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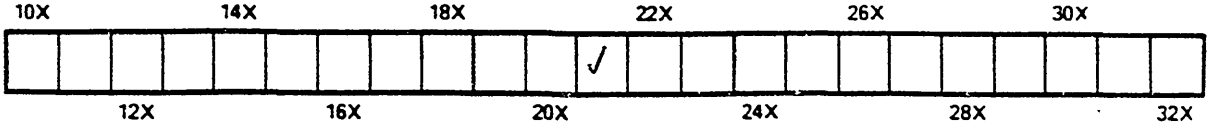

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THE

CANADIAN NATURALIST

AND

Quarterly Journal of Science.

WITH THE

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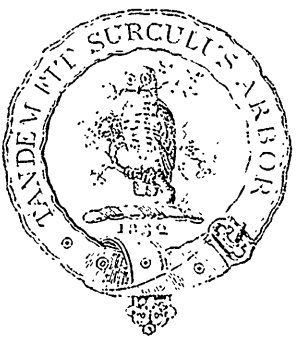

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THE

CANADIAN NATURALIST

AND

Quarterly Journal of Science.

OBITUARY NOTICE OF ELKANAH BILLINGS, F.G.S.

Palæontologist to the Geological Survey of Canada.*

By J. F. Whiteaves.

The founder of this journal, whose loss we have so recently had to deplore, was the second son of Mr. Bradish Billings, whose farm and dwelling were situated on the east bank of the Rideau River, in the township of Gloucester, some three miles distant from Bytown, or Ottawa as it is now called. About a hundred yards to the south of his residence, Mr. Billings built a bridge across the river, and the circumstance is commemorated by the name still borne by the little village which has recently sprung up around it.†

Including two who died in their infancy, there were nine children in all, but of these only two showed any very decided taste for natural history studies, viz. Bradish, the eldest, who died in 1872, having previously gained some reputation as a botanist and entomologist, and the subject of the present memoir. In answer to some inquiries as to the early history of the family, the youngest son, Mr. Charles Billings, writes as follows: "My father's maternal ancestors came from Wales and those on his father's side from England: the name Billings is of Saxon origin

* Altered slightly from a paper read before the Natural History Society of Montreal, on the 27th of November, 1876.

† Billings' Bridge.

and exhibits two separate coats of arms in the book of heraldry. My mother, whose maiden name was Lamira Dow, was, I think, of Irish extraction on her mother's side and of Scotch on her father's, so you see we have pretty nearly the whole British Empire at our backs. My grandfather was a Dr. Elkanah Billings who settled near Brockville and practised there until he died. My father was born in the State of Massachusetts and my mother in the State of New York."

Elkanah Billings, our esteemed associate for so many years, was born at the family homestead, on the fifth of May, 1820. His first teacher was a governess (Miss Burrit) his next a family tutor named Maitland, and he afterwards went to three small schools in the neighbourhood kept respectively by Messrs. Colquhoun, Collins and Fairfield. In 1832 the youth was placed at the Rev. D. Turner's school in Bytown as a day pupil, and after a four years' interval, during which he remained at home on the farm, his parents sent him in 1837 to the St. Lawrence Academy at Potsdam in the State of New York, of which the Rev. Asa Brainard was principal.

On leaving this institution Mr. Billings entered the Law Society of Upper Canada as a student in 1839 and was articled to Mr. James McIntosh, a barrister in Bytown. Mr. McIntosh died in the same year and was succeeded by Mr. Augustus Keefer, with whom Mr. Billings remained for nearly four years; and it appears that he was for a short time also in the office of the late Mr. George Byron Lyon Fellowes, in the same town. In 1843 he went to Toronto and studied for a twelvemonth longer with the legal firm of Baldwin & Wilson, and was admitted to practice as an attorney in the fall of 1844. Soon after this he returned to Bytown and entered into partnership with Mr. Christopher Armstrong, who was then one of the judges of the County Court, but a law having been passed prohibiting judges from pleading, the partnership was dissolved after having lasted only six months.

In the summer of 1845 Mr. Billings went to Toronto where, having first been called to the bar, he married a sister of Mr. Adam Wilson, the junior partner of the firm previously mentioned, now the Hon. Judge Wilson. From August 1845 until about the end of 1848 he practiced his profession in Bytown partly alone and partly in partnership with Mr. Robert Hervey. In 1849 he removed to Renfrew, and remained there, still practic-

ing as a barrister, until the 10th of June, 1852. The following day he returned again to Bytown, and here though he opened an office ostensibly to pursue his professional calling, he practically deserted it to a large extent to follow that of a journalist. In those days there were two newspapers in Bytown the "Citizen" and the "Gazette." The editorial chair of the one was occupied by Mr. Billings,* that of the "Gazette" by a Mr. Gibb. A wordy war not unfrequently arose between the champions of the rival papers, like that which raged between the editors of the Eatanswille Gazette and Independent as chronicled in the pages of Pickwick. On one occasion Mr. Billings' effusions were more forcibly than politely spoken of as "Billingsgate" in the columns of the Gazette, and Mr. Gibb's utterances in their turn were contemptuously summed up as "Gibberish." Many of Mr. Billings' leaders in the Citizen, however, were in a very different vein, being popular articles on geological topics, and these are interesting as illustrative of the commencement of a new mental phase in the writer's existence. They shew the enthusiasm of a student just entering upon a new world of inquiry, who has first begun to catch glimpses of his true vocation. They are marked, also, by the absence of that extreme caution which characterized some of his later efforts. First law, then journalism, each in its turn were gradually absorbed by, or rather forsaken for, what ultimately became the ruling passion of his life. The fossiliferous Silurian rocks of the banks of the Ottawa soon had greater charms for him than the tedious routine of the district courts, or the editing of a newspaper over whose columns he had no control. Whilst practising at the bar, his keen sense of justice was often wounded by what seemed to him unjust juridical decisions, and it is said that he once barely escaped being indicted before the Grand Jury by his former partner Judge Armstrong for remarks published in the "Citizen" reflecting on one of his judgments.

Most of Mr. Billings' time between 1852 and 1856 was employed in the collection of the organic remains of the Lower Silurian rocks near Ottawa city, and he obtained, in particular, a fine and unique series of Crinoids, Cystideans and Star-fishes, which are now in the Museum of the Geological Survey. On

* Apparently from the fall of 1852 until the close of 1855, though the writer has not been able to ascertain the exact dates at which Mr. Billings' connection with that newspaper began or ended.

the seventh of January, 1854, he was elected a member of the Canadian Institute of Toronto, and in the same year his first purely palæontological paper was published in that society's journal. It was entitled "On some genera and species of Cystidea from the Trenton Limestone," and was issued in two parts.

In 1855 a committee was appointed to endeavour to secure a creditable representation of the products and industrial resources of the country at the first Paris Exhibition, and prizes were offered for the best essays on Canada. The first of these prizes was adjudged to John Sheridan Hogan (whose tragic fate in Toronto may be remembered by some of the readers of these pages), the second to the Hon. Alexander Morris, the present Lieutenant-Governor of Manitoba, and the third to J. C. Taché, M.P.P. In accordance with the recommendation of the Judges, the executive committee awarded three extra prizes, of twenty-five pounds each, to the authors of the essays bearing the following mottoes: "Suam quisque pellem portat"; "Reddit ubi cererem tellus inarata quotannis"; and "It is with nations as with nature, she knows no pause in progress and development, and attaches her curse to all inaction." The authors of these essays were declared to be Hector L. Langevin, of Quebec; E. Billings, of the city of Ottawa; and W. Hutton, secretary to the Board of Statistics, Quebec.

The first number of the *Canadian Naturalist* was issued by Mr. Billings in February, 1856, with a prospectus shewing the objects aimed at in the new venture. A copy was sent to each of the members of Parliament, and one was also forwarded to Sir W. E. Logan, accompanied by a letter, of which the following is a copy:

OTTAWA, 29th February, 1856.

SIR KNIGHT,

I have taken the liberty of sending you the first number of the *Canadian Naturalist and Geologist*, and hope that it may find favour in the opinion of one who has achieved so much for science in this province. It is scarcely necessary to say to you that a work commenced under the circumstances cannot be without imperfections. I feel satisfied, however, that with practice and perseverance I can improve its appearance. You are aware that during the last few years I have been studying geology,* and during last summer I

* With the view of qualifying himself for a field geologist, he had also at this time mastered the first principles of optics and trigonometry, as the writer learns from the perusal of other letters to Sir W. Logan.

also connected zoology with it (principally the mollusca and reptilia of the country), and have learned that the youth of Canada little know how full of curious and beautiful objects the whole of this fine province is. The object of my magazine is to place within the reach of my young countrymen as much of that knowledge which is necessary to examine for themselves, as I can collect. They are not without talent and taste for the study of nature, but they are yet without the key to her stores. I have abandoned my profession, and intend to devote the rest of my life to the study of Natural History. I have commenced the publication of this magazine partly as a means of subsistence, and partly for the purpose of arousing, if possible, the youth of this country to pursuits for which they have everywhere most unrivalled facilities. *I am well aware that I shall have great difficulties to encounter, but I can overcome them as I have done others.* I hope you will agree that the object is at least good, and as for its execution—this must be left for me to work out as well as I can. Allow me to state that no man here yet received the order of knighthood with so much satisfaction to the people of this part of the country as yourself, a view in which no person can concur more heartily than I do.

I have the honour to be,
Sir,
Your very obedient servant,
E. Billings.

The latter part of the sentence italicised above is very characteristic of the man, who, whatever may have been his other deficiencies, was certainly not lacking either in energy or industry. It is almost superfluous to mention the fact that Mr. Billings was not only the originator but also the proprietor and editor of the "Naturalist" during the first year of its existence, for his name appears on the title-page of every number. In the first volume there are sixty-three articles, and of these no less than fifty-five were either written or compiled by him. They are all penned in a simple easy style, and being intended principally for the perusal of persons unacquainted with Natural History, are as free from technicalities as the nature of the subject would admit. Twenty-two of them contain plain descriptions of the habits and structural peculiarities of Canadian mammals; fourteen are on as many species of native birds; and all are supplemented by quotations from Wilson, Audubon, and other naturalists. Ten are devoted to the illustration of characteristic fossils of various strata in both provinces, and the rest are on general topics, though mostly connected with geology. The receipts arising from the sale of this volume were insuffi-

cient to defray the expenses of its publication, and Mr. Billing's self-sacrificing efforts to promote the diffusion of knowledge under such discouraging circumstances should be remembered with gratitude by every lover of Natural History in the Dominion.

Between the years 1852 and 1856 a regular correspondence had been kept up between Mr. Billings and Sir W. E. Logan, and in the latter year Sir William succeeded in obtaining for his friend the position of Palæontologist to the Geological Survey of Canada. This of course necessitated an immediate change of residence, and Mr. Billings accordingly removed to Montreal, and entered on the discharge of his new duties on the first of August, 1856. His first two months at the Survey were occupied, as he states in his first official report,* in a general examination of the large collection of fossils in the Museum, with a view to their final arrangement for the purpose of public exhibition.

Early in October of the same year, Mr. Richardson returned from Anticosti, bringing with him an extensive series of the fossils of that island, and shortly afterwards Mr. Billings examined these specimens together with Prof. James Hall of Albany, who happened to be on a visit to Montreal at the time. The report previously cited contains an analytical review of the palæontological relations of the Anticosti rocks, and descriptions of a large number of new species of Silurian fossils, principally crinoids, cystideans, and star fishes, from the Trenton limestone, and mollusca from Anticosti.

In August, 1857, the American Association for the Advancement of Science held its annual meeting in Montreal, and every effort was made both by Sir W. Logan and Mr. Billings to make as creditable display as possible of the collections in the Survey Museum for the inspection of the expected visitors. Among the eminent men of science who attended this meeting was Prof. A. Ramsay, of the Geological Survey of Great Britain, who was deputed to represent the Geological Society of London, and whose acquaintance Mr. Billings then made for the first time. The months of September and October, 1857, were employed in two short collecting expeditions. In the first, the Black River

* Geological Survey of Canada, Report of Progress for the years 1853-54-55-56, page 247.

and Trenton limestones of Jessups Rapids and of Lake Clear in the valley of the Bonnechere were examined, in company with Mr. J. McMullen, as was also the Chazy limestone of Golden Lake, in the same district. Next, the village of Trenton, in the State of New York, was visited, after which Mr. Billings proceeded to Belleville and Shannonville, and from thence to Guelph, Galt, Dundas, Hamilton, Thorold, Port Colborne, and Cayuga. Large collections of fossils were made at each of these localities, many of which were described and figured in his report for that year.

His first and only visit to Europe was made in 1858. Leaving Canada late in January, he landed at Liverpool on the 11th of February, and after a three days detention at that port, arrived in London on the 15th. The objects of this journey were threefold: first, to superintend the illustration of Decades Nos. 1 and 3 of "Canadian Organic Remains"* in London; secondly, to compare a number of fossils from the Survey collection, which he took with him, with types in European museums; and thirdly, to endeavour to secure the services of a professional artist for the staff in Montreal. At the Museum of Practical Geology in Jermyn Street, he was introduced by Prof. Ramsay to all the officers of the Geological Survey of Great Britain, and a work room was set apart for his special use. He took lodgings in Montpelier Square, Brompton, and carefully studied the Silurian and Devonian invertebrates in the public collections of the metropolis. With the late lamented S. P. Woodward he critically examined the Canadian fossils in the British Museum collected by Dr. Bigsby and others and described by Stokes, and compared them with specimens recently brought by Prof. Hind from the Saskatchewan district. The two species of Beatricea collected by Mr. Richardson at Anticosti had been previously described by Mr. Billings as plants, and specimens of each were submitted to Dr. Hooker at Kew, who finally concluded that they did not belong to the vegetable kingdom. Salter at the time maintained that they were the tracks of some gigantic annelid, but this view does not seem to have been received with much favor by palæontologists. During his stay in London, Mr. Billings went to a conversazione at Sir Roderick Murchison's, and on another occasion had a long conversation with the late Lord Palmerston in the

* Then in process of publication.

galleries of the Jermyn Street Museum. In a letter to Sir W. E. Logan, dated London, April 19th, 1858, he says, "since I have been here I have examined, I may say, thousand of specimens of Silurian and Devonian fossils in the different museums and am astonished to find so few that are identical with our own." Contrary to my expectations, the number of species common to the two sides of the Atlantic must be reduced instead of increased." Of course the "our own" in this case applies only to the two Provinces now called Ontario and Quebec. In April of this year he was elected a Fellow of the Geological Society of London, the signers of his certificate previous to the election being Sir Roderick Murchison, Prof. A. Ramsay, and Prof. Huxley. Soon after this he attended the annual dinner of the Society, respecting which he wrote to Sir W. Logan, as follows: "the Royal Hammerers had a jolly dinner a few days ago, I was there. Your health was drunk and Ramsay made a great speech in praise of our Survey. I returned thanks. Sir Roderick Murchison was in the chair." Previous to his departure from England he paid a short visit to Paris and inspected the Palæozoic corals described by Edwards and Haime; here too he met the great Bohemian palæontologist, Barrande. At the suggestion of Prof. Huxley, Mr. Billings induced Mr. Horace S. Smith to accompany him on his return voyage to Canada and to accept the position of artist to the Survey. Accordingly they sailed from Liverpool on the 2nd of June and arrived together in Montreal on the 15th of that month.

