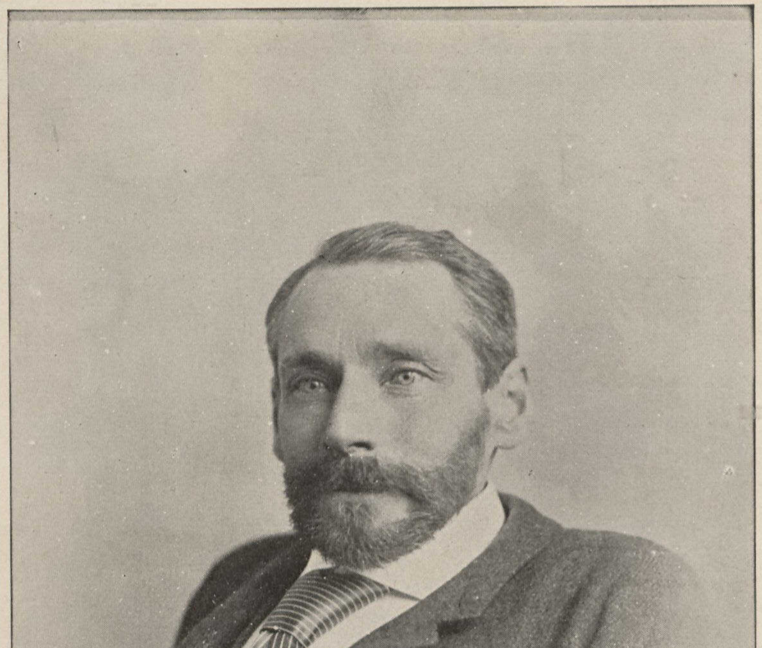

Yours truly
George M. Dawson

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George Mercer Dawson.

By Bernard J. Harrington, M.A., Ph.D., LL.D.

The widespread expressions of deep regret and personal loss following the death of Dr. G. M. Dawson show that his was no ordinary life. Called away while in his prime, and with a past which gave promise of great achievements yet to come, he has left a blank which will not soon be filled.

Dr. Dawson was the second son of the late Sir J. W. Dawson, and was born on the 1st of August, 1849, in Pictou, Nova Scotia. In 1855 his father, who had for some years been acting as Superintendent of Education for Nova Scotia, received the appointment of principal of McGill University, Montreal, and with his family took up his residence there. Instead of the magnificent structures of to-day, there were then on the college grounds only two "unfinished and partly ruinous buildings, standing amid a wilderness of excavators' and masons' rubbish, overgrown with weeds and bushes. The grounds were unfenced and pastured at will by herds of cattle, which not only cropped the

* Fifty years of work in Canada—Autobiographical notes by Sir William Dawson, p. 98.

grass, but browsed on the shrubs, leaving unhurt only one great elm, which still stands as the "founder's tree,' and a few old oaks and butternut trees." * Surroundings of this kind were not ideal from a university point of view, but made a delightful environment for an intelligent boy. The numerous wild flowers, the birds' nests, the fossil shells in the blue clay, the waste waterway, where leaves and twigs became "petrifactions," the lively brook where mimic fleets could be navigated and dams constructed—these and many other objects of interest were there, and with the guidance and encouragement of an ever-ready father, the boy's inborn love of nature was daily stimulated and increased.

At ten years of age, Dawson entered the Montreal High School, remaining there for one year, and taking a high place in his classes. Subsequently, however, owing to ill-health, his education was carried on for the most part under tutors ; and while this system no doubt cut him off from some advantages, it gave him on the other hand wider opportunities for pursuing and mastering subjects which had special attractions for him. Surrounded by books, chemical apparatus, paints and pencils, the days were never too long, and photography, book-binding, painting magic lantern slides, and even cheese-making, afforded him fascinating occupation and amusement. One who knew him well at that time says : "He seemed to absorb knowledge rather than to study, and every new fact or idea acquired was at once put into its place and proper relations in his orderly mind. He was always cheerful, amusing and popular, other boys flocking round him and invariably submitting to his unconscious leadership"

At the age of eighteen, Dawson entered McGill College as a partial student, attending lectures on English, chemistry, geology, etc., during the session of 1868-9. While a student at this time, he wrote a poem on Jacques Cartier which, while but a boyish effort, was thought very well of by his instructors and gave evidence of his keen love of nature and poetic instinct. The view from the summit of Mount Royal, whither Cartier was conducted by the red men of Hochelaga, is thus described :

"Far on the western river lay,
Like molten gold, the dying day.
Far to the east the waters glide
Till lost in twilight's swelling tide ;
While all around, on either hand,
Spread the broad, silent, tree-clad land ;
And in the distance far and blue
Long swelling mountains close the view."

The following year, Dawson went to London and entered the Royal School of Mines, at that time on Jermyn street. He was fond of the sea, and on this occasion made the passage in a sailing ship, he and another young man being the only passengers. During the voyage, he amused himself making observations on the surface life of the ocean, and the phenomena of phosphorescence. He also studied navigation, under the direction of the captain, and the knowledge then acquired afterward stood him in good stead when he had to navigate a schooner along the dangerous coast of British Columbia and the Queen Charlotte Islands.

At the School of Mines, he took the full course of study, extending over three years, and passed as an associate. At the end of his second year, he carried off the Duke of Cornwall's scholarship, given by the Prince of Wales, and on graduation stood first in his class, obtaining the Edward Forbes medal and prize in Palæontology and Natural History, and the Murchison medal in Geology. While at the School of Mines, he paid special attention to the study of geology under Ramsay, Huxley, and Etheridge, but also devoted much time to chemistry and metallurgy, under Frankland and Percy respectively, and to mining, under Warrington Smith. Even in his holidays, he was never altogether idle, and during most of the summer of 1871 he was attached to the British Geological Survey, and worked with the late J. Clifton Ward in the Cumberland Lake district. While in England, he made many warm friends, with some of whom he corresponded regularly for years afterwards.

On returning to Canada in 1872, he was engaged for some months examining and reporting upon mineral properties in Nova Scotia, and subsequently went to Quebec, where he delivered a course of lectures on chemistry at Morrin College, which was attended by a large and appreciative class. In 1873, he was appointed geologist and botanist to Her Majesty's North American Boundary Commission, which had been constituted to fix the boundary line between British North America and the United States, from the Lake of the Woods to the Rocky mountains, and which had been carrying on its labours for about a year. From early boyhood, Dawson had been keenly interested in travel and exploration, and in the Canadian North-West he saw a region ready to yield up a rich harvest of discovery. There was the charm of novelty afforded by a well-nigh untrodden field, and the many hardships to be encountered only seemed to lend attractions to the expedition. In those days, no Canadian trains rolled across the continent. Fort

Garry, now the fast-growing city of Winnipeg, with more than 40,000 inhabitants, was then practically the last outpost of civilization, and the great prairies had to be traversed on horseback or on foot, provisions and equipments of every kind being carried in Red river carts, drawn by oxen or ponies, with shaganappy harness. The two years of Dawson's connection with the Boundary Commission were for him years of incessant activity, but the results of his work were of great scientific value. They were embodied in a report addressed to the head of the commission, major (now general) D. R. Cameron, R.A., and published in Montreal in 1875.* The volume, which is now looked upon as "one of the classics of Canadian geology," is a model of what such reports should be —scientific facts being clearly and succinctly stated and the conclusions logically drawn. The main geological result arrived at was the examination and description of a section over 800 miles in length across the central region of the continent, which had been previously touched upon at a few points only, and in the vicinity of which a space of over 300 miles in longitude had remained even geographically unknown. The report discussed not merely the physical and general geology of the region, and the more detailed characteristics of the various geological formations, but also the capabilities of the country with reference to settlement. The whole edition was long ago distributed, and the volume is now exceedingly scarce and difficult to obtain. While attached to the Boundary Commission, Dawson made large collections of

* Report on the Geology and Resources of the Region in the vicinity of the Forty-ninth Parallel, from the Lake of the Woods to the Rocky Mountains, with Lists of Plants and Animals collected and Notes on the Fossils.

natural history specimens, which were forwarded to England and found a home in the British Museum, as well as at Kew and elsewhere. The British Museum obtained no less than seventeen species of mammals not previously represented in its collections.

