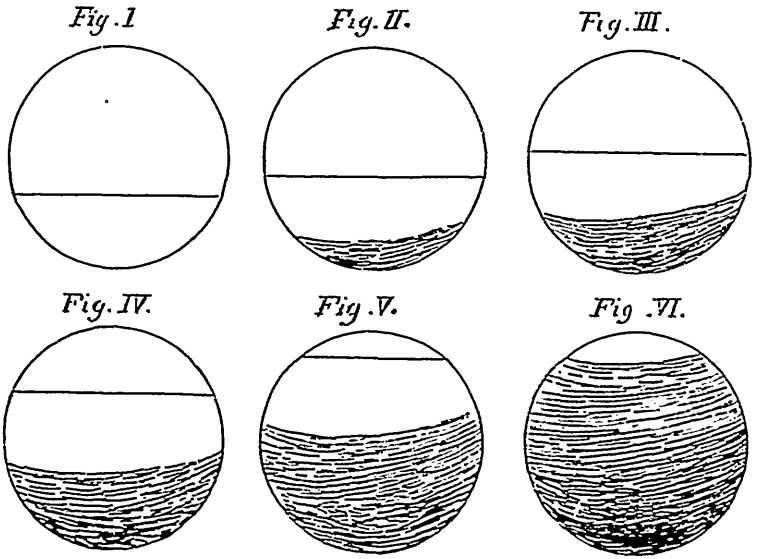
But there is one further merit which I claim for my system that I have not yet laid before the public. You are aware that I contemplate an outfall pipe of steel 6 feet in diameter, conveying the sewage out to a depth of 33 feet of water. I recommend several openings along the pipe near the outlet to be used alternately. This would give a better distribution and prevent accumulations of solids. Again, as the sewage would be discharged at intervals with great force, it would prevent a deposit of the solids around the mouth of the outlet. And even between the intervals of flushing, while the sewage of the low-level sewer would be passing slowly out of the outlet-pipe there would be no deposit around the mouth. As at such time the motion would be so slow as to allow a deposit to take place in the pipe, only the comparatively clear effluent would flow out, leaving the solids along the bottom of the pipe until the next rush would take place, when half a million gallons sweeping along at the rate of 6 feet per second would again scour the pipe and carry the solids far beyond the end of the outfall.

Mr. Crimp recommends the adoption of the gravity schemes where possible, notwithstanding the greater initial expense. He also is in favor of provision being made for flushing all sewers of insufficient fall.

He also describes a very ingenious precipitating tank in use at Dortmund, Germany, and also Mr. Webster's treatment of sewage by means

of electricity, styled electrolysis, which is also fully described, but time precludes me from giving a description of them in the present paper.

III. Under the third head I wish to point out some general defects in the sewerage and sewage disposal works of towns and cities. The first defect relates to the size and fall required by sewers. These should be considered with a view to the amount of sewage required to be carried by them. They should be regulated to such a size that they will run from ½ to ⅔ or ¾ full. Let me illustrate what takes place when a sewer is too large. We will suppose a-sewer is constructed 4 feet in diameter, and that the depth of sewage flowing in it is one foot,—much less than this is very common. I was informed that on Perth street a sewer 4 feet in diameter was being constructed, and I am satisfied that the depth of sewage flowing in it will not average one foot.



Owing to the small volume of sewage coming in contact with the comparatively large surface of sewer pipe as in Fig. I., the friction will be comparatively greater, and though the fall might be sufficient to produce a scouring action were the sewer running full or half full, the motion will be retarded till deposits begin to take place as in Fig. II. This, you will observe, increases the frictional surface and still more retards the flow; when sedimentation will go on more rapidly as in Fig III., IV. and V. Here you might suppose that the evil would begin to cure itself, as the restriction of the passage, as in Fig. VI., would cause an increased velocity, but not so; increased velocity cannot be obtained

without increased head and when you consider that the system of sewers forms a net work you will see that this head cannot be obtained, as the sewage will make its escape through other connections, and the sedimentation goes on till the pipe is completely choked. This may be seen again and again in Queen street sewer and other sewers throughout the city.

Fig. VII.

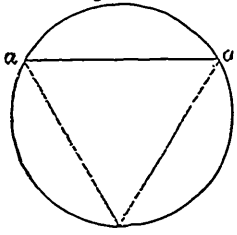


Fig. VIII

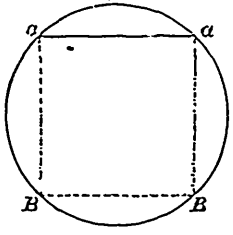
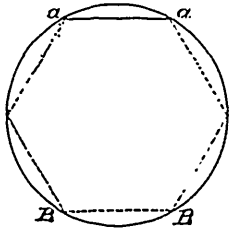


Fig. IX.