Except on an occasional visit to some fossiliferous locality not far distant from the city, Mr. Billings scarcely ever left Montreal after this journey across the Atlantic, but devoted himself sedulously for the remainder of his life to the study and description of the fossils in the Survey collection. The titles of his writings since 1858 are too numerous to quote in full, yet they afford the only true index to his intellectual labours from this date. His most important separate memoirs are monographs on the Cystidea, Asteroidæ and Crinoidea of the Lower Silurian rocks of Canada, in decades Nos. 3 and 4 of Canadian Organic Remains," Montreal, 1858–59; Palæozoic Fossils, Vol. I, Montreal, 1865; also Vol 2, Part 1, Montreal, 1874; and "Catalogues of the Silurian Fossils of the Island of Anticosti, with descriptions of some new genera and species," Montreal, 1866. From first to last he contributed no less than ninety-three

articles to the "Naturalist," and besides numerous official reports in the publications of the Survey, he wrote valuable papers for the Journal of the Canadian Institute of Toronto, for the American Journal of Science and Arts, and for the Geological Magazine of London. He was awarded a bronze medal in Class 1 by the jurors of the London International Exhibition of 1862, and a similar one at the Paris Exposition Universelle in 1867.

For three years before his death, Mr. Billings' state of health was such as to cause grave uneasiness to his friends. Slowly and insidiously his originally vigorous constitution was undermined by that affection of the kidneys known as Bright's disease to which he ultimately succumbed on the morning of the 14th of June, 1876.

As is the case with so many original thinkers, Mr. Billings was entirely a self-taught man, so far at least as science was concerned. The success of his career as a palæontologist—and that it was a success can scarcely be doubted—was largely due to the concentration of his mind on one object. To this must be added the possession of analytical powers of mind of a high order, which enabled him to discriminate readily between specific or generic distinctions as opposed to merely individual differences. In his knowledge of the invertebrates of the Lower Palæozoic rocks of Canada he had no equal, though his weakest point was unquestionably the Protozoa of these deposits. From the Silurian and Devonian formations in the Dominion he described about one thousand new species of fossils, and the frequency with which his writings are enquired for both in America and Europe, afford the best proof of the high estimation in which they are held abroad. Until his health failed him, he was to be found at his desk as early as half-past seven in the morning, and he often took his work home with him at night. He possessed a capacity for brain labour such as falls to the lot of few, and taught himself enough of German, Norwegian, Swedish, and Danish to be able to construe palæontological essays in either of these languages with ease. That he was enabled to devote twenty years of his life exclusively to the prosecution of researches for which he shewed so much aptitude, was no doubt a very great advantage, yet on the other hand he had many difficulties to contend with, especially in the earlier part of his life. Before 1856 he had access to no public collections or to any good scientific libraries, Apart from his visit to England, and he stayed

there only four months, he travelled very little. If therefore in his writings there is occasionally to be traced an inclination to make unnecessarily minute sub-divisions of strata which cannot be recognized over large areas, or to unduly multiply species, it should be remembered that his experience in the field was both limited and local; also that if life had been spared him, his intention and hope was to have revised his work.

Mr. Billings' patient elaboration of the fauna of the "Quebec Group," as exhibited in this province and in the island of Newfoundland, is a master-piece of palæontological acumen, and he is justly entitled to the credit of being the first to point out the true geological horizon of these rocks. Although, as before stated, the invertebrates of the Silurian and Devonian rocks were the objects of his special study, he was well acquainted with other branches of Natural History. His essay "on the remains of the Fossil Elephant found in Canada" shew that he was a very good comparative osteologist. It is the only paper of the kind that he ever printed, though he once read before this Society a paper on the bones of a species of Beluga dug up near Cornwall, and he has since examined and determined the nature of a few mammalian remains collected by Mr. Richardson near Victoria (V. I.) in 1874, and by Mr. Ells from the Saskatchewan district in 1875. Entomology at one time was a favourite science with him, and he made a very good collection of native coleoptera, which he presented to the museum of this Society a few years ago, in whose cabinet it is still preserved. The article "on the pine-boring beetles of the genus Monohammus," is his first and last contribution to the literature of entomology. For many years he was a zealous collector of minerals, and although he always refused to give an opinion upon specimens which might be submitted for his inspection, and never wrote anything directly bearing on the science, he was nevertheless tolerably well versed in mineralogy.

It is to be regretted that no manuscripts exist which would enable the second volume of the Palæozoic Fossils to be completed. Ever since the publication of the first part (in 1874), Mr. Billings' time was almost exclusively occupied in the study of the fossils of the Upper Silurian rocks of the eastern portion of the Dominion, more especially of those collected by Sir W. E. Logan and Prof. Bell near Cape Gaspé, by Mr. T. C. Weston at Arisaig, and by Mr. T. Curry at Port Daniel in the Bay of

Chaleurs. The whole of the material from these localities had been carefully examined, and it only remained to write the descriptions of the different species, but this, alas, he was not destined to accomplish. As it is, the only clue to the conclusions arrived at with regard to them, is the existence of labels attached to some specimens in the Museum of the Survey, with new names, proposed but not yet published, printed on them.

Mr. Billings' private character was marked by great firmness and decision, by an unswerving love of truth and justice, and by an unaffected and winning modesty of demeanour. In his intercourse with his fellow-men he was unusually reticent and reserved, especially of late years, but this was largely due to the fact that he rarely met with people who either understood the nature of his studies or sympathized with their object. That he was not devoid of geniality, many of his more intimate friends could easily testify.

It is pleasant to be able to add that this Society was one of the first to appreciate and foster Mr. Billings' peculiar talents, and that its members have never ceased their endeavours to help him in his official work. On the 25th September, 1854, the year in which he published his first palæontological paper, he was elected a corresponding member of the Society, his name having been proposed by Dr. Benjamin Workman and seconded by Mr. J. H. Joseph. On the 29th of September, 1856, a few weeks after he had accepted the position of Palæontologist to the Survey, he became a resident member. In the following year the Society relieved him of the responsibility of editing the "Canadian Naturalist," and has regularly superintended its publication up to the present time. The Council and members of the Society voted him its silver medal in 1867, by way of showing their sense of the value of his life-long efforts for the promotion of science in Canada. Since 1862 Mr. Billings has been regularly elected a Vice-President of the Association, and has frequently been pressed to accept the office of President, although he invariably declined nomination. The resolutions passed by the members at a special meeting held soon after his decease, are a tribute of esteem to his personal worth and scientific attainments, while the fine portrait by W. Raphael, now hanging in the Society's Hall, is a silent witness to their thoughtful efforts to perpetuate his memory.

NOTES ON SOME GEOLOGICAL FEATURES OF THE NORTH EASTERN COAST OF LABRADOR.

By Henry Youle Hind, M.A.

(*Continued from page* 240.)

I. Symmetrical structure of the Strata.—II. Concretionary structure.—III. Boulders and outliers of the Upper Laurentian or Labrador Series.—IV. Permanent Snow Drifts.—V. Influence of Winds on the composition of the Drifts.—VI. Mechanical effects produced by Snow Drifts.—VII. Amount of Snow fall in North Eastern America.—VIII. Direction and Force of the Winds.—IX. Influence of Snow Drifts as Geological Agents.

1.—Symmetrical Structure of the Strata.

It has been already stated that in general the structure of the North Eastern Coast of the Labrador is very symmetrical, and that the strata are often seen to be arranged in grand curves, which in some instances maintain a uniform outline for miles.

The strike of the rocks in Hamilton Inlet is about S. 75 W. and this course would carry the limestones already described to an exposure of the same rock noticed many years ago by Mr. W. H. A. Davies,* on the Grand or Hamilton River (which is the same as the Ashwanipi), some distance below Keith Lake, and 130 miles from the mouth of the river. Here, according to Davis, "primary marble of a beautiful whiteness, was seen cropping out at the edge of the water; it was found in contact with a quartz rock passing into mica slate, having crystals of common garnet embedded in it."

In sailing towards Rigoulette, and on approaching the islands called "The Sisters," the uniform foldings are specially remark-

* Trans. Lit. and His. Soc. of Quebec, 1842.

able, and the strata present themselves in enormous anticlinal and synclinal folds, which are easily traced, in some instances over half a quadrant. In numerous examples, too, the dips were found to be low, varying from 15 to 45 degrees, and the prevalence of low dips was noticed at localities a hundred miles apart, as for instance in Porcupine Bay, near to Sandwich Bay, and in Lake Melville at the head of Hamilton Inlet. At Esquimo Island, close to the mouth of the Narrows above Rigoulette, the dip was from 20 to 25 degrees, and in the vicinity of English River, for long distances, about 25 to 30 degrees. In the neighbourhood of trap intrusions the strata are necessarily disturbed, but as these intrusions appear to follow certain well defined lines, the undisturbed portions of the Lower Laurentian in and about Hamilton Inlet and Lake Melville, show a regular and symmetrical folding.

II.—Concretionary Structure.

When the ice-planed surfaces of those beds which present a dip more nearly approaching the vertical, are carefully examined, the observer is very liable to be misled, unless he follows out the apparent undulations which may arrest his attention. These are frequently found to be due to a concretionary structure on a grand scale. Small and thin lenticular beds of micaceous schist, for instance, are seen to be followed regularly by larger zones of the same rock, and the impression is conveyed that many of the supposed minor undulations are merely part of great concretionary forms.

The tendency to a lamellar arrangement of thin sheets about a nucleus, highly compressed and drawn out, is oftentimes very marked and very deceptive; it was observed in several cases to extend over more than a hundred yards in length, without a break, and probably the concretionary structure involves very much larger masses, and may not unfrequently give rise to apparent instances of supposed folding.

III.—Boulders and Outliers of the Upper Laurentian or Labrador Series.

Boulders of Labradorite and occasionally of Hypersthene, are of common occurrence all the way from Porcupine Bay to the head of Lake Melville (140 miles), in a south-westerly course.

Some of them are of enormous size; one near the mouth of English River, of Labrador felspar, was estimated to contain 8000 cubic feet; another, but of smaller dimensions, and composed chiefly of Hypersthene, was seen perched on a hill 300 feet high, at Cape Porcupine. Mr. Colchester found a boulder of chatoyant Labradorite at the summit of St. John's Island, some 500 feet above the huge erratic just described, lying near the mouth of English River, and three miles distant from it. In the valley of English River were numerous worn and also *angular* masses of Labradorite of large dimensions. Dr. Packard found domes or bosses of the Upper Laurentian series resting upon probably Lower Laurentian rocks at Square Island, which lies at the mouth of a deep bay, north of Cape St. Michael, and about eighty geographical miles south east of Cape Porcupine.*

Dr. Hunt considers that the domes of Labradorite found by Dr. Packard, not only at Square Island but also at Domino Run, as "probably nothing more than outlying portions of the newer Labrador formation resting upon the Laurentian strata." This conclusion is fortified by the occurrence of Crystalline Limestones of the older Laurentian, described in the first part of this paper, in Hamilton Inlet; and we may regard the great accumulation of Labrador felspar strewed over these older rocks, as the ruins of a vast sheet which formerly covered this part of the Labrador peninsula, and which maintains itself in great force beyond Ukkasiksalik, and exhibits a large development of the most beautiful and delicately coloured varieties in the neighborhood of Nain.

But boulders and angular masses, and masses partially worn, or pan ice-polished where exposed surfaces have been reached, are to be found all along the coast line in sheltered coves; possibly also outliers, as at Square Island and Domino Run, may be found distributed through the country between these distant points. These however, whether in position or in the form of an assemblage of loose masses, are the remnants of a formation

* Dr. A. S. Packard—On the Glacial Phenomena of Labrador and Maine. Memoirs of the Boston Society of Natural History, Vol. I, p. 2, 1867. See also an article by Dr. Sterry Hunt "On Norite or Labradorite Rock," read before the American Association for the Advancement of Science at Salem, Aug. 1869.

which is recognized at intervals as far south as Massachusetts, and as far east as St. George's Bay in Newfoundland. Its pre-eminently felspathic character causes it to be greatly subject to joints, and susceptible of cleavage. Its wear and waste has been much facilitated by these characteristics, and the removal appears to have been accomplished to some extent in recent geological times, and through the instrumentality of *snow* as a first or leading cause, followed by the propelling and abrading power of *pan ice*.

IV.—Permanent Snow Drifts.

Sailing in a north westerly direction, near the Atlantic coast of the northern part of Newfoundland, and thence on to the Labrador, the permanent patches of snow which occasionally show themselves in the mountains, increase in numbers and dimensions, until on arriving in the latitude of the Mealy Mountains (54° N.) they form a constant and marked feature in the aspect of the country.

These snow patches are drifts of great extent occupying ravines or valleys in the mountain sides, and they vary from a few square yards to many hundred acres in extent, generally increasing in area with the altitude. The mountain ranges on the Labrador, between Sandwich Bay and Ukkasiksalik, trend from north-east by east to south-west by west. The Mealy Mountains, as seen on the coast near Sandwich Bay, do not exceed 1500 feet in altitude, according to the Admiralty chart, but on the south shore of Lake Melville they attain an estimated elevation of between 4000 and 5000 feet, and are very imposing in their peaked and serrated outline.

On the northern side of Hamilton Inlet and Lake Melville are the Kokkok Range, the Fox Mountains and the China Range, which, with some detached peaks, give to the whole of that part of the country a rugged and elevated character. The Kokkok mountains, as seen from Lake Melville, were thought to be fully as high as the Mealy Mountains, and the Salt-water Lake Range or Toush-ia-lik Mountains, which lie north of the Fox Range, may next approach them in altitude. On all of these separate ranges permanent snow patches exist. These masses, which in some particulars have a glacial character, diminish in size during the summer, until the first snow storms in September, but they always form a marked feature in the scenery, and according to

the Esquimo and residents on the coast, are permanent; some years appearing larger in August than during other seasons, but always there. In a stretch of a hundred miles one sees perhaps the same number of permanent snow patches, until Cape Mokkovik or Aillik is past, when they become more frequent, and reach much lower down the hill sides, in fact actually descend to the shore on the range which terminates at Cape Hurricane (lat. 55° 50′).

The snow drifts on the coast line—some of them covering many hundred acres in area—maintain themselves without much apparent diminution in size during August and part of September, even when their base is but a few feet above the sea level. Farther in the interior the bases appear to rise in vertical altitude above the sea with the increase of temperature, and probably they may disappear altogether farther inland, below an elevation which is still very considerably lower than the snow line, especially if the country should be wooded, or no surface features exist which would permit of the growth of drifts.