More or less in connection with the above work were published papers on the "Lignite Formations of the West," the "Occurrence of Foraminifera, Coccoliths, etc., in the Cretaceous Rocks of Manitoba," on "Some Canadian species of Spongillæ," on the "Superficial Geology of the Central Region of North America," on the "Locust Invasion of 1874 in Manitoba and the North-west Territories," etc.

When the work of the Boundary Commission was brought to a close, Dawson received an appointment on the staff of the Geological Survey of Canada and began in that connection the long series of explorations of the North-West and British Columbia, which brought such great credit to himself and his country. In 1883, he was made an assistant director of the survey, and later, on the retirement of Dr. Selwyn, in 1895, became head of the department, a position which he occupied until the time of his death on the 2nd of March last. Throughout his connection with the survey, his reports were always of a high order, bearing evidence of his striking powers of observation and deduction. Though thoroughly scientific, they always took account of the practical and economic side of geology, and accordingly commanded the attention and confidence of mining capitalists, mine managers and others interested in the development of the mineral resources of the country. When in the field, geology was, of course, the principal object of his investigations, but his wide knowledge of collateral sciences enabled him not merely to collect objects of natural history in an intelligent and discriminating way, and to discuss the flora and faunas of different districts, but also to make important observations on the habits and languages of Indian tribes, to keep continuous meteorological records and to determine latitudes and longitudes. We accordingly find that his reports generally conclude with a series of most valuable appendices, giving special information which could not well be included in the body of the document.

In an elaborate notice of his report on the Queen Charlotte islands, published in Petermann's Mittheilungen (Vol. 27, 1881), the writer, after calling attention to the fact that the report dealt not merely with the geology of the islands, but also with their topography, natural history, climate and ethnology, says : "One is amazed at the rich results which he brought back in all these branches, especially as he had only one assistant, Mr. Rankine Dawson, and remained in the islands only two and a half months, from the 12th of June to the end of August, and that in most unfavourably wet weather."

In addition to his field-books proper, he generally kept copious journals which contain much interesting information. He had a habit, too, of jotting down notes and sometimes verses on scraps of paper or on the backs of telegraph forms. In the wilds of British Columbia, for example, he writes :

"Contorted beds, of unknown age,
  My weary limbs shall bear,
Perchance a neat synclinal fold
  At night shall be my lair.
Dips I shall take on unnamed streams,
  Or where the rocks strike, follow

Along the crested mountain ridge,
Or anticlinal hollow;
Or gently with the hammer stroke
The slumbering petrifaction,
That for a hundred million years
Has been debarred from action.

* * * * * * * *

We can fancy him, too, sitting by his lonely camp fire on the shores of the Pacific and penning the following lines :

"To rest on fragrant cedar boughs
Close by the western ocean's rim,
While in the tops of giant pines
The live-long night the sea-winds hymn,
And low upon the fretted shore
The waves beat out the evermore."

Dr. Dawson's geological work was carried on chiefly in the region of the great prairies of the North-West and British Columbia, but he was thoroughly informed as to the geology of all parts of the Dominion. In the North-West, he paid particular attention to the relations of the Cretaceous and Laramie formations ; and he discovered the presence in the Cretaceous of southern Alberta of an important series of rocks—the Belly River group—which, he says, "must be considered on the whole as a fresh-water formation." The Kootanie group was also recognized by him as constituting a portion of the early Cretaceous in the Rocky Mountain region. His study of a large area in the interior plateau region of British Columbia established the existence there of a great series of mica-schists and gneisses supposed to be of Archæan age and succeeded by Cambrian, Ordovician, Silurian and Carboniferous strata ; while in the Cordilleran region of the same province he described the occurrence of great deposits of contemporaneous volcanic rocks, in various stages of metamorphism. While working in connection with the Boundary Commission also, he studied the crystalline rocks in the Lake of the Woods district, and concluded that a considerable portion of the Huronian formation there consists of metamorphosed volcanic rocks.

He was a careful student of glacial phenomena and, according to Dr. G. J. Hinde,* was the first to describe the glacial origin of the Missouri Coteau, and, in the interior of British Columbia, he has shown that at one period of the Ice age there was a confluent ice-mass, the surface of which stood at a level of 7,000 feet above the sea, and that it must have been at least from 2,000 to 3,000 feet in thickness. He has further established the fact that the movements of the glacier ice in this region were not only to the south and south-east, and through the transverse valley and gaps of the Coast ranges to the ocean, but that it had also a northerly flow, and passed down the valleys of the Pelly and Lewes branches of the Yukon river. Dr. Dawson also maintained that the northern part of the great plains had been submerged, and that their glaciation was in the main due to floating ice.

With regard to his ethnological work we cannot do better than quote from Mr. W. J. McGee's recent appreciative notice in the *American Anthropologist.* Mr. McGee says: "While several of Dr. Dawson's titles and the prefatory remarks in some of his papers imply that his ethnological researches were subsidiary to his geological work, and while his busy life never afforded opportunity for monographic treatment of Canada's aborigines, it is nevertheless true that he made original observations and records of standard value, that much of his work is still unique, and that

½ Geological Magazine, May, 1897.

his contributions, both personal and indirect, materially enlarged knowledge of our native tribes. It is well within bounds to say, that in addition to his other gifts to knowledge, George M. Dawson was one of Canada's foremost contributors to ethnology, and one of that handful of original observers whose work affords the foundation for scientific knowledge of the North American natives."

Dawson's most notable contribution to ethnology was undoubtedly his memoir on the Haida Indians of the Queen Charlotte islands, but he also published "Notes on the Indian Tribes of the Yukon District and Adjacent Northern Portion of British Columbia," a valuable memoir entitled "Notes and Observations of the Kwakiool People of Vancouver Island," "Notes on the Shuswap People of British Columbia," and other papers.

When, in 1884, the British Association appointed a committee to study the physical characters, languages and social conditions of the north-western tribes of Canada, Dr. Dawson was made a member, and it devolved upon him to organize and administer the work of the committee. The work was carried on for years with much success and small money expenditure, and when, in 1896, an Ethnological Survey of Canada was instituted, Dawson was chosen as the head of the survey committee.