A formula for calculating the coefficient of friction in pipes running partly full is as follows:—Coef. of F $= \frac{\text{F. Sur.}}{\text{V. of Sew.}}$; regarding the coef. as unity when the pipe is running full or half full, as you will thus see, the whole F. Sur. $\div$ whole vol. $= 1$. or $\frac{1}{2}$ F. Sur. $\div \frac{1}{2}$ vol $= 1$.

Fig. VII. shows the circle divided into two segments by the side of an inscribed equilateral triangle, figures VIII. and IX. are similarly divided by the side of an inscribed square and hexagon respectively. In Fig. VII., consider the sewer filled to the line *a. a.*, the frictional surface would be represented by $\frac{2}{3}$, while the Vol. of Sew. $= \frac{1}{2}$. Then by applying the formula $\frac{2\cdot3}{4\cdot5} = \cdot833$, = Coef. of F. While the small Seg. would give $\frac{1\cdot3}{1\cdot5} = 1\cdot6 =$ Coef. of F. The latter being double of the former.

Similarly, if Fig. VIII. were filled to the line *a. a.*, the F. Sur. would be $\frac{3}{4}$, while the Vol. of Sew. would be $\frac{1}{11}$; then by applying the formula we get $\frac{3\cdot4}{10\cdot11} = \cdot825$, = Coef. F. While the smaller Seg. shown by *b. b.* would be $\frac{1\cdot4}{1\cdot11} = 2\cdot75 =$ Coef. of F. The latter more than three times the former.

Fig. IX. gives a more marked contrast still. In the large Seg. cut off by *a. a.* the F. Sur. is represented by $\frac{5}{6}$ while the Vol. of Sew. is $\frac{17}{18}$, then $\frac{5\cdot6}{17\cdot18} = \cdot882$, = Coef. of F. While the small Seg. cut off by *b. b.* would give a result of $\frac{1\cdot6}{1\cdot18} = 3.00$. Coef of F., nearly four times as great as in the larger segment. You will observe that figures VII. VIII. and IX. give Coef. respectively, of ·833, ·825 and ·882, thus Fig. VIII. having the lowest Coef. would give the best maximum of velocity. And thus we obtain the paradoxical result that a pipe flowing partly full will have a better Coef. of discharge than when flowing full.

By applying this formula to Mr. Jennings's Outfall Sewer, which is designed to have a diameter of 8 feet, with a fall of 1 inch in 1500, the conditions would be as described in Fig. VIII., small segment. Allowing from 8 to 12 million gallons daily flow, sedimentation would take place very rapidly.

I did intend going into a minute criticism of the present scheme before the city, but as you are, no doubt, pretty well loaded up with the subject, and as there appears no immediate prospect of putting it or any other scheme into operation for some time to come, I shall, with your permission, reserve it for a future time.

LAKE CURRENTS.

BY L. J. CLARK.

(Read 7th March, 1891.)

With the opinion that there are any regular, constant, well-defined lake currents, I feel inclined to disagree. The theory that the waters of the Niagara River make direct across the lake and strike the north shore about the neighborhood of Scarborough Heights, and are then deflected to the east or west, forming currents, is, I think, a highly delusive one; or, as Mr. Sandford Fleming characterizes it, "a theory wild and incapable of defence, though some there are bold enough to venture it." Crossing the lake one day last summer, when nearing the mouth of the Niagara river, I asked the captain how far out he felt the influences of the current? He replied, "about two or three miles." I asked him what velocity he supposed it had? He said from three to four miles per hour, and that when a strong east wind was blowing it would be turned to the west, and *vice versa;* and that it deposited its detritus a short distance from shore; thus showing that its current is practically checked when it strikes the great body of water in the lake.

I believe that the uniform tendency of the water is towards its outlet at the east end of the lake, and that the only other currents that exist owe their origin to such causes as stated by the captain above referred to, namely, the winds. That there are currents produced by this agency no one will, I think, deny. But it is to the currents in our immediate neighborhood, and along our own water front that I shall call your attention to-night.