The coast climate, deriving its severity and humidity from the Labrador current, reduces the mean temperature to such an extent as to permit snow drifts of certain dimensions to remain throughout the year on exposed fronts facing the south-east or east, which is generally the *lea side* on the Labrador. There is thus a zone existing for hundreds of miles on this coast throughout which permanent snow drifts in valleys and ravines prevail to a large extent, and the aggregate area they occupy in August gradually increases as we progress towards the north-west.

The breadth of this zone varies with the mountainous character of the country, and is especially dependent upon forest growth. Where there are unbroken forests, however stunted, there are no permanent drifts. Hence conflagrations, destroying forests, tend to foster the growth of snow drifts and their disintegrating and polishing work.

V.—Influence of Winds.

Apart from the reduction of temperature on and near the coast line, due to the constant presence of the cold current, there is superadded the prevalence of strong north-westerly winds for a considerable part of the year, which not only occasion the snow drifts, but from their low temperature and moisture preserve them.

I had time and opportunity to examine with care one only of the drifts or snow banks on the coast line south of Hamilton Inlet. It lay under the lea of a huge wall of ice-polished trap, on a plateau about 100 feet above the sea level. It was remarkable at a distance owing to a belt of vivid green at its base, bordered by a dark band gradually fading off into a grey, which blended with the white of the snow above it. Climbing to the edge of the green stripe, it was found to consist of a deep and luxuriant growth of moss and grass. The dark belt succeeding was found to be a layer of fragments of peat and particles of sand with a few pebbles, resting upon snow, and driven there by the wind. The grey band succeeded by stainless snow, consisted of smaller bits of peat with a little sand and a few pebbles sunk into the snow. The whole mass was evidently slowly moving to the edge of the cliff which terminated the plateau, and pushing before it a small belt of accumulated debris. Its breadth was about 60 feet, its length may have been 250 feet, but its depth could not be ascertained with the appliances at hand.

This snow bank was an illustration on a very small scale of numerous larger drifts seen farther to the north-west, and a pigmy compared with the giant drifts filling ravines and valleys on the mountain sides. Generally it may be said that nearly every ravine on the slope of the range which terminates at Cape Hurricane, had its permanent snow drift, with accumulated layers of wind-blown sand, small pebbles, and fragments of peat, the whole mass slowly sliding towards the beach, and some of them within a few feet of the wave-washed base of the hills.

VI.—Mechanical Effect of Snow-Drifts.

Personal experience does not enable me to describe the mechanical effects of the larger drifts which are found farther to the north, but the testimony of Mr. Lieber, who accompanied the United States Solar Eclipse Expedition to Eclipse Harbour in 1860, supplies the information respecting snow-drift work beyond Cape Mugford. Mr. Lieber describes the slopes of Mount Bache in Eclipse Harbour, lat. 59° 48′ as covered with loose angular blocks. Mount Bache rises 2150 feet above the sea level, and so strewed was its summit and sides with "unchanged blocks of gray gneiss" being part of the solid strata

beneath them, that the uptilted beds of the parent rock *in situ* were seldom seen. "Clearly," says Mr. Lieber, "that force which had riven its beds asunder, no other than the frost, had broken the rest from their foothold and prepared them for removal by another coming into play at a later season; the thawing down-gliding *snow*." "Many of the blocks were probably but slightly removed from their original position, perhaps barely turned over or merely forced a little out of place. Yet the effect to the eye of the beholder would be as great as if they had been transported hundreds of miles."

"When we descended from the mountain we crossed over a broad patch of snow, deeply packed, twenty feet deep, which clearly taught us how the blocks were moved. In truth this was a miniature glacier, and a regular moraine was piled up along its edges. It is impossible for us to form any estimate of the amount of snow which may fall per square foot in a winter, but from the fact that such quantities were still remaining late in July, and certainly they never altogether thaw away, we may reasonably infer that during its downward progress, either as snow or water, a tremendous force must be exerted, a force quite sufficient to account for the characteristic surface phenomena just described."

Scoresby's account of the effects of frost on the rocks of Spitzbergen, agrees with Mr. Lieber's descriptions. This enterprising discoverer and observer notices also the movements of masses of broken rock down the steep sides of hills, when disturbed, and their bounding down the declivities and lodging in a bank of snow, two thousand feet below his point of observation.

Angular blocks of gneiss and other rock species are constantly met with on the Labrador in protected valleys, such as English River, and they may also be seen in Newfoundland and elsewhere in much lower latitudes, pointing to the separation of the blocks at the joints by alternate freezing and thawing, and their probable subsequent movement by means of snow. It is to the polishing and striating effects of snow drifts that I would also wish to direct attention.

There is on the Labrador no "soil cap" to produce the motion of blocks of strata recently described by Sir C. W. Thomson in the February number of '*Nature*,' but there is, nevertheless, a powerful agent in snow and wind combined, in

not only denuding rock masses, but also in moving the debris down the least slope which can give motion to a snow bank.

We are apt to underrate the mechanical effects of snow when we see it uniformly spread, as in Canada, over the surface, where trees prevent drifting; but when high winds, combined with a snow fall of six to ten feet is piled in great masses on the lea side of hills, it becomes a mechanical agent possessing enormous power constantly acting, if the drift be permanent. Even at the present day the snow fall throughout much of the forest covered portion of British North America, forms a sheet, as we shall presently see, averaging six feet in thickness, and constitutes a true snow zone. If this sheet could be gathered into great wind-rows, as it really is on the exposed and treeless Labrador coast, its mechanical force would be called into play in a very striking manner.

VII.—Amount of Snow-fall in North-Eastern America.

The snow-fall on the coast of North-Eastern Labrador is very considerable, but not nearly so great as one would suppose from the vast accumulations on lea slopes and in ravines facing the east or south-east. As far as I could gather from the accounts of the Missionaries, Esquimo and resident trappers on the coast, the snow does not, in general, exceed eight feet in the woods, when it is protected from winds. Judging by this rude method, the annual snow-fall may average some thirty or forty inches more than in the Maritime Provinces of the Dominion, or some parts of Ontario. But this zone of snow, even when we confine its limits to a depth not more than five feet on the level or about 60 inches, allowing for evaporation, is a power, when moved by winds and thrown into drifts, which, under favourable circumstances, exercises an influence in moulding the outline of the surface to an extraordinary extent, and is strictly comparable with the more striking, because concentrated effects, of other forms in which frozen water or vapour is seen to act.

But a snow drift remaining throughout the year on an exposed slope, and slowly, almost imperceptibly, gliding down to a lower level, affords of itself no measure of the mechanical work it directly effects by gravity and motion. It is a never-ceasing agent for condensing the vapour of the atmosphere, and to the mechanical effect it produces by its own weight as snow, must be added the effect produced by the moisture it condenses from the

air, throughout the entire period of its existence. Mr. G. P. Marsh * draws attention to the observations made in Switzerland on the hygrometric functions of snow in relation to the condensation of atmospheric vapor by the snows and glaciers of the Rhone Basin. It is estimated that the total of this condensation is nearly equal to the entire precipitation of the valley. There can be no doubt that permanent snow drifts on the Labrador condense an immense amount of moisture, which must find its outlet during the summer months in the counterpart of miniature glacial rivers, and these proceeding from a snow drift a square mile in area, will be no insignificant streams. There are very many such drifts on the N. E. Labrador coast.

The following tables show the existence of a great snow zone in North America stretching far down into temperate latitudes, which is doing extensive geological work on the Labrador. It there represents a modern and existing continuation of work formerly done over wide-spreading areas farther to the south, and in its mode of operation it represents, in innumerable miniature forms, the action of alpine glaciers, and is yet thousands of feet below the line of perpetual snow, in the ordinary acceptation of the term.

1. *Table showing the Annual Snow Fall in the several Provinces of the Dominion of Canada, and in Newfoundland.*†

IN INCHES.

Provinces.	1873.	1874.	1875.
Ontario	101	75	97
Quebec	152	107	123
New Brunswick	132	106	126
Nova Scotia	110	86	104
Prince Edward Island	124	127	136
Newfoundland	116	100	196
Manitoba	40	63	41

* "The Earth as Modified by Human Action." By George P. Marsh. New York, 1874.

† These tables are framed from the data contained in the extensive and important series published under the supervision of Professor Kingston at Toronto, in the Reports of the Meteorological Office of the Dominion of Canada.

The difference between the annual depth of snow which falls in the interior continental Province of Manitoba and the Maritime Provinces of the Dominion, is very marked, but this difference fails to convey a correct idea of the snow fall on the coasts of the Gulf of St. Lawrence and the Atlantic. There is a snow zone there, where the average depth each year does not fall short of ten feet, and sometimes the total fall approaches double that great precipitation of snow, as for instance at Quebec in 1873.

2. *Table showing the amount of Snow-Fall at Stations on Lake Ontario and the St. Lawrence, the Gulf of St. Lawrence, and the Atlantic Ocean.*

IN INCHES.

	1873.	1874.	1875.
Lake Ontario and the St. Lawrence.			
Toronto	114	67	107
Brockville	123	86	135
Montreal	145	119	115
Quebec	237	150	182
Gulf of St. Lawrence.			
Chatham	....	115	162
Dalhousie	....	75	148
Atlantic Coast.			
Halifax	103	89	87
Sydney	142	126	138
Newfoundland.			
St. John's	116	138	169
Harbour Grace	....	122	137

We see that on the Gulf Coast, in the Lower St. Lawrence, and on the Atlantic Coast from Cape Breton northwards, the annual snow fall at some stations, occasionally reached twelve feet in vertical depth of fall as measured in the ordinary way. When settled, as in forests in the spring, it often measures five feet in depth, sometimes six feet, or about half the registered fall.

If we take the total precipitation for the year for the several stations named, it will be observed that geographical position and altitude above the sea, has a great influence, even in a limited area, in determining whether the precipitation takes place in the form of rain or snow, consequently these data are all important in estimating the probable geological effects of snow, when such conditions prevail as to permit it to remain in the form of permanent drifts.

3. *Table showing the Total Annual Precipitation in the several Provinces of the Dominion of Canada and Newfoundland.*

Provinces.	1873.	1874.	1875.
Ontario	32.79	26.90	31.66
Quebec	38.64	36.64	42.32
New Brunswick	45.90	37.50	45.19
Nova Scotia	50.07	45.60	41.07
Prince Edward Island	41.38	40.39	43.46
Newfoundland	50.01	47.8	43.97
Manitoba	25.00	20.00	16.35

4. *Table showing the amount of Total Precipitation at Stations on Lake Ontario and the St. Lawrence, the Gulf of St. Lawrence, and the Atlantic Ocean.*

	1873.	1874.	1875.
Lake Ontario and the St. Lawrence.			
Toronto	31.59	24.34	29.73
Brockville	38.85	29.39	34.17
Montreal	42.76	39.03	39.69
Quebec	49.02	39.49	43.81
Gulf of St. Lawrence.			
Chatham	....	41.45	47.51
Dalhousie	....	....	43.42
Atlantic Ocean.			
Halifax	48.48	54.74	51.48
Sydney	....	51.26	44.23
Newfoundland.			
St. John's	54.72	64.13	45.47
Harbour Grace	45.52	50.64	39.20

In order to complete this outline sketch of the differences which exist between the total precipitation and the form in which it occurs near the seaboard and at inland stations, it is necessary to introduce a table showing the total precipitation and total fall of snow at certain stations where geographical position and elevation above the sea produce corresponding effects.

5. *Table showing the total Precepitation and total Snow-fall at certain selected Stations in the Dominion of Canada and Newfoundland.*

Stations.	Total Precipitation Inches.			Snow Fall. Inches.			Above the Sea, in feet.
	1873.	1874.	1875.	1873.	1874.	1875.	
Ontario.							
Woodstock.....	38.69	29.07	34.08	114	72	72	980
Kincardine.....	43.98	32.67	....	140	134	...	684
Stratford.....	40.06	33.33	37.90	102	114	136	1182
Quebec.							
Cape Rosier....	30.62	41.47	....	199	154	...	39
Quebec.....	49.02	39.49	43.81	237	150	182	293
Montreal.....	42.76	39.03	39.69	145	119	115	182
N. Brunswick.							
Bass River.....	....	34.66	40.87	183	119	138	70
Bathurst	36.75	29.67	36.53	144	87	93	4
N. Scotia.							
Sydney.....	....	51.26	44.23	142	126	138	27
Halifax.....	48.48	54.74	51.48	103	89	87	122
Newfounland.							
St. John's.....	54.72	64 13	45.47	116	138	169	150
Harbour Grace *	45.52	50.64	39.20	16.42	12.25	137	60

* At Harbor Grace instead of the depth of snow its equivalent in water is given in 1873 and 1874. (Toronto Meteorological Report.)

From these tables it will be observed that ten and twelve feet of snow falling throughout the winter, year after year, is the rule at sea-board stations in the Maritime Provinces, and also at certain elevated stations in the interior of Ontario. If the climate and the surface of the country were such as to permit this large quantity of snow to drift in such a manner that considerable portions might remain in great accumulations throughout the year on the slopes of hills and mountains, as now occurs on the Labrador, some conception may be formed of the vast amount of glacial work which would be accomplished by the slow downward movements of the drifts.

But during the recognized submergence of the continent to the extent of several hundred feet, throwing the Labrador current in the direction of the valley of the St. Lawrence—always pressing westerly by the rotation of the earth—the necessary conditions of climate would be induced over a vast area. Wherever we find arctic and some sub-arctic shells in the drift, there too, on the neighbouring coasts, would snow drifts have accumulated

and effected their mechanical work of polishing the sides of ravines, moving rock masses, and assisting in a marked degree the general resulting denudation.

VIII.—Direction and Force of the Winds.

The constant high winds which prevail on the Labrador from west to east, coupled with the absence of forests on and near the exposed coast line, are the causes of the great drifts described in preceding paragraphs. The work of the drifts is determined by these winds to lie in a uniform direction, and their denuding effects are in general on the east or lea side of hills and mountain ranges, but not always so.

The following abstract shows the proportionate length of time that the winds from each point of the compass prevailed at Nain, Labrador, as indicated by the number of observations. (From Professor J. H. Coffin's Memoir on the "Winds of the Northern Hemisphere." Smithsonian Contributions to Knowledge, 1854, Vol. VI.)

Nain, Labrador.

Period one year.

North	160
N. E	82
East	77
S. E	7
South	6
S. W	12
West	180
N. W	140
Calm	2

The resultant of these observations is a direction very nearly parallel to the coast line and in the direction of the Labrador current.

Professor Coffin gives the general resultant direction of the winds at Nain for the period of eleven months as N. 25° 55′ W. with a note of enquiry (?), July being not recorded. The ratio of the progressive motion in the mean direction to the total distance travelled by the wind being as 50 to 100, showing a remarkable constancy of direction and force.

At St. John's, Newfoundland, this ratio is 18 to 100, and the mean direction S. 78° 4′ W. or not far removed from west and east, the number of years embraced in the observations being

four. The mean direction of the winds at Nain are therefore nearly at right angles to those of St. John's.