Not the least of his services to his country were those in connection with the Behring sea arbitration. He was one of the commissioners and was sent by the British government to the north Pacific ocean to enquire into the conditions of seal life there. Subsequently, his evidence and forcible arguments undoubtedly secured for the British side of the case a much more favourable finding than would otherwise have been obtained. Lord Alverstone (now Lord Chief Justice of England) writing of him in this connection, says: "It is not possible to overrate the services which Dr. Dawson rendered us in the Behring sea arbitration. I consulted him throughout on many questions of difficulty and never found his judgment to fail, and he was one of the most unselfish and charming characters that I ever met. I consider it a great pleasure to have known him." In recognition of his services on the arbitration, Dr. Dawson was made a Companion of the Order of St. Michael and St. George (C.M.G.).

He received the degree of D.Sc. from Princeton in 1877, and that of LL.D. from Queen's University in 1890, from McGill University in 1891, and from Toronto University some years later. In 1891, he was awarded the Bigsby gold medal by the Geological Society for his services in the cause of geology, and was also elected a Fellow of the Royal Society. In 1893, he was elected President of the Royal Society of Canada, and in 1897 was President of the geological section of the British Association for the Advancement of Science at the Toronto meeting. In 1897, he was awarded the gold medal of the Royal Geographical Society. Last year, he was President of the Geological Society of America, and gave his retiring address at the Albany meeting in December, choosing as his subject, "The Geological Record of the Rocky Mountain Region in Canada." This address was published as a bulletin of the Geological Society of America, and will be prized as giving a summing up of his latest views on some of the problems connected with the complex geology of the west. Many other distinctions, which cannot be enumerated here, fell to his lot, and he had won for himself the esteem and confidence of his fellow-countrymen in all parts of the Dominion. Nowhere was he more beloved than in British Columbia—the province in which he had done so much of his best work, and in which, he sometimes said to the writer, he would like to spend his last days.

After the Toronto meeting of the British Association, in 1897, he accompanied a party of the members on a trip across the continent, and all were struck with the warmth of the welcome everywhere accorded to him. "Among the many distinguished visitors," writes the *Victoria Colonist*, "by whose presence Victoria has been honored during the past few days, none holds a higher or more deserved place in the esteem of Canadians than George M. Dawson. In one sense he is the discoverer of Canada, for the Geological Survey, of which he has been the chief, has done more than all other agencies combined to make the potentialities of the Dominion known to the world. He has been engaged in the work so long that he can look back over it with the profound satisfaction which comes from the knowledge that his judgment on points of extreme interest and value has been justified by events. The development of Kootenay, the hydraulic mines of Cariboo, and the gold mines in the Yukon are all foretold in the interesting pages of Dr. Dawson's earlier reports. Therefore, when we find in the voluminous products of his pen, wherein the results of his observations are recorded, anticipations of great mineral development in parts of the province that are as yet unexplored, we feel almost as if such development were guaranteed. A careful observer, a conservative reasoner, a skilful writer, Canada possesses in Dr. Dawson a public servant the value of whose services can never be over-estimated. His name carries authority with it on any subject on which he speaks. That a long career may be before him is the hope of all, for we all know how much that means to the Dominion."

Dr. Dawson was a ready and prolific writer and a brilliant conversationalist. His quiet humour was infectious, and any dinner party which numbered him among the guests was sure to be a merry one. He seemed to have an inexhaustible fund of information, not merely about his own special lines of work, but covering the widest range of subjects. The marvel was how in his busy life he had acquired so much and such varied knowledge. For one of apparently delicate constitution, his powers of enduring prolonged physical exertion were as remarkable as his capacity for continuous mental activity. He was at work at his office until two days before his death, the immediate cause of which was capillary bronchitis. The secret of Dr. Dawson's widespread popularity, no doubt, lay in his downright unselfishness and in his sunny and sympathetic nature.

An Experimental Investigation into the Flow of Marble.

By Frank D. Adams, M.Sc., Ph.D., and John T. Nicolson, D.Sc.

In a paper read before the Royal Society of London last June and which has since been published in Transactions of the Society, an extended account was given of a series of experiments on the Flow of Marble carried out in the laboratories of McGill University. It is desired here to present a brief summary of this paper, indicating the methods employed in the investigation and the results attained.

That rocks, under the conditions to which they are subjected in certain parts of the earth's crust, become bent and twisted in the most complicated manner is a fact which was recognized by the earliest geologists, and it needs but a glance at any of the accurate sections of contorted regions of the earth's crust which have been prepared in more recent years to show that there is often a transfer or "flow" of material from one place to another in the folds. The manner in which this contortion, with its concomitant "flowing," has taken place is, however, a matter concerning which there has been much discussion, and a wide divergence of opinion. Some authorities have considered it to be a purely mechanical process, while others have looked upon solution and redeposition as playing a necessary *role* in all such movements. The problem is one on which it would appear that much light might be thrown by experimental investigation. If movements can be induced in rocks under known conditions, with the reproduction of the structures found in deformed rocks in nature, much might be learned concerning not only the charcter of the movements, but also concerning the conditions which are necessary in order that the movements in question may take place.

It is generally agreed that three chief factors contribute to bringing about the conditions to which rocks are subjected in the deeper parts of the earth's crust, where folding with concomitant flowing is most marked. These are :—

1. Great pressure.
2. High temperature.
3. Percolating waters.

With regard to the first factor, it must be noted that mere cubic compression does not produce movements of the nature of flowing, although it may produce molecular rearrangement in the rock. A differential pressure is necessary to give movement to the mass. As Heim has pointed out, there is reason to believe that "Umformung ohne Bruch" takes place when a rock is subjected to a pressure which, while greater in some directions than in others, in every direction exceeds the elastic limit of the rock in question. Whether all these factors, or only certain of them, are actually necessary for the production of rock deformation is a question which also requires to be determined by experiment, for by experiment the action of each can be studied separately, as well as in combination with the others.

In the paper a first contribution to such a study is presented, pure Carrara marble being the rock selected for study. The investigation is now being extended to various other limestones, as well as to granites and other rocks.

In order to submit the marble to a differential pressure, under the conditions above outlined, it was sought to enclose the rock in some metal having a higher elastic limit than marble, and at the same time possessing considerable ductility. After a long series of experiments, heavy wrought-iron tubes of special construction were adopted. These were made, following the plan adopted in the construction of ordnance, by rolling thin strips of Low Moor iron around a bar of soft iron, and welding the strips successively to the bar, as they were rolled around it. The core of soft iron composing the bar was then bored out, leaving a tube of Low Moor iron, the sides being about ¼ inch in thickness, and so constructed that the fibres of the iron ran around the tube instead of being parallel to its length. These were found to answer the requirements admirably.

The following procedure was then adopted. Columns of the marble, an inch or in some cases 0.8 inch in diameter and about 1.5 inch in length, were accurately turned and polished. The tube was then very accurately fitted around the marble. This was accomplished by giving a very slight taper to both the column and the interior of the tube, and so arranging it that the marble would only pass half way into the tube when cold. The tube was then expanded by heating, so as to allow the marble to pass completely into it and leave about 1.25 inch of the tube free at either end. On allowing the tube to cool, a perfect contact between the iron and the marble was obtained. In some experiments the tube was subsequently turned down, so as to be somewhat thinner immediately around the marble. Into either end of the tube, containing the column, an accurately fitting steel plug or piston was then inserted, and by means of these the pressure was applied. The high pressure required was obtained by means of a powerful press, especially constructed for the purpose, consisting of a double hydraulic "intensifier," the water pressure being in the first instance obtained from the city mains. By means of this machine, pressures up to 13,000 atmospheres could be exerted on the columns having a diameter of 0.8 inch, and the pressures could be readily regulated and maintained at a constant value for months at a time, if required.