The question becomes of primary importance when considered in connection with any method of sewage disposal, which looks to diverting the sewage, crude or partially purified, into the lake. An investigation, then, of the Lake currents bears the same relation to sewage disposal that *testing the waters of Lake Simcoe does to the gravitation scheme*, or the newer method of supply by artesian wells; first find the *flowing region.*

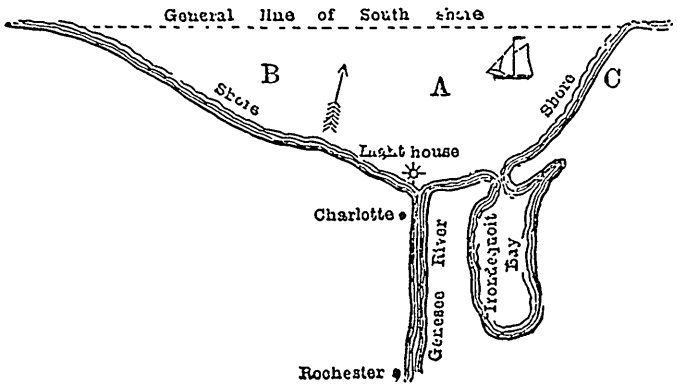
A somewhat remarkable statement was made by a prominent sanitarian, within the last twelve months, to the effect that the proposal to discharge the crude sewage into the lake would be fraught with the greatest danger to our water supply, as it was proved that any impurity

thrown into the lake as far as seven miles east of the intake pipe would, under the influence of strong east winds, reach the pipe in three hours. If this statement could be proved it would settle the matter in short order. It led me to follow up the question a little further and I reasoned thus; if the winds drove the water along at the rate of 2⅓ miles per hour it would reach Hamilton in about 16 hours. It is quite evident that the surface of the water is more influenced by the wind than at greater depths. We will suppose that 10 feet of the surface is so influenced, and that a storm lasts, as most easterly storms do, from two to three days; then consider that the cross section of the lake is somewhere about 40 miles broad, and that 10 feet of the surface is focussed on Hamilton for three days; the unhappy fate of that city may easily be predicted. She would no longer offer a butt for the stale jokes of Toronto wits, but we should speak of her in all sisterly tenderness as the "dear departed." The mountain would no doubt come in handy to the natives of the Ambitious City.

But, in all seriousness, it must be conceded that the influence of the winds and waves has a tendency to move the surface more or less in their own direction, and that during a strong easterly gale a few feet of the surface of the water is driven in a corresponding direction; and this is verified by the fact that under such conditions we find the level of the lake raised a few feet along the Hamilton beach. But though the storm may continue for days with unabated force it does not rise any higher; so what is the only conclusion we can arrive at? Only this, that the head so raised forces a portion of the water back as an undertow, and forms a current in the opposite direction. Thus it is evident that were a sewage outlet located well to the east of the intake of water, say in the neighborhood of Scarborough Heights, very little danger, if any, need be anticipated; for when an easterly storm arises it will give rise to an undercurrent in an opposite direction, which will first flow past the intake of water, thence on to the sewage outlet and so on to the east. So that any charge of water contamination from such a cause is as baseless as the wolf's indictment of the lamb for disturbing the water he was drinking. The answer which the lamb made will suffice for us, "Pray how can that be since the water flows from you to me." If this theory be true it will seriously militate against a westerly discharge of sewage as advocated by some local sanitarians, or against the two or three minor outlets to the west as recommended in the latest report on the subject. It stands to reason that it is unwise to have outlets both to the east and west of the intake of water, for whatever the conditions or nature of the currents that will render the one secure will cause the other to be a certain danger.

Reverting to my theory of an undertow current in an opposite direction, I may say that it rests on something better than "empty air." I was fortunate enough to meet with a gentleman who assisted in making some observations of lake currents in 1884 and 1885, and he informed me that the floats of a few feet in depth invariably travelled in the direction of the wind, but that the floats over twenty feet in depth always travelled in the teeth of an easterly storm, but he had not observed it to do so in the case of a westerly storm. I should have stated at an earlier period that, in my opinion a wind from the west does not produce an undercurrent in an opposite direction, for the very obvious reason that the outlet of the lake is to the east, and when the water is blown down the lake it makes its exit by the St. Lawrence instead of returning as an undertow.

But I have better evidence still than the above. Some two months ago I explained this theory in a newspaper article, and in response to it I received the following from an eminent American engineer. And I trust he will not consider it a breach of confidence if I give it in his own words: "I was greatly interested in reading your article in the *Globe* on 'Lake Currents,' and perhaps you will be interested in the following facts which were communicated to me by the captain of a life saving crew at Charlotte. The shape of the lake shore is as sketched. A



yacht capsizes at A during a severe westerly gale, the ballast shifts to the bow, leaving the stern rising out of the water so as to form a float. Despite the heavy wind and surface currents tending to drive the yacht to C, it was observed to travel slowly westerly in the teeth of the wind and found a few hours later at (B)! As you describe it, the water was piled up along the shore at C, and by the head so formed a portion ran backward as an undertow towards B, thus making a temporary whirlpool. This is due to the peculiar shore conformation, and the sewage problem

must be studied with reference to such matters. In your shore a similar indentation is formed by Humber Bay, and you are right in advocating a sewage outlet to the east, where the coast line is straight for a considerable distance."