It is a legitimate conclusion from observed results that the mean direction of the wind during the winter months at any station will have an effect upon the distribution of snow drifts there. Hence where these drifts are permanent throughout the year, the mean direction of the wind determines also the aspect of the accumulations, and as a consequence the aspect of the denudation. Where the mean direction is from north to south, the southern slopes of hills will be precipitous, the northern sloping; where the mean direction is from east to west, the west exposures will be steep and abrupt, the eastern inclined. Hence the wind, acting through the instrumentality of snow, will ultimately exercise considerable influence in moulding and sculpturing the surface.

The *spruce trees* on the Labrador coast, which in some exposed localities have succeeded in obtaining a footing in a belt or series of narrow belts extending from north-west to south-east, furnish a remarkable illustration of the power and direction of the wind. They are rarely more than six feet long in the trunk before they begin to bend at right angles, and their branches and the upper half of the gnarled trunk grow horizontally, forming a very pretty level expanse of intricately interwoven branches, which are so compact as to leave the space beneath covered as it were with an impenetrable roof of green. One can creep underneath this miniature branch-woven forest, but to pass through it without cutting a road with an axe, or selecting a deviating course under the dwarfed trees from one open spot to another, is impracticable. One can get over it, and in some cases walk for a few yards on *the top of it*, but all attempts to get directly through it are unavailing. Peering and creeping underneath these tiny dwarfed forest roofs, one sees the leafless branches which underlie the surface sheet of green, all directed horizontally towards the south-east. The total height of most of the narrow "belt of woods" on the exposed coast did not exceed seven feet, but as soon as a sheltered cove or valley was reached, secure from the prevailing north-westerly winds, *and with a soil*, there the trees grew tall and straight, but such instances on and near the coast are rare, the surface is generally so denuded of soil by winds and drifts, that peat only and a few bushes, with berry bearing plants preserve a lodgment under the

ceaseless attacks of the north-westerly winds. The different methods in which winds affect the configuration of the surface, is discussed at great length in an article in Peterman's Mittheilungen by Dr. Frances Czerny of which an abstract appears in '*Nature*' (Jan. 11, 1877) entitled "The Action of the Winds in determining the form of the Earth."

IX.—Influence of Snow Drifts as a Geological Agent.

The description given by Mr. Lieber of angular masses of rock on Mount Bache, slowly moving down hill under the ceaseless influence of snow, offers an explanation of the sub-ærial denudation of large areas successively brought under the influence of snow drifts. Natural joints and cleavage in the first instance, greatly facilitate this operation, and those strata which are most subject to joints and weather easily, are the first to suffer from the effects of frost and yield to the influence of pressure. Although some of the strata of the Labrador series are exceedingly compact and tough yet others weather very easily, and are rapidly acted upon by frost, thus becoming worn and disintegrated by the pressure of slowly moving snow-banks on sloping surfaces. Dr. Hunt briefly describes the rocks of this series as follows: "The anorthosite rocks of the Labrador series present great variation in texture, being sometimes coarsely granitoid, and at other times finely granular. They not infrequently assume the banded structure of gneiss, lines of pyroxene, hypersthene, garnet, titanic iron ore or mica, marking the planes of stratification. Probably three-fourths of the anorthosites of this series in Canada, whether examined in place or in the boulders which abound in the St. Lawrence valley, consist of pure or nearly pure felspar rocks, in which the proportion of foreign minerals will not exceed five hundredths." *

Dr. Packard† describes the conical hills of Square Island, as weathering very easily, large masses being detached by frosts and readily crumbling to pieces. The great hypersthenic boulders at Porcupine Hill and on the shores of Lake Melville show a crumbling exterior.

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* On Norite or Labradorite Rock, by T. Sterry Hunt, LL.D., F.R.S.

† Observations on the Glacial Phenomena of Labrador and Maine. 1866.

I have shown elsewhere that land slides, in valleys cut through this series, (Explorations in the interior of the Labrador Peninsula; 1862) are numerous, and that the felspathic strata are those which first yield to frost, arising probably from cleavage, coupled with mechanical texture.

It may be mentioned here that on an Island about seven miles from Hopedale, and also in the vicinity of Hopedale, I found rocks which may belong to a formation separate from either the Upper or Lower Laurentian. Sufficient information regarding these beds has not yet been obtained on which to base an opinion. During the present summer opportunities may occur for securing more facts.

The existence of the Labrador series over a very wide extent of country between the St. Lawrence and the Northern Labrador, in the form of *Outliers* or detached areas surrounded by the Lower Laurentian rocks, and the presence of innumerable boulders show that it has been subjected to great but irregular wear. The thickness of the series is estimated at 10,000 feet. One may suppose that the process of denuding the Lower Laurentian of the Labrador series over a considerable part of the Labrador Peninsula, has been to a considerable extent effected through the instrumentality of Snow Drifts, which appear to have done very important work as a geological agent on the coast, and in earlier times in far lower latitudes, where the excavating work has been solely attributed to glaciers.

It will be seen that the argument here presented rests in the main upon the presence of an Arctic current. In all attempts to describe the origin of boulder-clays, the transportation of boulders, the scratchings on rocks in certain directions, apart from strictly glacial scratches, and the heaping up of vast accumulations of gravels, the presence of an Arctic current is always presupposed. Indeed, without such a cold current coming from the north or the south, drift work as we see it in very many instances, could scarcely be explained in the present state of our knowledge. We know that the slow subsidence of the continent would bring an enormous area under the prolonged influence of this current, which would be pressed to the westward by the rotation of the earth. The gradual rise of the land for a second time brings the successively rising surfaces under the influence not only of pan ice, but of snow drifts acting in the manner described, and like glaciers, continually retreating with the rise of

the land farther to the north. Hence I claim for SNOW DRIFTS an amount of denuding and polishing work which, when joined to that of PAN ICE, may assert for these simple agencies, now operating to an immense extent, an influence powerful enough to place them with denuding agents of the first class, among those different forms of ICE which assist in denuding the SURFACE.

NOTES UPON THE OCCURRENCE OF EOZOIC ROCKS IN THE SOUTH RIDING OF HASTINGS COUNTY, AND IN PRINCE EDWARD COUNTY, ONTARIO.

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It is well known that the South Riding of Hastings County, and also Prince Edward County, are generally noted for a large development of Cambro-Silurian rock, particularly of Trenton limestone. Two well-defined exceptions to this are met with, however; one in Hastings County, near Shannonville, about six and a-half miles east of Belleville (by rail), and the other in Ameliasburgh Township, Prince Edward County, about six miles south-west of Belleville.

The former of these areas is an outcrop of crystalline rock, the most southern extremity of which is met with immediately opposite the Grand Trunk station of Shannonville, on the north side of the railroad, distant about three-quarters of a mile from the village. It occupies a great part of lot number five, in the first Concession of Tyendinaga Township, and is distant from the nearest outcrop of Laurentian rock, except the area referred to above, about twenty miles. It forms a ridge running north and south about two thousand and eighty feet, while its breadth varies from two hundred to one thousand feet, and its maximum height is about a hundred and ten feet. Like all other elevations in this and more northern latitudes, its northern face is steep and bluffish, and its greatest height occurs near the northern end, while it dies down gradually to the south.

It is composed of a gray and green slate conglomerate, weathering greenish-gray, and very much resembling the slate conglomerate of Lake Huron belonging to the Huronian system. The base of this rock is a schistose gray orthoclase with green hornblende and epidote, while the pebbles are of Laurentian gneiss, white and red micaceous and syenitic granite, syenite, felsite, dolerite, diorite, epidote, chlorite and quartz, these masses being generally rounded, particularly the gneissic pebbles, and very rarely angular, while in size some exceed a foot in diameter, and others are not over two or three inches. Excepting the rounded character of the fragments, its agreement with the breccia described on pp. 6 and 7 of Mr. Vennor's report on the Geology of Hastings County is very close. The measures are somewhat thin-bedded, some of the layers not exceeding one inch in thickness, and strike nearly uniformly N. 10° E. on an average, while they have a uniform dip of E. 10° S. $< 69°$. They are intersected by several quartz veins, having a general strike N. 40° E. one of which averages sixteen inches in breadth. Boulders and pebbles of the rock are of rare occurrence, and where found, *i.e.* only on its south-west side, constitute a small percentage of the erratics. No boulder of this character seems to be met with further south-west than three miles from the rock.

Although the line of junction with the Trenton limestone is everywhere concealed, yet according to Professor McCoun it was plainly visible many year ago before a quantity of limestone had been quarried for building purposes; the latter was then seen overlying unconformably the slate conglomerate of the ridge. On the west side the limestone forms several small folds with east and west axes and moderate dips of 15° to 20° to south and north. The summits of these anticlinals have been denuded and partly filled with soil, the breadth of surface denuded nowhere exceeding a hundred feet. As exposed on the railway track, the limestone is intersected by two sets of joints at right angles to each other, viz. one from north to south, and one from east to west. On the east side the limestone is not so well seen as on the west, and, where visible, occupies a much lower elevation; where seen, however, it has the same small corrugations as on the west side, and these extend in the same direction. The limestone has been most extensively denuded upon the northern and north-western sides of the ridge, where a bed of stratified sand and fine gravel at least fifteen feet thick is

exposed, the pebbles composing the gravel being in great part limestone from the underlying rocks. So far as known no ice groovings or scratches are visible on either the rock or the immediately surrounding limestone, although said to occur not further than half a mile to the south-east.

The second area of Eozoic rock occurs on a farm belonging formerly to one David Gibson, in lot number 70, Concession II, Ameliasburgh Township, Prince Edward County, and is hence known as "Gibson's Mountain," although, strictly speaking it should be called "Bell's Mountain" from the fact of its having been first studied by Professor J. T. Bell of Albert College. It is situated about six miles to the southwest of Belleville, and is distant from the "Picton road" about half a mile. The mass of rock occupies about fifteen acres, and rises about a hundred and fifteen feet above the plain, the greatest height occurring near its north end where it is bold and bluffish, while like the Shannonville outlier it dies gradually down to the south-west. It strikes north-east and south-west and is intersected by several small fissures; one, the most important nearly separating it into two masses. It presents the typical mammillated appearance of true Laurentian rock, and is similar in lithological aspect to this. It is composed principally of a flesh-red and dark-red orthoclase, the colour varying from nearly white to dark red, a small per centage of translucent quartz, a little dark green hornblende and a very little black mica, the two latter minerals being generally absent, and hence externally the rock is of a pale pink to dark red. Although several good sections are exposed—one in particular occurring where a downthrow of twelve feet has "slickensided" the rocks on one side and formed a small "valley of dislocation" with a strike of N. 23° E.—there is no distinct appearance of stratification in these. There are, on the contrary, several places where the rock becomes decidedly porphyritic, crystals of orthoclase of two inches in length having been met with there. Still its very close analogy with the more distinctly stratified rocks of the same lithological character in Labrador would cause one to describe it as a true Laurentian, very feldspathic, somewhat what porphyritic, coarse-grained, granitoid, syenitic gneiss. It is said to agree topographically with the "Red Hills" of Madoc Township, Hastings County, while it certainly appears to be almost identical with them lithologically, judging from the descriptions given by Prof. McCoun and other observers. Like

the Shannonville outlier, which it probably antedates, it possesses several veins of white quartz, two of the principal of which run, one in a direction N. 43° E. while the other intersects the down-throw referred to above with a strike N. 62° W. The latter is best seen upon the north-east face of the fault which is vertical, the opposite face being of gradual elevation from the lowest point and the vein being partly concealed by vegetation. Each of the veins is about sixteen to eighteen inches in width.

On the summit, whence a fine view can be obtained of the plain beneath, are several grooves and scratches and polishing caused by stones imbedded in ice, these being generally S. 67° W., or nearly parallel to the strike of the mountain, and also to the strike of numerous small cracks, while perpendicular to others, which seem to strike S. 62° E. In one place a most interesting groove runs along to the depth of two inches, the vertical face of a small eminence, this groove being continued with a strike S. 63° W. along the horizontal rock when again met with. Wherever a crack or fissure occurs transverse to the striation, it is noticeable that only the north-eastern face of the fissure has been acted on, the south-western always remaining intact. Boulders of the rock are very rare on its north-eastern side, but are rather common on the south-western edge. At various places on the south-east side of the mountain, and at intervals over its surface the Trenton limestone is readily discernible, dipping S. 33° E. $<$ 23° to $<$ 26°, while on its south-western face it dips S. W. $<$ 15°, and in many places the line of junction between the two formations can be easily made out. On its north-west side occurs a bed of stratified gravel, apparently about ten feet in thickness, extending to the south-west side of the mountain.

In conclusion, it may be remarked that a hill about half a mile in length trending apparently north-east, rising to the same height as the Shannonville outlier but presenting an escarped appearance, and distant about one mile to the north-west of the latter, is composed, according to Prof. McCoun, who has minutely examined it, of the thick-bedded limestone, which cropping out on the Bay of Quinte at "Ox Point" about four miles to the East of Belleville, is met with near Stoco (or Stucco) Lake in Hungerford, and overlying the metamorphic rocks of Madoc and Huntingdon on Hog Lake in the latter township. Professor McCoun has also collected from the Shannonville outlier the

following plants which have been shewn by him to be peculiar to the metamorphic rocks of Central Canada:

Aspleninm ebeneum.
Carex longirostris.
Arabis hirsuta, var. Virginica.
Polygonum tenue.
Ceanothus ovalis.
Dicranum Muhlenbergii.
Dicranum spurium.

NEW FACTS RELATING TO EOZOON CANADENSE.

By J. W. Dawson, LL.D., F.R.S.

(*From the Proceedings of the American Association for the Advancement of Science, Buffalo Meeting, August*, 1876.)

At the last meeting of this Association, I had the pleasure of exhibiting some specimens of *Eozoon Canadense*, and of giving some oral explanations as to its nature and mode of occurrence. I now ask permission to mention a few additional facts which have been made known since the meeting at Detroit, and which still further contribute to our knowledge of the most ancient known fossil.

(1.) I would first beg leave to direct attention to the very interesting series of specimens now on exhibition in Philadelphia, in the collection of the Canadian Geological Survey; and which give a rare opportunity to study the various aspects of the fossil. In connection with Eozoon, I would also mention the remarkable mass of Graphite from Buckingham on the Ottawa, exhibited by the Dominion Plumbago Company of Canada. This mass is from one of the great beds of that mineral occurring in the Lower Laurentian, on a horizon not remote from that of Eozoon, and which in my judgment are really Laurentian coals, representing the vegetation of that period, as yet altogether unknown to us in its forms and structures.

(2.) A very interesting specimen, found last autumn by Messrs. Richardson and Weston, at Petite Nation, has enabled

me to delineate, in a recent paper, the inverted conical form of a perfect small specimen of Eozoon, and also to show that the acervuline chambers on its upper surface are precisely similar to those small aggregations of spherical chambers resembling *Globigerinæ*, and to which I have given the name *Archæospherinæ*; so that these may not improbably be loose chambers or germs of Eozoon.