It having been ascertained that the columns of the marble 1 inch in diameter and 1½ inch in height crushed at a pressure of from 11,430 to 12,026 lbs. to the square inch, the column enclosed in its wrought-iron tube, in the manner above described, was placed in the machine and the pressure applied gradually, the exterior diameter of the tube being accurately measured at frequent intervals. No effect was noticeable until a pressure upon the marble, varying of course with the thickness of the enclosing tube, but generally about 18,000 lbs. to the square inch, was reached; when the tube was found to slowly bulge, the bulge being symmetrical and confined to that portion of the tube surrounding the marble. The distension was allowed to increase until the tube showed signs of rupture, when the pressure was removed and the experiment concluded. The conditions under which the marble was submitted to pressure were four in number :—

1. At the ordinary temperature in the absence of moisture. (Cold dry crush.)

2. At 300° C. in the absence of moisture. (Hot dry crush.)
3. At 400° C. in the absence of moisture. (Hot dry crush.)
4. At 300° C. in the presence of moisture. (Hot wet crush.)

Eight experiments were made on marble columns at the ordinary temperature, in the absence of moisture, the rate at which the presure was applied differing in different cases, and the consequent deformation being in some cases very slow and in others more rapid, the time occupied by the experiment being from ten minutes to sixty-four days. The amount of deformation was not in all cases equal, as some of the tubes showed signs of rupture sooner than others. On the completion of the experiment, the tube was slit through longitudinally by means of a narrow cutter in a milling machine, along two lines opposite one another. The marble within was found to be still firm and compact, and to hold the respective sides of the tube, now completely severed from one another, so firmly together that it was impossible without mechanical aids to tear them apart. By means of a steel wedge driven in between them, however, they could be separated, but only at the cost of splitting the marble through longitudinally. The half columns of the marble now deformed generally adhere so firmly to the tube that it is necessary to spread the latter in a vice in order to set them free. The deformed marble, while firm and compact, differs in appearance from the original rock in possessing a dead white colour, somewhat like chalk, the glistening cleavage surfaces of the calcite being no longer visible. The difference is well brought out in certain cases owing to the fact that a certain portion of the original marble often remains unaltered and unaffected by the pressure. This when present has the form of two blunt cones of obtuse angle whose bases are the original ends of the columns resting against the faces of the steel plugs, while the apices extend into the mass of the deformed marble and point toward one another. These cones, or rather parabolas of rotation, are developed, as is well known, in all cases when cubes of rock, Portland cement, or cast iron are crushed in a testing machine in the ordinary manner. In the present experiments they seldom form any large portion of the whole mass.

In order to test the strength of the deformed rock, three of the half columns from different experiments, obtained as above described, were selected and tested in compression. The first of these, which had been deformed very slowly, the experiment extending over sixty-four days, crushed under a load of 5350 lbs. per square inch; the second, which had been deformed in 1½ hours, crushed under a load of 4000 lbs, per square inch; while the third, which had been quickly deformed, the experiment occupying only 10 minutes, crushed under a load of 2776 lbs. per square inch. As mentioned above, the original marble, in columns of the dimensions possessed by these before deformation, was found to have a crushing weight of between 11,430 and 12,026 lbs. per square inch. These figures show that, making all due allowance for the difference in shape of the specimens tested, the marble after deformation, while in some cases still possessing considerable strength, is much weaker than the original rock. They also tend to show that when the deformation is carried on slowly the resulting rock is stronger than when the deformation is rapid.

Thin sections of the deformed marble, passing vertically through the unaltered cone and the deformed portion of the rock, were readily made, and when examined under the microscope clearly showed the nature of the movement which had taken place. The deformed portion of the rock can be at once distinguished by its turbid appearance, differing in a marked manner from the clear transparent mosaic of the unaltered cone. This turbid appearance is most marked along a series of reticulating lines running through the sections, which, when highly magnified, are seen to consist of lines or bands of minute calcite granules. They are lines along which shearing has taken place. The calcite individuals along these lines have broken down, and the fragments so produced have moved over and past one another, and remain as a compact mass after the movement ceased. In this granulated material are enclosed great numbers of irregular fragments and shreds of calcite crystals, bent and twisted, which have been carried along in the moving mass of granulated calcite as the shearing progressed. This structure is therefore cataclastic, and is identical with that seen in the felspars of many gneisses.

Between these lines of granulated material the marble shows movements of another sort. Most of the calcite individuals in these positions can be seen to have been squeezed against one another and in many cases a distinct flattening of the grains has resulted, with marked strain shadows, indicating that they have been bent or twisted. They show, moreover, a finely fibrous structure in most cases, which, when highly magnified, is seen to be due to an extremely minute polysynthetic twinning. The chalky aspect of the deformed rock is in fact due chiefly to the destruction by this repeated twinning of the continuity of the cleavage surfaces of the calcite individuals, thus making the reflecting surfaces smaller. By this twinning, the calcite individuals are enabled under the pressure to alter their shape somewhat, while the flattening of the grains is evidently due to movements along the gliding planes of the crystals. In these parts, therefore, the rock presents a continuous mosaic of somewhat flattened grains.

From a study of the thin sections it seems probable that very rapid deformation tends to increase the relative abundance of the granulated material, and in this way to make the rock weaker than when the deformation is slow.

When the marble is heated to 300° C. in a suitably-constructed apparatus and is then subjected to deformation under conditions which otherwise are the same as before, the cataclastic structure is found to be absent and the strength of the deformed marble rises to 10,652 lbs. to the square inch, that is to say, it is nearly as strong as the original rock. The calcite grains, which in the original rock are practically equidimensional, are now distinctly flattened, some of them being three or even four times as long as they are wide. Some grains can be seen to have been bent around others adjacent to them, the twin lamellæ curving with the twisted grain. In others again of these twisted lamellæ, the twinning only extends to a certain distance from the margin, leaving a clear untwinned portion in the centre. The rock consists of a uniform mosaic of deformed calcite individuals.

When the deformation is carried out at 400° C. no trace of cataclastic structure is seen.

An experiment was then made in which the marble was deformed at 300° C., but in the presence of moisture, water being forced through the rock under a pressure of 460 lbs. per square inch during the deformation, which extended over a period of fifty-four days, or nearly two months. Under these conditions the marble yielded in the same manner as when deformed at 300° C., in the absence of moisture, that is, by movements on gliding planes and by twinning, but without cataclastic action. The deformed marble, however, when tested in compression, was found actually to be slightly stronger than a piece of the original marble of the same shape. The structure developed was identical with that of the marble deformed at 300° C. in the absence of water. The presence of water, therefore, did not influence the character of the deformation. It is quite possible, however, that there may have been a deposition, of infinitesimal amount, of calcium carbonate along very minute cracks or fissures, which thus helped to maintain the strength of the rock. No signs of such deposition, however, were visible.