But, however satisfying this theory may be to the scientist, it should be put to the severest test before the least reliance is placed in it. And I hope the city authorities will not allow the present season to go by without ascertaining to the fullest possible extent the direction and velocity of the lake currents, both deep and superficial, under all existing circumstances.

The result of the recent analysis of water from the bell buoy by Professor Ellis, might be considered a staggering blow to the credulity of those who had faith in the purity of the water from that source when not contaminated with impurities from the bay through leakage into the conduit, but not necessarily so. The rather does it show the danger from western sewage outlets, and from the polluted waters of the bay. It was very ably shown by, I think, a writer in the *Mail*, that the wind rising in a certain quarter, and veering around to a different quarter, would tend to bring the foul waters of the bay directly to the intake pipe. This mechanical cause may have been aided by a physical cause, namely, the difference in temperature and consequently a difference in density. Thus at the time the sample was taken the weather was tolerably cold, the ice had just left the bay. The water in the shallow portions inside the harbor is much more susceptible to changes of temperature than in the deep water just outside the island. Suppose the temperature of the water in the bay to be 39° Fah., its limit of greatest density, and that outside to be 40°. Then as the water would be driven out of the western gap as before described and around Lighthouse Point, it would encounter the lighter waters of the lake and sink beneath them, carrying down its load of sewage pollution to the bottom to contaminate the water at the intake. But this state of things is not irremediable. Cleanse the harbor, cut off the westerly sewage outlets, and extend the intake pipe out to 70 feet of water and all danger will vanish; for it must be remembered that conditions may arise that would contaminate the surface water at the location of the intake pipe which would be perfectly harmless at a depth of 70 feet below.

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In answer to numerous enquiries concerning the Publications of the Canadian Institute, and applications for missing numbers, the attention of members and Correspondents is requested to the following :—

1. The FIRST SERIES began August, 1852 ; concluded December, 1855 ; contains 41 numbers in 3 vols. 4to. It has for title, "The Canadian Journal ; a Repertory of Industry, Science and Art ; and a Record of the Proceedings of the Canadian Institute." Vols. II. and III. of this series can still be supplied. Vol. I. is nearly out of print.

2. The SECOND SERIES began January, 1856 ; concluded January, 1878 ; contains 92 numbers in 15 vols. 8vo. It has for title, "The Canadian Journal of Science, Literature, and History." This series can still be supplied, except Part 5 of Vol. XV., which is quite out of print. Of Vols. X., XI., XV. but few copies remain.

By inadvertence, No. 85 (November, 1873), Vol. XIV. of this series immediately follows No. 79. There is, however, no *lacuna* between these two numbers, as is shown by the fact that the paging is consecutive.

3. The THIRD SERIES, commenced in 1879, concluded April, 1890, contains 20 numbers in 7 vols. Its title is "Proceedings of the Canadian Institute." Parts 1 and 2 of this series are entitled "The Canadian Journal ; Proceedings of the Canadian Institute."

Vol. I.,	Third Series,	contains	5	Fasciculi.	
" II.,	"	"	3	"	
" III.,	"	"	4	"	
" IV., V., VI. and VII.		"	2	"	each.

Of Vol. I., Parts I and 3, and of Vol. II., Part 1, are out of print. Of Vol. II., Part 2, very few copies remain. Of Vol. III., Part 1 and of Vol. IV., Part 2 are out of print.

4. The FOURTH SERIES commenced October, 1890. Its title is "Transactions of the Canadian Institute." Vol. I., containing Parts 1 and 2, has been published.

5. Only four Annual Reports of the Institute have been published in a separate form, viz., for 1886-87, 1887-88, 1888-89, and 1889-90. There has been no Annual Report between the Third Report (Session 1888-9) and the Fourth Report (Session 1890-91). The latter should have been printed (Session 1889-90).

6. Missing numbers will be supplied on application, except those mentioned above as out of print. The Institute will be glad to exchange the back volumes of its publications for an equivalent of those of any Society with which it exchanges.

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8. It is requested that all publications sent to the Canadian Institute should be addressed :—

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