(3.) Mr. W. J. Morris of Perth, Ontario, has in the past summer found abundant specimens *in situ* of Eozoon mineralized with Loganite, in the original locality at Burgess. These specimens show that the Burgess variety is on the whole thicker and more continuous in its sarcode chambers, and less developed as to the separating walls than the Grenville and Petite Nation specimens. These new specimens from Burgess have also enabled me for the first time to detect in their dolomitised walls traces of the canal system, into which, however, the Loganite does not penetrate. In some in which the dolomite is mixed with calcite, there is also an extremely minute granular structure, which I believe to indicate an originally porous character of the cell-wall, of which only obscure indications exist in other specimens.

(4.) Mr. G. F. Matthew has sent to me from the Laurentian of Lily Lake, near St. John, New Brunswick, specimens of a dolomitic limestone containing fragments of the skeleton of Eozoon, showing the canal system. This is the first recognition of this fossil in the Laurentian of New Brunswick. A notice of the fact has appeared or will shortly appear in "Silliman's Journal."

(5.) Recent explorations by Mr. Vennor of the Gelogical Survey have thrown further light on the precise geological horizon of Eozoon in the great Laurentian system. In Sir William Logan's original sections on the East side of the Ottawa, the lowest rock represented is a great thickness of orthoclase gneiss, corresponding probably to the fundamental or Bogian gneiss of the Scandinavian and Bavarian geologists. Above this is a very thick limestone, that of Trembling Lake, which has afforded no fossils. Next is another vast thickness of gneissic beds. Then comes a second limestone, also non-fossiliferous as yet, that of Green Lake. Then another gneissic series and a third limestone, that of Grenville, which is the special resting place of Eozoon, and is also associated with beds rich in graphite and in calcic phosphate. Still higher is a fourth limestone, and then the

Upper Laurentian. Mr. Vennor's observations relate to a region about eighty miles distant, on the west side of the Ottawa, and remarkable for its rich deposits of apatite and graphite, though affording Eozoon only in a few places, and in these not precisely in the same state of mineralization as at Petite Nation and Grenville. In this region Mr. Vennor has worked out a series corresponding in its main features with that ascertained by Logan, and it now appears that in both series Eozoon is apparently confined to one horizon, and that in this it is associated with the more important deposits of graphite and apatite. It is true that in the districts explored by Mr. Vennor there are some groups of strata of uncertain age, and which may be upper Laurentian or even Huronian; but the main accordance above stated seems to be certain. It would thus appear that Eozoon and those deposits of graphite and apatite which are probably of organic origin, are characteristic of one great zone of the Lower Laurentian.

(6) The abundant phosphates occurring in the Lower Laurentian, and as already stated in irregularly stratified beds, and associated with graphite and Eozoon, naturally raise the question whether they are of organic accumulation. The apatite of the Lower Laurentian has indeed as yet afforded no organic structure. Some light may however be thrown on its origin by the analogy of later deposits of similar character; and I have endeavored, in a paper recently read before the Geological Society of London, to show that the calcic phosphate contained in the Cambrian and Silurian rocks of Canada presents in its mode of occurrence points of similarity to that of the Laurentian; while the prevalence of low forms of life, as *Lingulæ*, *Trilobites* and *Hyolithes*, having much calcic phosphates in their skeletons, in the Primordial seas, and the consequent accumulation of beds rich in phosphatic concretions and coprolites, points to the possibility of similar conditions in the earlier Laurentian. I may also here refer, as corroborative of this view, to the recently published researches of Hicks and others on the Silurian Phosphates of Wales.

(7.) The objections to the animal nature of Eozoon recently promulgated by Otto Hahn, and which have been answered in detail by Dr. Carpenter and myself, have directed attention anew to the geological relations of serpentine; and though I must protest against the idea prevailing in some quarters, that there is any necessary connection between this mineral and Eozoon,

yet as serpentine exists in connection with many specimens of this fossil, it is time that geologists were warned against the extravagant ideas of pseudomorphism which have been promulgated in connection with it. I have, therefore, been engaged in the present summer in re-examining large series of specimens of serpentines associated with organic remains, and have visited some of the Canadian localities of such serpentines, and have studied their geological relations. I hope to show, when these researches are complete, that microscopical and palæontological evidence completely vindicates the theory of aqueous deposition of serpentine as maintained by Dr. T. Sterry Hunt, and shows that this mineral, like glauconite and similar silicates, may fill the pores and cavities of fossils, without in any way destroying their forms or structures. I have examples of Silurian corals and other fossils mineralized with true serpentine, precisely like Eozoon in the Laurentian. Further it can be shown that the Lower Silurian serpentines of Canada, alike in their interstratification with fossiliferous limestones, and in their passage into limestone, dolomite and even red slates, conform in a striking manner to the known laws of deposition of hydrous silicates in the modern oceans. Whatever opinions may be held as to the metamorphic origin of certain serpentines, or as to the mode of formation of serpentine veins, the facts I already possess are amply sufficient to show that such theories have no application to the ordinary serpentines found in beds associated with fossiliferous rocks.

(8.) I may add that I hold Gümbel's elaborate exposition of the foraminiferal nature of *Receptaculites*, in the Transactions of the Royal Bavarian Academy, and the announcement by Prof. Karl Moebius of a recent sessile Foraminifer from the Mauritius, not very remote from Eozoon in its general mode of growth, to be important contributions towards the history of this oldest fossil; whose investigation, as will be seen from the above notes, is by no means fully worked out.

NATURAL HISTORY SOCIETY.

PROCEEDINGS FOR THE SESSION 1876-77.

FIELD DAY AT BELŒIL.

On Saturday, June 10th, 1876, the Society held a field-meeting at Belœil mountain, to which, as on former occasions, the public was invited. A special train was engaged, and a party of between eighty and ninety friends of the Society left the Bonaventure station at 9.30 a.m. and reached St. Hilaire at 11 o'clock. From thence the excursionists leisurely proceeded to the lake near the Iroquois house, some on foot, others in various kinds of vehicles. On their arrival at this point about noon, Dr. J. Baker Edwards explained the programme of proceedings for the day, and read a letter from Bruce Campbell, Esq., in which that gentleman regretted that he was not able to be present at the meeting, but welcomed the visitors to the grounds, and gave some historical particulars about the mountain. An interval of an hour having been allowed for luncheon, at the expiration of that time the ascent of the mountain was commenced, and when the summit was gained, the President gave the following brief explanation of the geological features of the district.

Principal Dawson said that it devolved on him, as President of the Society, to address a few words to the friends who had honoured the excursion with their presence. He regretted the unavoidable absence of some gentlemen who might have spoken on this occasion; and expressed the thanks of the Society to Mr. Campbell, the Seignior, both for the use of his beautiful grounds and for the interesting historical information which he had been good enough to communicate, and which had been read to those present. The geology of Belœil, and the country visible from it, had been several times, on occasions of this kind, ably expounded on this breezy summit, so unfavourable in some respects for a geological lecture, but so inspiring in the wide and beautiful view which it commands. He would refer very shortly to the fact that Belœil mountain stands, with some other hills, in the midst of an undisturbed Silurian plain, and that the view from

it is bounded on the north by those oldest foldings of the crust of the earth which constitute the Laurentian hills, and on the south by the somewhat less ancient wrinklings which have produced the hills of the Eastern Townships and the Green Mountains. The mountain itself is an igneous or volcanic mass, rising through rocks of the Hudson River or Cincinnati group, which are seen on its flanks, and consisting of dense crystalline material such as that which forms the deeper and hidden part of modern volcanoes, but which has here been lald bare by the removal of the lighter scoriaceous and tufaceous matter which once covered it. The date of the activity of these Lower Canadian volcanoes is far back in geological time. They were probably cooled out before the close of the Silurian age, and since that time they have been subjected to the denuding action of the atmosphere and its waters, and more than once to the waves and currents of the ocean. The last known residuum of the sea in the Lower Canadian plain is evidenced by the clays and sands of Pleistocene date, and holding marine shells, scattered over its surface; and also by the occurrence on this mountain, at a height of 1100 feet above the sea, of water-borne Laurentian boulders from the Laurentide hills to the north, specimens of which may be collected on the path leading to the summit. Any one viewing from the present standpoint the wide and low valley of the St. Lawrence and the blue Laurentian hills, at least fifty miles distant, from which these stones must have been borne (and they probably came from much greater distances than the nearest margin of the Laurentian), must be convinced that no other means than those of floatage by water could have carried them so far. We are thus carried back to that phase of the so-called glacial period when Belœil was a mere rock in the sea, and fields and bergs of ice were drifting against it, borne on by the northeasterly Arctic currents, from the distant Laurentian hills, then little elevated above the sea, and probably for the most part snow-clad.

We are reminded by these geological facts of the treasures that exist in the rocks and soils which are overlooked from this summit,—the iron, lead, plumbago and phosphates of the Laurentian range; the vast expanse of fertile soil in those fields that stretch almost interminably over the plain of the St. Lawrence; the copper, the gold, the antimony, the iron, the slates, the marbles of the southern hills. This is a rich inheritance of

wealth, but yet utilised only in a small degree compared with its capabilities. To receive the full benefit of these great treasures which Providence has placed within our reach, we need more practical science. We have seen too much of the neglect and loss of valuable minerals and of the deterioration and waste of soils, of the squandering of money on worthless objects, of the neglect of science and its votaries by our public men and our business men. The ignorance of the masses of our population, the want of appreciation of the value of science on the part of capitalists, the paltry sums granted by our government for scientific research, the almost entire want of encouragement and support to our scientific schools, these are features of Lower Canadian life saddening to any man who wishes well to his country, discouraging to those who have struggled for better things. Let us hope that a brighter time is coming, and that even the little twinkling light which our Natural History Society has sustained amidst the darkness, may be revived and made to shine more brightly in the time to come.

Although in the morning the clouds looked threatening, the day on the whole was bright and sunny, with the exception of one or two light showers which fell in the afternoon. A list of the plants met with at this locality has already been published in these pages, and few, if any, additional species were collected on this occasion. The entomologists of the party were, however, more successful, as the following list of insects taken or observed during the day, kindly prepared by Mr. F. B. Caulfield, will testify:

Coleoptera.

Cicindela purpurea Oliv.	One specimen.
" sexguttata Fabr.	do.
Pterostichus lucublandus Say.	Two specimens.
Harpalus Pennsylvanicus Degen.	Several taken.
" ——? undetermined.	Three specimens.
Silpha peltata Cates.	One specimen.
Leistotrophus cingulatus Grav.	do.
Aphodius fossor Fabr.	do.
Geotrupes excrementi Say.	do.
Dichelonycha elongatula Fitch.	Several.
Ancylocheira maculiventris Say.	One specimen.
Telephoens Carolinus Fabr.	Several.
Melandrya striata Say.	One specimen.
Meloe augusticollis? Say.	do.

Asclera ruficollis? Say. Several.
" ——? undetermined. Several.
Callidium antennatum Newm. One specimen.
Galeruca ——? undetermined. do.
Labidomera trimaculata Fabr. Several.
Calligrapha Bigsbyana Kirby. One specimen.
Coccinella ——? A beautiful species, not represented in any Canadian collection that Mr. Caulfield has seen.

Lepidoptera.

Papilio Turnus Linn. Tiger swallow-tail. Several seen.
Pieris rapae Linn. The cabbage white. Two seen.
" oleracea Harris. Grey veined white. One taken.
Colias Philodice Fabr. Clouded sulphur. Several seen.
Lycaena Lucia Kirby. Spring azure. One taken.
Vanessa Antiopa Linn. Camberwell beauty. One seen.
Nisoniades brizo. The brizo skipper. One taken.
Atrytone zabulon Boisd. Tawny skipper. do.
Sesia uniformis Grote. Humming-bird moth. do.
Deilephila Chamaenerii Harris. Lilac hawk moth. do.
Euprepia Americana Harris. American tiger moth.
Two caterpillars taken nearly full grown.
Clisiocampa Americana Harris. American tent caterpillar.
" sylvatica. Forest tent caterpillar.
Caterpillars of both of these moths were seen during the day.
Ctenucha Virginica Charp.
A cocoon of this moth was found on a fence by the road side.
Cucullia Intermedia Speyer. One specimen taken.
Lozogramma difluaria. do.
Drasteria erecthea Guen. do.
Cidaria ——? undetermined. do.
Two undetermined species.

Orthoptera.

Gryllus neglectus Scudder. Common field cricket.
One specimen taken, several heard during the day.
Tragocephala infuscata Harris. Dusky locust.
One specimen taken, several seen.

Neuroptera.

Panorpa rufescens Rambur. The rusty scorpion fly.
Two specimens taken, not hitherto recorded from Canada, so far as Mr. Caulfield is aware.

After spending some time in gazing on the beautiful landscape spread out beneath them, and in examining the various objects of interest to be met with at this elevation, the party returned to the lake, and after wandering round its margin for an hour or

more, made its way back to the St. Hilaire Station at 4.30 p.m., and reached town a little after six o'clock.

The first prize, for the largest number of named species of flowering plants, was awarded to Mr. J. B. Goode, but no other prizes were given, as the collections submitted for competition were not deemed to be of sufficient merit.

MONTHLY AND OTHER MEETINGS.

Special Meeting of the Society, held June 26th, 1876.

The meeting was called for the purpose of considering the desirability of procuring a suitable memorial of the late Mr. E. Billings.

On motion of Mr. G. L. Marler, seconded by Mr. J. H. Joseph, it was resolved:

"That on the occasion of the decease of Elkanah Billings, F.G.S., one of the Vice Presidents of the Society, and for many years one of its most eminent members, the founder of the *Canadian Naturalist and Geologist*, and above all the careful and accurate describer of the Palæozoic Fossils of Canada, it becomes this Society to testify its sense of the great scientific services of the deceased, and its high estimate of the importance of palæontological research to the practical and scientific exploration of this Dominion. This meeting would therefore record its appreciation of the life-long labours of Mr. Billings in the cause of science, and its sorrow for his removal from among us, and would convey to his widow and other relatives its sympathy with them in their bereavement."

On motion of Mr. J. F. Whiteaves, seconded by Mr. Christian Hoffman, it was further resolved:

"That a Committee of the Society, to consist of the President, the Rev. Dr. DeSola, Rev. Canon Baldwin, Drs. B. J. Harrington, John Bell, and the mover, be appointed to take such steps as may seem to them desirable to provide a suitable memorial to the late Mr. Billings."

The opinion of those present was in favour of obtaining an oil painting of the deceased, to be hung in the Society's rooms, and Mr. Whiteaves with Dr. John Bell were requested to inquire if there were any existing portraits from which a copy might be made.

It was then moved by Mr. J. H. Joseph, seconded by Mr. C. Robb, and resolved:

"That the same Committee be empowered to take steps for procuring a portrait of the late Sir W. E. Logan for the Society's rooms."

1st Monthly Meeting, held October 30th, 1876.

The members of the Lecture and Conversazione Committee of last year (viz. Rev. Dr. DeSola, Dr. J. Baker Edwards, Dr. Harrington, Rev. Canon Baldwin, and Prof. Darey) were re-elected, and the name of Dr. W. Osler was added.

Principal Dawson then made a communication "On some features of the Geology of the Intercolonial Railway."

Some remarks on this topic were made by Mr. A. R. C. Selwyn, who also moved a vote of thanks to Principal Dawson for his interesting exposition of the subject.