By studying the marble deformed at a temperature of 300° C., or better at 400° C., it will be seen that structures induced in it by the movements, and the nature of the motion, are precisely the same as those observed in metals when they are deformed by impact or by compression. In a recent paper by Messrs. Ewing and Rosenhain, "Experiments in Micro-metallurgy : Effects of Strain," which appeared in these Proceedings, three photographs of the same surface of soft iron, showing the results of progressive deformation under pressure, are shown, which photographs could not be distinguished from those of thin sections of the marble described in the present paper, at corresponding stages of deformation. In both cases, the movements are caused by the constituent crystalline individuals sliding upon their gliding planes or by polysynthetic twinning. In both cases the motion is facilitated by the application of heat. The agreement between the two is so close that the term "flow" is just as correctly applied to the movement of the marble in compression under the conditions described, as it is to the movement which takes place in gold when a button of that metal is squeezed flat in a vice, or in iron when a billet is passed between rolls.

In order to ascertain whether the structures exhibited by the deformed marble were those possessed by the limestones and marbles of contorted districts of the earth's crust, a series of forty-two specimens of limestones and marbles from such districts in various parts of the world were selected and carefully studied. Of these, sixteen were found to exhibit the structures seen in the artificially-deformed marble. In these cases the movements had been identical with those developed in the Carrara marble. In six other cases the structure bore certain analogies to those in the deformed rock but were of doubtful origin, while in the remaining twenty the structure was different.

The following is a summary of the results arrived at :—

1. By submitting limestone or marble to differential pressures exceeding the elastic limit of the rock and under the conditions described in this paper, permanent deformation can be produced.

2. This deformation, when carried out at ordinary temperatures, is due in part to a cataclastic structure and in part to twinning and gliding movements in the individual crystals comprising the rock.

3. Both of these structures are seen in contorted limestones and marbles in nature.

4. When the deformation is carried out at 300° C., or better at 400° C., the cataclastic structure is not developed, and the whole movement is due to changes in the shape of the component calcite crystals by twinning and gliding.

5. This latter movement is identical with that produced in metals by squeezing or hammering, a movement which in metals, as a general rule, as in marble, is facilitated by increase of temperature.

6. There is therefore a flow of marble just as there is a flow of metals, under suitable conditions of pressure.

7. The movement is also identical with that seen in glacial ice, although in the latter case the movement may not be entirely of this character.

8. In these experiments the presence of water was not observed to exert any influence.

9. It is believed, from the results of other experiments now being carried out but not yet completed, that similar movements can, to a certain extent at least, be induced in granite and other harder crystalline rocks.

OSTRACODA OF THE BASAL CAMBRIAN ROCKS IN CAPE BRETON

BY G. F. MATTHEW, LL. D., F.R.S.C.

Investigations of the Cambrian rocks in Cape Breton has brought to the writer's notice a number of new types of these small Entomostracans, and with the permission of the Director of the Canadian Geological Survey, these are communicated to the Natural History Society of Montreal.

The species all come from the Etcheminian sandstones and shales, and from a body of shales included in the volcanic rocks which underlie them. This part of the Cambrian appears to contain three faunas, one in the shales of the volcanic rocks, and two in the Etcheminian sediments.

Only two species of Ostracoda have been found in the shales of the volcanic rocks, so that the bulk of the fauna is Etcheminian. The distribution of the forms throughout this series of beds will be readily seen by the accompanying table. The three larger divisions of the Etcheminian shown in the table are lithological, and the Lower Etcheminian Fauna is confined to the two lower divisions; the Upper Fauna is in No. 3, the upper division. The letters beneath these divisional spaces indicate the successive assises in which fossils have been found. No Ostracoda of the Protolenus Zone have been recognized in these beds, and so it is supposed they are older than that fauna.

LIST OF OSTRACODA OF THE COLDBROOK AND ETCHEMINIAN TERRANES IN CAPE BRETON WITH THE HORIZONS AT WHICH THEY ARE FOUND.

	NAMES OF SPECIES AND MUTATIONS.	Coldbrook.	ETCHEMINIAN. 1 *a*	1 *b*	1 *c*	1 *d*	1 *e*	2 *a*	2 *b*	2 *c*	3 *a*	3 *b*	3 *c*	3 *d*	3 *e*	3 *f*
	Leperditia (?) rugosa															x
Rutelliform.	Bradorona perspicator					x										
	" " mut. maxima				x											
	" " " magna								x							
	" " " major															x
	" spectator				x	x										
	" " mut. acuta			x		x										
	" " " spinosa						x									
	" " " æquata													x		
Oblique.	" observator					x										
	" " var. benepuncta					x										
	" " mut. lævis			x						x						
	" " " ligata														x	
Small.	Bradoria scrutator														x	
	" vigilans														x	
	" " mut. obesa, &c			x	x	x										
	" rugulosa														x	

LIST OF OSTRACODA. &c.—*Continued.*

NAMES OF SPECIES AND MUTATIONS.	Coldbrook.	ETCHEMINIAN.													
		1					2			1					
		a	*b*	*c*	*d*	*e*	*a*	*b*	*c*	*a*	*b*	*c*	*d*	*e*	*f*
Bradoria (?) ornata				x											x
Escasona rutellum															
" (?) vetus					x										
" (??) ingens	x													x	
Indiana ovalis						x									
" " mut prima	x														x
" lippa														x	
Schmidtella (?) pervetus															
" " mut. concinna					x									x	x
" (?) acuta															
	2		3	4	8	2		1	1				1	7	5

4 genera.
15 species.
11 mut'ns.
1 variety.
} 27 forms.

OSTRACODA.

The Ostracoda found in those deposits afford a means of discriminating the layers, second only to the Brachiopoda. They are not nearly so numerous as the latter, or they would be even more valuable in this respect, as they show considerable liability to variation.

From their small size they are easily overlooked, but their thick and strong shells have resisted destructive agencies, and give examples that have not suffered so much from distortion and pressure as some of the Brachiopods.

They possess some features of form and structure which are peculiar. One notable feature is the position of the main muscle scar.

Mr. E. O. Ulrich, who has given much attention to the study of the Ordovician and Silurian Ostracoda seems to assume that the place for the muscle is near the centre of the valve. At least he speaks of this as the position of this mark in Leperditia* ; it is from the hinge to this point that the sulcus or transverse groove extends in this genus And if there is any meaning in this connection in the central depression of the valve a similar position for the muscle scar may be inferred for Primitia Primitiella Isochilina, Kerbya, Entomis and other genera.

But in the Etcheminian species of Ostracoda and in many of those of the Protolenus Fauna of the St. John Group, we have not been able to find any in which the muscle scar is so placed. On the contrary many examples occur in which the scar holds an anterior position near the hinge line. This peculiarity would have given great mobility to the valves and it is a fact that while in many cases we find the valves spread somewhat apart, there are others in which they are spread out flat and yet retain their normal connection.

* Lower Silurian Ostracoda of Minnesota. p. 633.

If there is any meaning in these furrows that extend from the hinge as indicating muscular attachment there is a sugestion of a posterior muscle, towards the posterior end of the cardinal line in the depression that exists there in Beyrichona and Hipponicharion, and is faintly shown in Escasona. But of such posterior muscle we have no sure evidence. Of the anterior adductor muscle, however, there are plain indications on the interior of many valves.

It is clear that Ostracods having such a radical difference of structure from those others of a later time, must have had different habits of life, and among other peculiarities noted is that they usually occur solitary. Seldom do we find any aggregations of individuals and never the swarms on a single layer of rock that may be found in occurrences of the later Ostracods; hence they appear not to have possessed in any marked degree the gregarious habit of these later genera.

Another peculiarity of the Etcheminian and Protolenian forms, as distinguished from the prevalent Ostracoda of Ordovician and Silurian Time, is the unusual convexity of the front moiety of the valve as compared with the other. This for some time led the author to be uncertain as to which was the anterior end of the valve in the genus Beyrichona. He, however, now has no longer any doubt, as the related genus Bradoria, with its prominent ocular tubercle sets this matter at rest, and shows that the thick end of the valves is the anterior one.

Another common feature is the prevalence of species which are as wide or wider than long. This peculiarity is connected with a long hinge line and with more or less abrupt cardinal curves of the margin, before these merge into the true anterior and posterior margins of the valves (see Plate I. figs. 1 to 6, *a* & *b*). When the angle at the lower end of these cardinal curves is acute, a tubercle is sometimes developed, in addition to that which marks the anterior and often the posterior end of the hinge line (Pl. I. fig.13, *a* & *c*.

These laterally expanded valves are in a number of species pointed at the lower margin and in most the ventral margin is more or less angulated (Pl. I figs. 2, 3 and 6). It thus admits of division into two portions which may be designated the anterior and posterior curves (*e* and *d*), according to whether the part of the margin indicated is in front or behind the ventral angulation. Sometimes the anterior curve of the margin will be stronger as in Beyrichona (Fig. 3) (and Escasona? Fig. 6), sometimes the posterior curve, as in Indiana (Fig 1) and Bradorona (Fig. 2), is the stronger. In Hipponicharion (Fig. 4) the two are about equal,

The cardinal curves (Pl.I.figs. 2 etc., *a* and *b*,) extend from the hinge line along the margin until it becomes at right angles to the hinge, and they also vary greatly in direction and extent. Thus in Indiana (Fig. 1) the posterior one is long, the anterior shorter ; in Bradorona (Fig. 2) they are approximatively of equal length ; in Beyrichona (Fig. 3), sp. *papilio,* the posterior one is almost obsolete but in other species (*tinea, planata, etc.,*) of this genus, it is well shown, and with these the species of Escasona (Fig. 6) agree. In Bradoria (Fig. 5) both cardinal curves, and especially the posterior are well shown. In Hipponicharion on the contrary these curves are almost obsolete.

The relation of the muscle scar to the ocular tubercle is also a means of discriminating the genera in these early forms of Ostracoda : thus in Bradorona (Fig. 2) and Bradoria (Fig. 5) it is diagonally behind and below the tubercle, but in Beyrichona it is below and somewhat in front of the tubercle. In Hipponicharion (Fig. 4) the muscle print presses in behind and below the tubercle. In Indiana (Fig. 1) the scar though not well recognized appears to be as in Bradorona (Fig. 2). In Escasona neither muscle scar nor tubercle have been certainly identified.

Comparing this group of genera with those of the Ordovician and Silurian, we note some obvious differences from them. Perhaps the most notable is the way in which the visual and muscular organs are crowded at the front end of the hinge. This would exclude them from the great family of the Leperditidæ, Jones, in which the muscle scar is near the middle of the valve, The lateral expansion of the valves also is characterestic, and still more the way in which many are pointed at the middle of the ventral margin.

We see no nearer relation in these species to the "zoe" group of giants described by Barrande, than to the Leperditidæ; these remind one more of the bivalve carapaces of Phyllopod crustaceans. The Canadian forms, though many are above the average size of the fossil Ostracoda, are far inferior in this respect to Aristozoe and its allies.

It seems to the writer that the position of the main adductor muscle scar separates these species from all described Ostracoda, and he would suggest for them the designation **Bradoriidæ,** taking as types the genera Beyrichona and Bradoria. Hipponicharion is widely divergant from the others and in its strongly ridged surface simulates Beyrichia and may for the present be placed in the family Beyrichidæ.

LEPERDITIA ? ? RUGOSA, n, sp. Pl. I. fig. 7*a* to *c*.

This species may prove to be of another genus when more numerous examples are found. The single example found does not seem to justify a final reference to any described genus.

Only the right valve is known and this is rather flat, and flattened toward the hinge and the posterior slope; its greatest convexity is in the middle and the lower third The outline is broadly oval, with a hinge line half of the length of the valve. The anterior and posterior cardinal curves are long; the posterior marginal curve and the lower side of the valve are both somewhat straightened, and the anterior marginal curve strongly rounded.

There is an obscure ocular tubercle situated at the upper front angle of the valve; and an obscure, short and weak furrow behind it; about the middle of the cardinal line is a low, faintly marked tubercule. There is a trace of a marginal furrow along the posterior margin.

Sculpture. Corrosion of the surface has obscured the usual markings, leaving a rough surface, which is crossed in several directions by broken ridges, without regularity; except towards the lower margin of the valve, where there are several sub-parallel to the margin.

Size. This is the largest Ostracod obtained from the Etcheminian Group—Length 6½ mm, width 5 mm, depth about 1¼ mm.

Horizon and locality. Assise E. 3. f. Upper Etcheminian, at Gillis', Indian Brook, Escasonie N. S. Scarce.

The flat form and wrinkled surface of this valve indicates a thin chitinous test. It may have distant affinities with *Isoxys*, Walcott, but is entirely different in form. It also approaches in outline *Aristozoe rotundata* Walcott,* but is of different relief.

BRADORONA, n. sub-gen.

The description of the genus Bradoria applies more particularly to the smaller elongate forms, described in the Bulletin of the Natural History Society of New Brunswick.† But beside these the Etcheminian beds contain a group of larger forms, with similar ocular tubercle and muscle scar, but broader and more triangular in form; most of them belong to the Lower Etcheminian Fauna but there are stragglers in the upper. With their more angulated form they have the front marginal curve straightened. These we propose to distinguish as a subgenus under the name Bradorona.

BRADORONA PERSPICATOR, n, sp. Pl. I,, fig. 8*a* to *d*.

This is one of the largest Ostracods, found in the Cape

* Fauna of the Olenellus zone p. 627 pl. i. xxx fig. 3.

† Bull Nat. Hist. Soc. N. B. Vol. iv. p. 204 St John 1899.

Breton Etcheminian rocks and, if the following mutations are properly referred to it, extends through them in varying forms and sizes.

In this typical form the hinge is more than three-fifths of the width of the valves. The posterior cardinal curve is long and straight, the margin bears a thread-like marginal fold on the left valve and there is a narrow obscure furrow, within the margin along the anterior and posterior marginal curves. The hinge margin is thickened, and a tubercle marks the posterior end of the hinge line (of at least the right valve). The ocular tubercle is distinct in each valve, behind which is a shallow furrow extending a short distance below it. There is also a short, obscure ridge extending obliquely downward from the ocular tubercle toward the lower margin of the valve.

The greatest convexity of the valve is two-fifths below the hinge line, and the slope to the anterior margin is steep.

Sculpture. In all the forms of this species obtained, the sculpture has been obscured by corrosion, but remains of the cortex that have escaped this destructive change, show a pitted surface. By a linear arrangement of the pits along the anterior and posterior slopes of the valves an appearance of parallel ridges has been produced.