2nd Monthly Meeting, held November 27th, 1876.

Dr. Buller and Dr. Alloway were elected resident members, Mrs. E. K. Greene and Miss Atwater, associates, and Albert J. Hill, a corresponding member of the Society.

An obituary notice of the late Mr. E. Billings was read by the Recording Secretary. This will be found at the commencement of the present number.

3rd Monthly Meeting, held January 29th, 1877.

Messrs. G. S. Wilson, James Walker, N. R. Mudge, and Humphry were elected resident members.

Dr. W. Osler then read a paper "On the Fresh Water Polyzoa of Canada," illustrating the subject by diagams and microscopical preparations.

After some remarks by the President, the meeting was adjourned.

4th Monthly Meeting, held February 26th, 1877.

It was resolved "that the name of Mr. J. Fraser Torrance be associated with that of Dr. Harrington in the editorial supervision of the *Naturalist*."

A collection of coleoptera from the Upper Peace River country, collected by Mr. A. R. C. Selwyn and Prof. Macoun in 1875, and named by Dr. Leconte, was exhibited and placed by Mr. Selwyn on deposit in the museum.

Dr. Donald Baynes and Mr. P. S. Ross were elected members of the Society.

A paper by Prof. H. Y. Hind, M.A., "on some Geological Features of the Northern Labrador coast," was then read by the Rec. Secretary. This will be found on page 262.

A discussion ensued, in which the President, Mr. Selwyn, and other members took part.

5th Monthly Meeting, held March 26th, 1877.

Mr. W. Kennedy was elected a member of the Society.

A number of photographs of inscriptions from Easter Island, of the natives, &c., of the same locality, were presented by the President on behalf of D. Robertson, Esq., and exhibited at the meeting.

A paper entitled "Notes on Elevation of the Land in British Columbia," was then read by Mr. G. M. Dawson.

Principal Dawson made a communication explanatory of the photographs of inscriptions, &c., from Easter Island, previously mentioned.

A paper from a gentleman resident in India, being a series of miscellaneous Natural History notes, was also read by the Rec. Secretary.

The proceedings were closed by the passing of a vote of thanks to thd authors of the papers read.

6th Monthly Meeting, held April 30th, 1877.

Mr. J. L. Macpherson was elected a resident member, and Count de Premio Real (Vice Consul for Spain at Quebec), a corresponding member of the Society.

The Rec. Secretary then read a paper by Dr. P. P. Carpenter "on the proposed alterations in the rules of the British Association for Zoological nomenclature."

Comments on some of the points raised in this communication were made by the President, the Rec. Secretary, and others, but the views advocated by Dr. Carpenter were on the whole approved by the meeting.

Dr. Harrington presented the second part of Prof. Hind's paper on the Geology of the N. E. coast of Labrador, which was laid on the table and taken as read.

SOMMERVILLE LECTURES.

The free public lectures of the Sommerville course were duly delivered during the months of January and February, 1877, to good audiences. The following is a list of the titles of the lectures, with the dates at which they were delivered, and the names of the authors.

1. Jan. 11th, 1877. The Andes of Ecuador.
   By Thomas Macfarlane, Esq.
2. Jan. 25th, 1877. Cuvier and his Contemporary Naturalists.
   By Prof. P. J. Darey, M.A., B.C.L.
3. Feb. 1st, 1877. Two years on the Amazon and Madeira rivers, Brazil.
   By Donald Baynes, A.M., M.D.
4. Feb. 8th, 1877. A visit to Sarawak, Borneo.
   By J. Fraser Torrance, A.B., B.A.Sc.
5. Feb. 15th, 1877. A visit to British Columbia.
   By G. M. Dawson, M.E., F.G.S.
6. Feb. 22nd, 1877. The Centennial Exhibition, Philadelphia.
   By S. C. Stephenson, M.A., Secretary to the Centennial Commission.

ANNUAL MEETING.

The annual meeting was held on the 18th of May, 1877.

The minutes of the last annual meeting having been read, the annual address was delivered by the President, Principal Dawson, as follows:

ANNUAL ADDRESS.

In closing another Session of this Society, we naturally turn to the work of the past year, and in this address it is more especially our scientific labours that claim attention. What have we done in the past year for the advancement of science, and for the credit of our country as one of the civilized nations of the world? I would not underrate what we have accomplished for the popular diffusion of knowledge, by means of our museum, our excursions and our popular lectures, but the original investigations which we have given to the world constitute our best title to regard as a scientific association.

In the course of the winter nine original communications have been laid before thie Society; and of these the greater number have appeared or will appear in our Journal. Of these commu-

nications two; namely, that on Inscriptions from Easter Island presented by Mr. D. Robertson, and Notes on Animals of India, did not refer to the natural history of this country. With respect to the former, however, I may say that it has a connection with America in the circumstance that so many indications point to a migration of civilized or semi-civilized men into America by way of the Pacific, and to the probability that Easter Island was one of the stations in this migration. Mr. Hyde Clarke and Dr. Wilson have both directed attention to this subject, and have shown that in languages and physical features there are links of connection between the Polynesian and the Peruvian races, and that the ruins of large stone buildings found in so many of the Polynesian Islands, as well as the arts practised in those islands, point to similar conclusions. The possession of a sort of picture writing for the keeping of family and tribal records in Easter Island, and the not very remote resemblance of this to some familiar American contrivances of the same kind, furnishes an additional link of connection. On the often disputed question of the source or sources of the aboriginal American population, it now seems to be the settled conclusion of archaeology that we have good evidence of prehistoric migrations of man into America by Behring's Straits from Northern Asia; by the Pacific Islands from Southern Asia; and by the Equatorial Atlantic, by way of the Canaries and West India Islands. To these we have to add the probability of Chinese and Japanese ships having at various times been drifted upon the Pacific coast, and the discovery of Greenland and part of the mainland of America by the Norsemen in the tenth century. Thus there seems to be not one way merely but several in which America may have received its early population, and by which we may account for the native races of America with their languages and customs merely as derivatives from the old world, and without supposing these tribes to be true Autochthones.

Two very interesting communications of a geological character were those of Prof. Hind on the Geology of Labrador, and of Mr. G. M. Dawson on Recent Elevations and Subsidences of the Land in British Columbia. Remote though these regions are from each other, they present some remarkable points of similarity, especially in relation to their more recent geological history. In both we have the evidence of the great glacial age. In both the surface glaciation and transport of boulders seem to

have been caused by the joint or successive action of water-borne ice, and glaciers. In both there are the most remarkable evidences of submergence to a great depth in the Post-pliocene age. It is a remarkable illustration of the vastness of the geological changes which have occurred in comparatively modern times, that we should find on the mountains of the Pacific Coast and those of the North Atlantic seaboard the indications of a common submergence, and this of very great amount. Such vicissitudes are not to be accounted for by merely local causes, but by grand agencies effecting at once a whole hemisphere or the whole earth.

In British Columbia there seems to be good evidence of the submergence of the land to such an extent that sea margins occur 5270 feet above the level of the sea, and at various elevations between this and the present sea level. In the Rocky Mountains Mr. Dawson had previously measured the height of similar terraces 4400 feet above the sea. While those great depressions occurred in the Post-pliocene period, there is evidence to show that in the preceding Pliocene age the land in British Columbia may have been 900 feet higher than at present. On the other hand, in modern times the coast would seem to have been going down at a rate in some cases of as much as ten to fifteen feet in a century; while there are Indian traditions of sudden waves overflowing the land, and perhaps occasioned by earthquake movements. With reference to these modern changes, it should be observed that British Columbia forms a part of that great band of volcanic and seismic activity which extends along the west coast of America, and which presents in our own time and in the more recent geological periods, evidences of agencies which have long slumbered on the eastern margin of the continent.

On our own side of America, the numerous terraces so well developed on the Lower St. Lawrence, mark the stages of recession of the Post-pliocene ocean. Mr. Richardson informs me that he has found one of these terraces on the west coast of Newfoundland, at a height of 1225 feet above the sea. On Belœil Mountain, in our own neighbourhood, we find travelled Laurentian stones which must have been water-borne, at a height of nearly 1200 feet, and if the travelled stones found by Prof. Hitchcock on Mount Washington have been deposited by floating ice, then the highest summits of our mountains must have been under water at the time of the greatest Post-pliocene submer-

gence. Mr. Milne Home has recently directed attention to many facts of similar import which are being accumulated in Great Britain and in Norway. Geologists are thus beginning to realize the evidence of a prevalence of the sea over the Northern hemisphere in the most recent of the geological periods; which at one time they would have regarded with the utmost scepticism.

While noticing these papers, I would also direct attention to the evidence which they afford as to the action of sea-borne ice as distinguished from that of glaciers; and in connection with this it is important to note the influence attributed to floating pack ice and "pan ice" by the officers of the late Arctic expedition, as well as by Prof. Hind and by Prof. Milne in recent papers in the Geological Magazine. On the other hand the observations of Hellond on the glaciers of Greenland, published in the Geological Magazine, state the interesting fact that one of the great glaciers of that country flows seaward at the surprising rate of 20 metres in a day, and gives off a vast abundance of bergs, more or less laden with earthy matter and boulders. A fact like this helps us to understand the gigantic furrows ploughed by some of the old local glaciers of the Laurentian hills, and of which the sluggish glaciers of the modern Alps afford no adequate explanation.

All these new facts tend to strengthen the conclusion that general submergence and the action of floating ice and of local glaciers afford the causes at work in the so-called glacial age.

In the department of Zoology we have reason to congratulate ourselves on the communication of Dr. Osler on the Fresh-water Polyzoa of Canada. These remarkable and interesting animals, though abundant in our canals and ponds and slower streams, have as yet received little attention. The contribution of Dr. Osler brought under our notice several species; some of them forming communities of considerable size, and all of them of very great interest and beauty.

Our attention was called by Dr. Carpenter to the subject of Zoological nomenclature, in connection with a circular issued by Mr. Dalle on behalf of the American Association for the Advancement of Science. With the replies prepared by Dr. Carpenter most of us I think in the main agree; and while we regard as very reprehensible many of the eccentricities of genus-makers and species-makers, more concerned to gain credit to themselves than to advance the interests of science, we equally reprobate the

over-scrupulous antiquarianism which would revive uncertain and forgotten names to the exclusion of those sanctioned by long use. There is perhaps little hope that these evils can be wholly remedied in the present state of science, when there is in this respect no king in Israel, and every man does what is right in his own eyes. We believe however that the old rules sanctioned by the British Association, with a moderate amount of self-abnegation and common sense, will be sufficient to secure all that is really necessary.

The lamented death of Mr. Billings is a heavy blow to this Society, as well as to the cause of science in Canada; and one of our meetings was appropriately occupied with an obituary notice by his successor, Mr. Whiteaves. It is not necessary for me to refer to the details contained in that notice. I may remark however that Mr. Billings may be considered as the creator of Canadian Palæontology, in so far as the Invertebrate fossils of the Palæozoic rocks are concerned. This department he built up from its foundations, and built so extensively and so well, that it will be long before his work can be hidden from view by any additions to be made by his successors. As a worker he was painstaking and cautious rather than rapid, and his results were always regarded with respect and confidence by those engaged in similar pursuits elsewhere. He was not a mere describer of species, but a geologist of sound and broad views, and his earlier works show a power of lucid and popular presentation of his subject which it is perhaps to be regretted he did not follow up in his later years. One of his greatest failings was a certain shrinking from publicity, which rendered him indisposed to take a prominent position even in the work of our own Society, and still more tended to prevent him from entering into any presentation of his favourite studies to the general public in any other form than that of official reports and scientific papers. Such men as Mr. Billings are produced in small numbers in any country, and it may be long before Canada possesses as one of her own sons a second Billings. It is however a remarkable coincidence that such a man should have been preparing himself to second the work of Sir William Logan just at the time when Palæontological work had become a prime necessity for the Canadian Survey.

I have reserved to the last some remarks connected with the subject of my own paper on the Geology of the Intercolonial

Railway, and which subject I desire here to refer to in a somewhat broad and discursive manner, demanded I think by the present condition of science and the industrial arts in this country. I would in this connection desire to direct your attention to the immense importance of that great public work, and to the effects which would flow from a further extension of similar enterprise in the west. I can remember a time when the isolation of the Maritime provinces from Canada proper was almost absolute. There was a nearly impassable wilderness between, and no steamers on the waters, and the few whom business or adventure caused to travel from Halifax or St. John to Quebec or Montreal, had to undertake a costly and circuitous journey through the United States, or to submit to almost interminable staging through a wilderness, or to the delays of some sailing craft on the St. Lawrence. In later times steamboats have supplied a less tedious mode of communication, and now we see placards informing us that the Intercolonial carries passengers from Quebec to Halifax in twenty-six hours. But it has done more than this. The traveller may now see the coal of Nova Scotia travelling upward to Quebec, and the fresh fish of the Atlantic coast abundantly supplied in our markets, while the agricultural products of the interior travel seawards in return. This is however but the beginning of a great change. A delegation of coal owners was in Ottawa last month endeavouring to attract the attention of members of the Legislature to the fact that Ontario might be cheaply supplied with coal from Nova Scotia in return for her farm products. The representation led to no immediate practical results, but it foreshadows a great future change. Living as we do on the borders of that great nation without any name, except that of America, which does not belong to it, and which builds an almost impassable wall of commercial restriction along its frontier, we cannot long endure the one-sided exchange of commodities which takes place at present so much to our disadvantage. The Nova Scotian cannot buy flour and manufactured goods from a people who refuse to take his coal and iron in exchange; and the Ontarian or Quebecker cannot afford to have the commercial connection with the mother country severed in favour of a nation which will not take the products of our fields, our forests, our mines or our granaries in exchange. We shall have in self-defence to cultivate our own internal trade, and even if we must bring the

products of the Pacific and Atlantic Coasts across a whole continent to meet each other, this will be cheaper in the end than to sacrifice our own interests and those of the empire to the Chinese policy of our neighbours in the South.

The diversities of products in countries depends much on differences in latitude, but there are also diversities depending on longitude, and, fortunately our country possesses these in no small degree. On our Atlantic coast we have rich fisheries and minerals not possessed by the interior regions. In these last, through all the great regions extending from Quebec to the Rocky Mountains, we have vast breadths of fertile soil besides many of the elements of mineral wealth, and varied kinds of manufactures are growing up both on the coast and inland. What is to hinder a direct exchange of commodities within ourselves instead of an indirect exchange under the most serious disadvantages with the United States. Further, such direct exchange would increase our trade with Great Britain and the West Indies, and bind together the somewhat divergent sections of our own population. The opening up of railway communication across the great western plain might do for us what a similar process has done for New York. But from a railway terminus on the Pacific shore we could stretch our commercial relations over that great ocean, and bring all the treasures of the Orient to enrich our markets. Further, in establishing communication with British Columbia, we are not merely establishing a landing place on the Pacific, though this would be an inestimable advantage. British Columbia is in the mining point of view, one of the richest portions of the earth's surface. It is of more value acre for acre than any portion of the Eastern States or of Canada proper. In an appendix attached to a recent report on the Pacific railway, Mr. G. M. Dawson has collected some details as to the mineral wealth of this region. He mentions gold-fields yielding now more than a million and a half of dollars annually. In eighteen years British Columbia with only 10,000 inhabitants has exported gold to the amount of 40,000,000 of dollars; and it is no exaggeration to say that with a larger population and better means of conveyance this yield might be increased twenty fold.