Size. Length $4\frac{3}{4}$ mm. Width 4 mm. Depth of each valve $1\frac{1}{2}$ mm.

Horizon and locality. This is of the Lower Etcheminian Fauna, and occurs in Assise E. 1. d. at Dugald Brook, Escasonie, N. S.—Frequent.

The following measurements exhibit some variations in size.

A right valve,	length	$4\frac{1}{2}$ mm,	width	$4\frac{1}{2}$ mm,	depth	$1\frac{1}{2}$ mm.
Another	"	4 "	"	$4\frac{3}{4}$ "	"	$1\frac{1}{2}$ "
A left	"	4 "	"	$4\frac{3}{4}$ "	"	$1\frac{1}{2}$ "

Mutation MAXIMA, n. mut. Pl. I., figs. 9 *a, b.*

This is the largest form of the species observed; it is more rounded at the two ends and below, than the type and is flatter, but is of the same general form.

The hinge-line is two thirds of the length of the valve. The posterior cardinal curve is angulated. There is an obscure furrow behind the ocular tubercle, extending half across the valve; a low ridge extends along the anterior margin, a little within it, and a fainter ridge along and near the posterior cardinal curve; a narrow marginal furrow is visible along the anterior marginal curve; an obscure row of tubercles extends along and near the anterior half of the hinge of line.

Sculpture. Surface pitted, the spaces between the punctures becoming anastomosing ridges near the margin, and presenting ridges on the posterior half of the valve subparallel to the margin.

Size. Length 6mm, width 5mm, depth of a valve 1¾mm.

Horizon and locality. Assise E. i *c*, Lower Etcheminian, at Dugald Brook, Scarce.

Mutation MAGNA, n. mut. Pl. I., figs. 11 *a* and *b*.

Valves rather tumid, hinge-line shorter than in the type, two fifths of the length of the valve; ocular tubercle prominent, behind, and around it is a shallow furrow; cardinal curves of the margin long. No marginal furrow is visib*l*

Sceupture. Surface pitted; there are obscure anastomosing ridges between the pits parallel to and near the margin; a narrow obscure band extends from the ocular tubercle obliquely backward and downward.

Size. Length, 5 mm; width, 4 mm.; depth, of a valve 1½ mm.

Horizon and locality. Assise E. 2 b, Lower Etcheminian, at Dugald Brook, Scarce.

Mutation MAJOR, n. mut. Pl. I. figs. 10 *a* and *b*.

Valves rather tumid, hinge-line about three fifths of the length of the valve. Cardinal curves rounded; no marginal furrows seen. Ocular tubercle a little way from the hinge; a broad obscure furrow behind it. An obscure ridge runs from the posterior marginal curve to the anterior middle of the valve, and thence curves up to the lower end of the anterior cardinal curve.

Size. Length 5½mm.; width 4½mm.; depth of a valve 1½mm.

Horizon and locality. Assise E. 3. f., Upper Etcheminian at Dugald Brook, Scarce.

BRADORONA SPECTATOR, n. sp. Pl. I. figs. 12 *a* to *d*.

This species is smaller than the preceding and has a more finely pitted surface. The length and breadth of the valves are about equal. Length of the hinge more than half that of the valve (⅘); the anterior and posterior cardinal curves are about equal in length; both anterior and posterior marginal curves are convex. The upper part of the valve is most protuberent as in Schmidtella. A sharp marginal furrow shows on some valves. The ocular tubercle is prominent; some examples show a short thread-like ridge extending diagonally backward from the tubercle; this corresponds to a furrow on the inside of the valve.

Size. Length and breadth each 3½ mm.; depth of a valve 1 mm.

Horizon and locality. In the dark brownish gray sandy shale of Assise E. 1 *d*, Lower Etcheminian, at Boundary Brook, Escasonie, Rather common. Also in Assises E. 1. *b*. and E. 1. *d*. at Dugald Brook, Infrequent

Var. ACUTA, n. var.

This is a large form more pointed below than the type. Anterior marginal slope somewhat straightened. Ocular tubercle distinct.

Sculpture. Surface minutely punctate, and showing a strong striation near the hinge.

Size. Length and breadth each about 4 mm.; depth of a valve 1 mm.

Horizon and locality. Assise E. 1. b., Lower Etcheminian, at Dugald Brook, Infrequent.

A small example, supposed to be the young of this form is narrower, more acutely pointed below, and with straighter anterior and posterior marginal curve, was found in Assise E. 1 *d.* at Boundary Brook

Mutation SPINOSA, n. mut. Pl. I. figs. 13 *a* and *b.*

Wide below the cardinal curves. Anterior marginal curve straightened. A sharp marginal furrow all around except at the hinge.

The ocular tubercle is distinct and there are spines at the ends of the cardinal curves, except at the lower end of the posterior curve.

Sculpture. The surface is minutely punctate ; on the posterior slope of the valves and on a band descending backward from the ocular tubercle, the pits merge into interrupted striæ, divided by inosculating ridges.

Size. Length and breadth each about 4 mm.; depth of a valve 1¼ mm.

Horizon and locality. An entire carapace in the Assise E. 1. *e.*, Lower Etcheminian, at Dugald Brook, Scarce.

Mutation ÆQUATA, n. mut. Pl. I. figs. 14 *a* and *b.*

Anterior and posterior sides nearly equal. The form is oval, and is wide below the cardinal curves, which are long. Anterior as well as posterior marginal curve regularly arched.

Sculpture. The surface has been corroded, but shows traces of a minute pitting.

Size. Length and breadth each 3¾ mm ; depth of a valve 1 mm.

Horizon and locality. In Assise E. 3. *d.* Upper Etcheminian Fauna, at Dugald Brook, Rare.

BRADORONA OBSERVATOR, n. sp. Pl. I. figs. 15 *a* to *c.*

A small species of the same general form as the preceding, but the anterior marginal curve is more oblique to the hingeline, the ventral angle being opposite to the posterior half of the cardinal line; this (2 mm. long) is considerably more than half of the length of the valve.

The anterior cardinal curve is angulated at each end; the posterior is a third longer than the anterior. The anterior marginal curve is straightened and is considerably longer than the posterior, which is strongly arched outward. A narrow thread-like marginal fold is visible in some places. A thickened band within the margin, in some places shows slight protuberences.

Sculpture. In most examples the surface is scabrous from corrosion, but some show traces of a minute pitting, and near the margins of the valve these pit form continuous rows, or furrows. The mould of the interior shows a smooth surface having minute punctures. The muscle scar behind the ocular tubercle, is distinct on the mould.

Size. Length 3½ mm; width 3 mm; depth of a valve 1 mm.

Horizon and locality. In Assise E. 1. *d.*, Lower Etcheminian, at Boundary Brook, Common.

The following are measurement of several valves from this locality.

left valve,	length	3¼	mm,	width	2½	mm, depth	1 mm.
2 "	"	3½	"	"	3	" "	1 "
" "	"	3¼	"	"	2¾	" "	¾ "
" "	"	3¼	"	"	2¾	" "	¾ "
carapace	"	3¾	"	"	2¾	" "	2 "

Three forms which may be classed as varieties of this species are the following.

Var. BENEPUNCTA, n. var. Pl. I. fig. 16.