Coal exists on Vancouver's Island and the neighbouring mainland in inexhaustible abundance, and of excellent quality, and

represents the sole supplies of that mineral on the Pacific coast of North America. British Columbia might supply the whole Pacific coast and a vast interior region, and might produce many millions of tons annually.

Iron, silver and copper are known to exist in productive quantities, and there is reason to believe that mercury, lead, and platinum might be added.

In short, British Columbia posssesses all that mineral wealth which has enriched California and the States adjoining it; and the opening up of communication between it and other parts of the Dominion would be the beginning of a series of events that would build up great and wealthy cities and populous seats of industry in a region now scarcely inhabited, and cut off from direct intercourse with the other provinces politically connected with it.

What the Intercolonial has begun to do for our relations with the Atlantic provinces, the Canada Pacific must do for our relations with the Pacific province; and if I could present before you in a prophetic picture all that would follow from the establishment of such a connection, and the trade of the great sea and lands beyond, which might flow through our country, you as citizens of a commercial city, as well as in the capacity of votaries of science and scientific art, would at once say that at almost any sacrifice this great work should be executed. The difficulties in the way are undoubtedly great—so great that this generation of Canadians should scarcely be called upon to overcome them unaided, but they are probably not insurmountable, and the mode of meeting them is certainly at present the greatest public problem that our statesmen have to solve. It is further undoubtedly the duty of those whose scientific studies show them the grandeur of this great question and the nature of the practical results of its solution, to aid in every way that they can the progress towards an unobstructed highway through our territory from the Atlantic to the Pacific.

If it is in our power thus to bring together the resources of the whole breadth of the Continent, we may hope to consolidate our connection with the Mother Country by making ourselves indispensable to her interests, to relieve ourselves from the galling commercial yoke laid upon us by our neighbors, to provide homes and work for the surplus population of our older provinces, to build up the wealth of great trading centres, and to render

vast and naturally wealthy regions productive of subsistence for millions of men.

When I look forward to the future of this country and base my anticipations, not on the merely human elements of to-day, but on the geologic treasures laid up in past ages, I see the Dominion of Canada with a population as great as that of the United States, and with some of the greatest and wealthiest cities of this continent in Nova Scotia and British Columbia. Geologists are not merely prophets of the past, they know something of the future as well. It might perhaps be well if we could inoculate our statesmen with a healthy belief in the geological future of Canada, or even with some faint idea of the billions of dollars of accessible treasures that lie beneath the soil of British Columbia and Nova Scotia. We might then see them put forth some effort to realize this El Dorado within the time of those now living, rather than contentedly allow it to wait the action of men wiser and more energetic than ourselves.

Of the future of our own Society I shall say little. Much must depend on a judicious selection of officers, much on the liberality which the public may extend to us, much on the earnest efforts which our working members may put forth, and this not merely in the pursuit of new truths, but in cultivating in others a desire for that knowledge which we know from our own experience to be in itself one of the richest treasures which the world affords.

It is a matter of deep regret to us on this occasion that a recent Act of the Dominion Parliament renders it possible that the Geological Survey of Canada, which has since its commencement had its domicile in this city as the centre of commerce and practical science in the Dominion, may within one or two years be removed to Ottawa. That this, should it be carried into effect, would be a serious loss to this Society, the large number of papers and lectures contributed by members of the Survey, and the active part they have taken in the management of its affairs as officers and members testify. The removal of the Survey would also have its effect on the University, and on the interests of the numerous students who resort to this city for education, as well as on those of gentlemen connected with the numerous mining and similar enterprises which have their centre here. Nor would such removal be without injurious influence on the Survey itself. This Society was the first public body to urge on the

Government the undertaking of a scientific survey. The Natural History Society, the University and the citizens generally, have always supported the interests and aided the work of the Survey, and have in many ways promoted its efficiency. Nor can an institution possessing a Museum and Labratories which are the growth of so many years, be hastily removed without serious loss, only to be repaired by renewed effort and the lapse of time.

But to my mind these local considerations are overborne by the change in the constitution of the Survey which has been made, rather, I fear, in the spirit of a narrow bureaucracy than of an enlightened regard for science. Hitherto the Survey, while nominally under the control of an Ottawa Department, has been in reality an independent institution, recognized as such abroad. Its directors and principal officers have been men whose reputation has far transcended that of the gentlemen who temporarily occupy departmental offices at the seat of government. It is now to be a branch of the Civil Service, a mere appendage to the Department of the Interior. The effect of this may not be felt for a time, but it must eventually tend to deprive the Survey of its independent scientific action, to diminish its importance and consideration abroad, and perhaps in the end to reduce it to a mere industrial bureau, or to place it in the uneasy position of that American Survey of the Territories, which is in like manner attached to the Department of the Interior: but which is there supplemented by the military surveys, and by the surveys of the several states, some of which in their scientific results have far surpassed it. There can be no doubt that considerations of this kind weighed with the eminent and sagacious Canadian who founded the Survey and raised it to its present position of importance, in inducing him so strenuously to oppose its removal to Ottawa. It is to be wished that his fears may not be realised; but I cannot refrain from expressing my own strong conviction that these fears were well founded. The clause providing for the removal of the Survey is, however, not mandatory but only permissive. The carrying it into effect would involve a large expenditure and most serious loss, and would certainly contribute something to the cry beginning to arise, not only in this Province but in those of the Atlantic and Pacific Coasts, that this country is governed, not in the interests of the Empire or of the Dominion in its whole extent, but in those of a section of the people of Ontario. Let us hope

that wiser counsels may prevail, or that some turn of the political wheel may suggest other measures or bring in other men.

The report of the Chairman of Council was next read by Mr. G. L. Marler.

REPORT OF THE CHAIRMAN OF COUNCIL.

At the close of another session, your Council beg to submit the following short summary of its proceedings during the year, with an occasional note on other matters connected with the business working of the Society.

A field-day was held at Belœil Mountain on Saturday, June 10th, 1876, which was attended by about eighty persons, and a very enjoyable day was spent. It is to be regretted, however, that the receipts on this occasion were not sufficient to meet the necessary expenditure, a circumstance probably owing to the unfavourable aspect of the weather at starting.

On the seventh of September last our Scientific Curator and Rec. Secretary, Mr. J. F. Whiteaves, who has held these offices for fourteen consecutive years, tendered his resignation of both, at a special meeting called for that purpose. Resolutions of thanks for his past services, coupled with congratulations on his new appointment and good wishes for his future scientific career, were passed at this meeting.

In consequence of Mr. Whiteaves' resignation, new arrangements were entered into with Mr. Passmore, who agreed to give his whole time to the work of the Society, and to issue circulars for meetings, &c., for which additional services his salary was raised from $200 to $400 per annum.

A Museum Committee was also appointed, consisting of seven gentlemen, whose duties were understood to be to superintend the classification and labelling of specimens in the departments of mineralogy, botany, conchology, entomology, ornithology, and archæology, and to report at stated intervals to the Council on the condition of these collections. The Committee has reported twice since its election, but your Council would suggest the desirability of the appointment of a competent scientific curator who could devote a definite portion of his time to work urgently needed both in the museum and library.

Your Council have to report that ten new ordinary members, two lady associates, and two new corresponding members have been elected during the year. They have, however, to regret the loss of Mr. E. Billings, one of the Vice-Presidents of the Society, and one of its oldest and most zealous members.

The papers read at the regular monthly meetings having been already referred to in the President's address, call for no special notice here.

The free course of Sommerville lectures has been delivered in due course, and the titles of these lectures, the dates at which they were delivered, and the names of the authors, will be found in their proper place in the Society's proceedings. On the nights when these lectures were delivered, the museum was lit up and thrown open free to the public, a privilege of which many availed themselves.

About 1200 persons have visited the museum during the past year, and a large number of these have been admitted free of charge.

In accordance with a recommendation of the Council for the previous year, the walls of the premises have been tinted, and the ceilings whitewashed; the contents of the cases in the museum have been taken out, and both the specimens and the interior of the cases have been dusted and cleaned.

In October last the use of the rooms was granted free of charge to the Protestant Teachers' Association of the Province of Quebec.

No further action has been taken in the matter of the Fraser Institute.

Finally your Council have to report that the name of Mr. J. Fraser Torrance has been associated with that of Dr. Harrington in the editorship of the *Canadian Naturalist.*

The report of the Scientific Curater and Rec. Secretary was then read by Mr. Whiteaves, as under:

REPORT OF THE SCIENTIFIC CURATOR AND REC. SECRETARY.

The report of the work done in the museum since the last annual meeting embraces only a period of three months, and during this time two days a week were spent at the Geological Survey, by special permission of the Society.

The critical examination of the Marine Polyzoa of the River and Gulf of the St. Lawrence has been almost completed; the Cyclostomata are quite finished, and the Cheilostomata and Ctenostomata nearly so. In the naming of difficult species much assistance has been rendered by the Rev. A. M. Norman, one of the best authorities in Europe on this group, to whom a number of specimens have been sent for comparison, which have been subsequently returned. Mr. Norman has also presented to the Society a large number of named British types.

The fine and interesting collections of marine invertebrates made by Mr. Richardson in 1875 on the west coast of America, have also been carefully studied, and critical forms of molluscs, hydroids, and crustaceans have been sent respectively to Messrs. Dall, Verrill and Smith, which have also been returned. The whole series has now been named, with the exception of the Polyzoa, and a report on the whole is in process of preparation.

Some progress has also been made in the naming and mounting of the shells from the Andamans, presented by Col. Bulger.

A committee of the Entomological Society having requested the loan of rare Canadian insects for exhibition at the Centennial, a series has been selected and forwarded for that purpose. As soon as Mr. Pettit has completed the naming of the Coleoptera, the whole will be returned. In the late Mr. Ritchie's catalogue of the Island of Montreal, the Curculionidæ are omitted, probably because at the time no specialists had worked at this particular group. For some years Mr. Caulfield, Mr. Passmore, and myself have endeavoured to collect as many local species of this order as we could, and last summer, knowing that Drs. Horn and Leconte were engaged in a monograph of the group, all our material was sent to the latter gentleman, who has kindly named and returned all the species.

The rather extensive series of beetles collected in British Columbia by Mr. Selwyn and Prof. Macoun in 1875, has also been packed and forwarded to Dr. Leconte, and a list of them has been published in the Report of Progress just issued. This catalogue is an important addition to our knowledge of the distribution of insect life in the Dominion.

In consequence of the cleaning of the museum and the tinting of the walls mentioned in the report of the Chairman of Council, it has been necessary to take down all the ethnological specimens

which were hanging in the gallery. These have been re-hung in their places, but the labels for them have to be re-written. The mammals, birds, reptiles and fishes have also all been taken out of the cases, and after the inside of the latter had been dusted and cleansed, their previous contents were re-placed.

Appended to this short report is a general summary of the condition of the collections, at the date of my resignation of the office of Curator of the Museum.

MINERALS.

These are arranged in four series as follows:

1. *The Holmes Collection.* This originally consisted of about 4000 specimens, principally from the United States and Europe. A written catalogue accompanies it, but many of the original specimens were missing before the erection of this building. Cardboard labels corresponding to those in the catalogue are affixed on or near to each specimen.

2. *Canadian Rocks and Minerals.* A poor collection, of which a catalogue exists. It has been supplemented by some subsequent donations, but no special effort has been made to perfect it, in consequence of the presence in our midst of the fine and almost complete collection of the Survey. All the specimens are labelled like those last named, but both require going over, as some of the tickets may have become detached or misplaced.

3. *A fine series of the Volcanic Rocks and Minerals of Vesuvius and its neighbourhood.* All in good order and labelled, doubtful specimens having been kindly examined and determined by Dr. T. Sterry Hunt.

4 *Miscellaneous Rocks and Minerals.* All labelled, with the name of the species and the locality from which it was collected, when known.

FOSSILS.

The fossils in the museum are mostly from the United States and Europe, the intention being to supplement the Survey Collection as far as possible, and to illustrate such manuals as those of Lyell, Phillips, Jukes and Dana. All are named and labelled, but only a portion of the late Sir Duncan Gibb's donation has been incorporated into its place in the general series.

PLANTS.

A collection filling 21 portfolios of North American plants, arranged according to the Natural System. Although corrosive sublimate was mixed with the paste with which the plants are fastened to the papers, it has been recently noticed that a small beetle has been and is still making burrows through some of the fasciculi, and the matter requires immediate attention.

INSECTS.

Some additional species, mostly scarce Coleoptera, have been added during the year, which were collected by Mr. Passmore and myself. My reports for the past two years give a detailed account of the work done in this department. It was found during the summer that the larvæ of *Dermestes lardarius* had done some damage to a few Lepidoptera in one of the drawers, and the specimens affected were destroyed, and measures were taken to prevent further injuries from this source, but the cabinet will always require periodic inspection.

MOLLUSCA AND MARINE INVERTEBRATA.

This part of the collection is in tolerable order, but the nomenclature of the species requires some revision.

FISHES AND REPTILES.

The stuffed specimens are in fair condition, though some improvement can be made in the labelling of the Canadian fishes, which were identified only in a provisional kind of way several years ago. A commencement has been made of a new collection of alcoholic preparations, which are temporarily placed in the vestibule, but this part of the work was stopped for want of a supply of good glass stoppered bottles and of alcohol.

BIRDS AND MAMMALS.

The series, especially of native species, badly wants replenishing with new and fresh specimens; but those we have, though though mostly old and often in very poor condition, are all carefully named. The Society's collection of the eggs of North American birds, is very good, and could be made of much value to students at a very trifling expense.

MISCELLANEOUS.

A number of objects of interest, such as Indian antiquities and modern ethnological objects, have been temporarily arranged in the best manner the cases at my disposal would admit. Quite a large number are contained in drawers, &c., there being no cases available for their proper exhibition.

THE GULF DREDGINGS.

The history of these investigations may be briefly summed up as follows: In 1867 and 1869 dredgings in the Gaspe district were carried on at my sole expense in the summer months, and these require no further comment. In 1871 the Government gave me, as the Society's representative, a passage and some opportunities for dredging on government vessels. The cost of the necessary outfit and travelling expenses, amounting to about $120 or $130 were shared by the Society and myself, the Society paying about $90, and myself between $30 and $40. In 1872 and 1873 the Government defrayed all the expenses, but the Society paid my salary during the time of my absence.

All the alcoholic and many of the dry specimens obtained in these dredgings, with the exceptions which will shortly be noticed, are placed provisionally in a large cupboard in the vestibule, with five compartments, which was constructed for the purpose. A few of the mollusca and celenterates are incorporated into the general series in the gallery.

The whole of the collection of marine worms has been sent to Dr. McIntosh of Murthley, by Dunkeld, in Fifeshire, who is engaged in their examination, and who has published a report on part of them in the Annals of Natural History.

A few critical Polyzoa are also in the possession of the Rev. A. M. Norman.

The Ostracoda, which have been studied and reported on by Messrs. Robertson and Brady, have not yet been returned, but are still in the hands of the former gentleman.

Duplicates have been sent to Professors Verrill and Smith, of Yale College, and to Mr. Alfred Brown of Glasgow. From the former gentleman the Society has received a named series of marine invertebrates from their dredgings on the New England coast; and from Mr. Brown a number of species of exotic shells.

As soon as I can find time to put my notes into shape, I propose to publish a final report on the results of the whole of these dredgings.

COLLECTIONS DEPOSITED BY THE GEOLOGICAL SURVEY.

These consist of marine invertebrates from the Gulf of Georgia and other parts of the west coast of British North America, for the most part dredged or collected by Mr. James Richardson, also of a collection of dried plants from the Pacific coast made by the same veteran explorer. These require to be labelled with tickets stating clearly to whom they belong, in case they should be claimed by the Government or by the Directors at any future time.

Finally, while resigning the offices of Scientific Curator and Recording Secretary, permit me to express the hope that the members generally will overlook or excuse any shortcomings or remissness on my part during the past fourteen years, and that they will believe that my sole object during this long period has been to endeavour to promote the advancement of knowledge and to popularize the study of Natural History in this city.

Mr. E. E. Shelton, as Treasurer, submitted the annexed financial statement:

Dr. THE NATURAL HISTORY SOCIETY OF MONTREAL, *in account with* E. E. SHELTON, *Treasurer.* *Cr.*

1876-77.		1876-77.		
To Cash paid Mr. Whiteaves, salary	$200.00	By Balance in Treasurer's hands, May 17, 1876		$603.92
" Mr. Passmore, "	325.00	" Cash received, Government Grant		750.00
" " attend. meetings last year.	28.00	" " Member's Yearly Subs.—Ladies	$8.00	
" Mr. Foote, commission on collections	24.30	" " " " " Gentlemen	500.00	
" for Coal	131.45			508.00
" Gas Bills	77.15	" " Museum Entrance fees		34.75
" Water	43.95	" " Rent of rooms		432.00
" City Taxes, (overcharge $49.10 returned)	128.20	" Interest on Deposit in Bank		9.67
" Corporation for New Drain	84.75			
" Interest, Royal Institution	80.00			
" Insurance	36.05			
" Dawson Bros. for Naturalist	177.50			
" Whitewashing and Petty Expenses	162.48			
" Printing and Advertising	90.17			
" Loss on Excursion	40.93			
'77. May 16—To balance in Treasurer's hands	708.41			
	$2338.34			$2,338.34

LIABILITIES:

Mortgage on Society's Buildings in favor of Royal Institution $1000.00

MONTREAL, 17th May, 1877 } Audited and found correct, after comparing Vouchers, &c.

J. H. JOSEPH,
G. L. MARLER.

It was moved by A. R. C. Selwyn, seconded by Dr. J. Baker Edwards, and resolved:

"That the reports just read be adopted and printed separately for distribution to the members."

On motion of Mr. A. R. C. Selwyn, seconded by Mr. G. L. Marler, it was resolved unanimously:

"That Dr. P. P. Carpenter and Mr. J. F. Whiteaves be elected Honorary Life Members of the Society."

It was moved by Mr. Marler, seconded by Dr. J. Baker Edwards, and carried by acclamation:

"That the bye-law relating to officers be suspended, and that Principal Dawson be re-elected President."

Mr. Selwyn moved, seconded by Mr. Marler:

"That Mr. E. E. Shelton, be re-elected Treasurer."

The motion was carried unanimously.

On motion of Mr. Marler, seconded by Dr. J. Baker Edwards, Mr. F. W. Hicks, M.A., was elected Corresponding Secretary; and on motion of Mr. Selwyn, seconded by Mr. Shelton, Dr. J. Baker Edwards was elected Recording Secretary.

Messrs. M. H. Brissette and A. H. Foord having been elected scrutineers, the following gentlemen were elected officers, by ballot.

Vice-Presidents—Rev. A. DeSola, LL.D.; His Lordship the Metropolitan; Prof. P. J. Darey, M.A., B.C.L.; Dr. P. P. Carpenter; G. L. Marler, C. Robb, A. R. C. Selwyn, F.R.S., F.G.S.; Jas. Ferrier, Jr.

Council—Dr. W. Osler, R. W. McLachlan, J. F. Whiteaves, Prof. R. Bell, M. H. Brissette, J. H. Joseph, Dr. B. J. Harrington, J. B. Goode and W. Muir.

It was moved by Mr. Shelton, seconded by Dr. J. Baker Edwards, and resolved:

"That the members of the Library and Membership Committee be re-elected and that the names of Dr. Wolfred Nelson and J. Fraser Torrance be added to their number."

On motion of Dr. Wolfred Nelson, seconded by Mr. F. W. Hicks, a vote of thanks was passed to the officers of the past year, and a special vote to the same effect was also passed to the Scientific Curator for fourteen years services in that capacity, the mover being Mr. W. Muir and the seconder Dr. J. Baker Edwards.

APATITE: ITS MODE OF OCCURRENCE IN NORWAY.

The February number of *The British Mercantile Gazette* contains an interesting article on "Norwegian Phosphates," which we republish here, somewhat abridged, in the belief that it cannot fail to prove of value to such Canadian readers as may be interested in the great apatite deposits of Burgess and Ottawa County.

The palæozoic rocks of Norway correspond so closely to our Laurentian series, and the modes of occurrence of the chief deposits of minerals of economic value are so similar in the two regions that any practical information about the Norwegian apatite must benefit those engaged in mining here.

"It is, relatively speaking, but a few years since the Norwegians learnt the value and importance of their apatite mines. These mines are generally found at the bottom of granite rocks, and where the mines exist there appears on the surface an outcrop of the bed. These veins proceed from the principal deposit; they are of variable dimensions, but ordinarily very large, from 100 to 200 feet deep. . . . They are narrow at the surface, generally increasing in size as they approach the nucleus. A few of these veins contain, at variable distances, irregular pockets, more or less spherical, from six to eight feet in diameter, called roses.

"Those who were first engaged in the extraction of apatite, contented themselves with emptying these pockets. . . The veins are always enclosed in the granitic strata, and are conformable to their dip. At times the vein is suddenly broken and interrupted by the presence of an irregular mass of rock, but by continuing the work of extraction it will be found again in the same direction, a few inches lower, and ordinarily larger. It was through inexperience on the subject that in the beginning the Norwegians only worked the veins a short depth and then abandoned them.

"The greater part of the veins of apatite are surrounded by a thick layer of black mica or of hornblende. Science has not yet been able to determine the cause of their presence in this case where they enclose the apatite like a sheath or thin skin existing between the granite and the apatite vein. . . . The name

of apatite is given to very pure crystallised phosphate, averaging from 85 to 95 per cent. of phosphate. The apatite mines of Norway are but few, and all situated within an area of forty square miles The worst situated of all is that of Bamble, which lies a few leagues in the interior on the other side of the ports of Langesund and Bervil. The apatite of Norway is not quite uniform, but its richness does not vary much. It never yields under 85 per cent. The apatite we have seen and analysed gives about 91 per cent. tribasic phosphate of lime.

"The veins are generally from one to two feet thick at the surface, but on following them to fifty feet deep they are often found to increase to six or seven feet thick, and each vein is often from twenty-five to one hundred feet in length, more or less, and descends to an unknown depth. The apatite is massive and hard, and to extract it pits must be sunk, as the more the veins are dug the larger they grow. From this it should have been inferred from the beginning that at a depth of from 150 to 200 feet they would unite to a massive bed, of which these are but branches.

"At Bamble, in the month of June last year, a large bed was discovered after a vein had been followed to a depth of 160 feet. This fact confirms the preceding statement, and augurs well for the future of these apatite mines.

"The Norway apatite is generally crystallised and compact. In a few of the veins it is of a white colour, in others of a yellowish green or of a red tint.

"The mines of Husaas in the Bay of Risoer, are the principal and best situated in Norway. This large and important concession is perpetual, and free from all taxes. It comprises an area of about 1600 feet long and 800 feet wide. The mine is situated at from 200 to 300 feet from the shore in the interior of the bay, where it is deep enough for even the heaviest ships to load easily. From the mine to the ship, the distance being so short, expensive transport is avoided In these mines there are two large veins of white apatite of exquisite formation and great purity, containing from 89 to 91 per cent. of tribasic phosphate. One of the two lodes is 200 feet long. The other has not been worked so much, and has only been followed 90 feet, but there is every reason to believe that it extends much further. This remains to be verified, and is of secondary importance. The thickness of the veins naturally diminishes towards their extremities. As it is very large at their surface, we believe that the bed from which they emerge cannot be very deep, and that the thickness of the veins will double at about 50 feet. But calculating at a minimum upon their actual thickness, it may be stated that if, over their length, at distances from ten to twenty feet apart, only ten pits were dug six feet deep, from three to four tons of apatite per yard dug could be extracted, or for the united ten pits thirty tons per day. This would not take more than half a day, and would allow 18,000 tons to be extracted in a year of 300 working days.

"At the same estate of Husaas, at a few yards from the apatite mines and parallel to them there is a vein of nickeliferous and cobaltous pyrites which gives, according to the analysis of well known chemists of Christiania, from 2 to 2.70 per cent. of nickel and cobalt. This lode is narrow at the surface. It may be remarked that an analagous vein near Drammen attained the thickness of 30 feet at a depth of one hundred feet, and now returns fabulous profits to the proprietor. Considered on the whole, the mines of Husaas, for exceptional situation and importance, are without rivals in Norway.

"There are also in the same country, at a few leagues distance one from the other, two other rich apatite mines belonging to the Belgian Consortium. The first is the apatite mine of Noland Spiremir, situated at Rod Akeland, and is finely placed on the road separating the sea-ports of Sondeled and Rod, and is about a mile and a half from Rod, and three miles from Sondeled. The mine is on a slope of the mountain bearing the same name, and the concession is very large, covering several acres. There is but one vein, but it is of extraordinary power. Its length is about one hundred feet, and its breadth nine feet. Its depth is unknown, that is to say, it is not known whether 100 or 150 feet would be dug before coming to the massive layer. The vein is so exceptionally large that it is taken for granted that its extraction would immediately bring handsome profits. Only at the top the vein is irregular and strewn with fragments of rather soft stone, which may be easily picked out with a small hand pick from the blocks of apatite extracted. It is now being worked with a view to examine and compare its purity at a depth of twenty feet with that at the surface. The apatite of this mine is of a rose colour, and yields 89 per cent. of pure phosphate. As the mine is but a few yards from the grand road, and only forty-five minutes walk from the sea-ports of Sondeled and Rod, between which it is situated, it could be nearly as advantageously worked as that of Husaas."

The reports of our Geological Survey show that the apatite of Burgess is usually accompanied by quantities of mica and hornblende or pyroxene, and is bedded in Laurentian gneiss. In so far its mode of occurrence closely agrees with that of the Norwegian phosphate. But the Burgess deposit occurs in shallow synclinals, and at only one point has it been tested to a depth of over 100 feet. The deposits in the County of Ottawa are yielding a purer mineral, and may possibly extend to a far greater depth. The magnetic pyrites of the Laurentian usually contain some nickel and cobalt.

In Mr. Vennor's report for 1873 the causes of the poor success of most of the phosphate mines in Burgess and its vicinity are accurately determined and clearly explained. A study of this record may save some of our capitalists much trouble and disappointment when engaged in opening up the beds of apatite on the shores of the Lievre.

THE DAWN OF LIFE,

Being the history of the oldest known Fossil Remains, and their relations to Geological time and to the development of the Animal Kingdom.

By J. W. DAWSON, LL.D., F.R.S., F.G.S., &c. &c.
Principal of McGill University.

One vol. 12*mo*, *with many Plates.*

$2.00.

(From the *Daily News*, London, England.)

"In a little volume entitled "The Dawn of Life" (Hodder and Stoughton), Dr. Dawson, the well-known Canadian geologist, has sketched in a style strictly popular, yet without the least sacrifice of scientific exactness, the curious discovery of the Eozoon, in the limestones of the ancient Laurentian series which attain such an amazing thickness in Canada. Although the existence of organic remains in those rocks was, as the author justly remarks, a fair inference from our knowledge of them, and we may add, of the kindred rocks in Scotland and Ireland, better known to us as the Lewisian, it is entirely to the Canadian geologists that this curious solution of a difficult problem is due. It was they who perceived that, the basis of these rocks being limestone, it was more than probable, in spite of the metamorphic character they had assumed, that they were originally sedimentary deposits like the basis of other limestone, and had the same origin in the corruption of the remains of the myriads of little creatures which, both on the surface and in the depths of the ocean, are still, as the dredges of the Challenger teach us, forming beds of chalks and probably vast white cliffs to be revealed in future ages inconceivably remote. To the shrewdness of these American men of science we also owe the inference of vegetable life during the Laurentian period as evidenced by the existence of graphite or plumbago. Thus the final discovery of Eozoon, or the "Canadian dawn-animal," as it has been called from its presence in what we have ground to assume to be the very first of all aqueous deposits, was, as has been observed, somewhat like the discovery of the planet whose existence had been first determined *a priori* from planetary disturbances. How far back this discovery, at first received with scepticism, but now fairly established as a scientific fact, pushes the period of life on our globe beyond what was till lately known as the "primordial period," may be faintly conceived from the circumstance that the Laurentian was found on measurement by the officers of the Canadian Geological Survey to be 3,500 feet thick, in three beds, which have been computed to extend over an area of 200,000 square miles. Next to Sir William Logan, perhaps Dr. Dawson himself has had more to do with this discovery of the earliest known fossil than any one else. He speaks therefore with authority in his account of the nature and probable habits of the dawn-animal, and in tracing out the important relations which the discovery bears to facts and theories which extend far beyond the strict domain of the geologist. His monograph is written in vein of quiet enthusiasm which is justifiable, and while it attracts the novice, will not be unpleasing to the scientific reader. Very little is really wanting to the full comprehension of his theme beyond the preliminary explanations, the condensed sketch of geological periods, and the wood-cut illustrations which accompany the book. We will undertake to say that even a reader who is entirely unacquainted with the science will, if he have only ordinary curiosity about natural phenomena, find this volume not only perfectly intelligible, but entertaining in a high degree."

PUBLISHER'S NOTICE

COMMENCING with Volume Seven, the Natural History Society of Montreal has arranged to give to each of its Annual Subscribers a copy of the 'Canadian Naturalist' without additional charge.

The Magazine is issued four times a-year as before, but the parts consist of 60 pages only. The volume of 480 pages will thus spread over two years, and as the former price of three dollars has been retained, it is now quoted "per volume" instead of "per annum." Those who are not members of the Society will thus obtain the Magazine at precisely the same price as heretofore, viz. three dollars for 480 pages.

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