Anterior cardinal curve longer than the posterior; anterior marginal curve straightened and the greatest width of the valve posterior to the middle. Hinge-line nearly half of the length of the valve (2½ mm). Ocular tubercle distinct; a shallow furrow behind and below it. A faint ridge extends forward from the posterior end of the hinge half way to the furrow below the ocular tubercle. Another example, more oval and more tumid, has an obscure row of tubercules arching outward and forward from the posterior cardinal angle to the anterior cardinal curve. A low ridge extends back from the ocular tubercle to the hinge.

Sculpture. The surface is corroded, but on the posterior slope of the valve are anastomosing ridges parallel to the margin.

Size. Length 4½mm; width 3½mm; depth of a valve 1mm. A carapace from this locality had length 4¼ mm; width 3¼ mm; depth of the two valves 3 mm.

Horizon and locality. Assise E. 1. *d.*, Lower Etcheminian, at Boundary Brook. Scarce.

Mutation LÆVIS, n. mut.

Oval, cardinal curves long, the anterior one rounded. Hinge line more than half the length of the valve (⅝), a tubercle at the posterior end. Ocular tubercle off from the hinge-line and prominent; ocular furrow shallow. The right valve has a thread-like marginal fold; no fold on the posterior slope of the left valve.

Sculpture. Punctation fine, showing anastomosing ridges near to and parallel to the posterior slope of the valve. An example from the higher horizon shows a thickened band near the margin along the posterior marginal slope, that bears obscure elongated tubercles. An example of the mould from the same horizon has three small pits behind the ocular tubercle, parallel to the hinge.

Size. Length 4¼mm; Width 3¼ mm; depth 1 mm.

Horizon and locality. Occurs in assises E. 1. *b*, and E. 2. *c*, Lower Etcheminian, at Dugald Brook.

The following are measurements of examples from the two horizons:

E. 1. *b*, carapace,	length 4mm;	width 3 mm;	depth $2\frac{1}{4}$mm.
" "	" $3\frac{1}{4}$ "	" 3 "	" $1\frac{1}{2}$ "
" "	" $3\frac{1}{4}$ "	" $3\frac{1}{4}$ "	" 1
E. 2. *c*. right valve	" $4\frac{1}{4}$ "		

Mutation LIGATA, n. mut. Pl. I., fig. 17.

Oval, cardinal curves long, anterior marginal curve straight, posterior ornamented with a row of small tubercles; a similar row extends direct from the lower end of the posterior cardinal curve toward the lower end of the valve, near which it curves forward. Ocular tubercle obscure, it appears to be represented by four small tubercles; but the furrow is well marked.

Sculpture. Punctation rather coarse; anastomosing ridges near the two ends of the valve, parallel to the margin.

Size. Length 4 mm; width 3 mm; depth of two valves 2 mm.

Horizon and locality. Assise E. 3. *e.*, Upper Etcheminian, at Dugald Brook. Rare.

"BRADORIA.*

"In the Protolenus Fauna are two species of Ostracoda which for want of other known relationship were referred to the genus Primitia. It would appear now that they are representatives of an ancient type of crustaceans which has species in the Etcheminian Fauna. Though having the general form of Primitia, Primitiella and Aparchites they do not have the median pit, or sulcus of the first, the shallow median depression of the second, or the smooth valve of the third. Their most marked character is a prominence or tubercle just at the front of the hinge-line; from the smoothness of the summit of this tubercle, and its advantageous position for vision, it is supposed to be an ocular tubercle. Some of the species have close behind this tubercle, a short vertical furrow; or the fur-

* Nat, Hist. Soc. N. Brunswick, Bull. vol. iv, p. 204. Named for the Bras d'or, a salt water lake occupying the interior of the island of Cape Breton.

row may pass around the tubercle. In the five species referred here the marginal furrow is obscure, or in side view along the lower margin, invisible.

The known species are of nearly the same size—about 3 to 4 mm. long—and the surface of the valves is distinctly pitted, tuberculated or wrinkled. The following are the species which fall under this genus. *Primitia oculata* and *P. aurora* of the Protolenus Fauna and the following species."

BRADORIA SCRUTATOR. Pl. II, figs. 1 *a* to *c*.

Bradoria scrutator, n. sp. Nat. Hist. Soc. N. B. Bull. vol iv. p. 204, pl. iv, figs. 1. *a* to *c*.

"Outline of the valves ovate, with a straight hinge-line. Hinge-line more than half the length of the valve, terminating in front at a short transverse furrow, situated immediately behind the tubercle. The hinge is bordered all along its course by a narrow sharp ridge, similar to a marginal ridge. The tubercle is nearly marginal, and is situated just in front of the hinge-line. In front of it the margin of the valve turns downward, and is bordered by a narrow obscure furrow, which extends around the ventral margin of the valve. There is a slight angulation of the outline of the valve at the middle of the anterior border, separating there the cardinal and anterior curves. The posterior margin rounds regularly upward behind to the hinge-line.

Sculpture. The whole surface of the valve is covered with closely set, rather coarse, conspicuous pits that are finer toward the hinge where they have a linear arrangement." On the posterior half, toward the posterior margin the tubercles between the pits have a tendency to coalesce, and thus produce obscure ridges whose course is directed toward the lower border of the valve.

"*Size.* Length 3 mm; width" 2¼ mm; depth 1 mm.

Horizon and locality. Assise E. 3. *e.*, Upper Etcheminian, at Dugald Brook.

Additional material shows much better the characters of this species. In this the valves have been of a more distinctly oval form than in those of the preceeding species, the cardinal curves being rounded so that the straightening of the anterior marginal curve alone defines the length of the cardinal curve above it. The posterior cardinal curve is rounded to the hinge, and the lower edge of the valve is broadly rounded.

Sculpture. (2) The interior shows a large muscle scar near the hinge-line, behind the ocular tubercle; and also an unusually long straight groove, directed backward and downward, in front of the tubercle; a fainter, shorter groove directed toward the anterior margin lies in front of this. A thickened band of the shell substance making a slight ridge on the inner surface, exteuds from the posterior cardinal angle, around the ventral slope of the shell to the anterior marginal curve. The following are measurements of some valves;

Left valve, length 3 mm;	width 2¼ mm;	depth 1 mm.
Right " " 3¼ "	" 2¼ "	" 1 "
" " " 3 "	" 2⅓ "	" 1¼ "
Carapace " 2¾ "	" 2 "	" 2 "

As compared with the species of the Protolenus zone—this species is a little larger than *B. oculata*, from which it is easily distinguished by the character of the surface ornamentation; in the Etcheminian species tha pits are coarser and closer together, and it thus has a rougher surface than the species above named. The sculpturing is more like that of *Isochilina ventricosa*, which, however, is a much larger species. *P. aurora* of the Protolenus zone is nearly of the same size, but it differs in the strong anterior furrow, and in its finely pitted surface.

BRADORIA VIGILANS. Pl. II., figs. 2 *a* to *c*.

Bradoria vigilans, n. sp. Nat. Hist. Soc. N. B. Bull, vol. IV. p. 205. pl. iv. figs 2 *a* to *c*.

"Outline of the valves ovate, somewhat pointed behind, moderately arched transversely the valves somewhat ridged lengthwise. The right valve has a hinge-line about half of the length of the valve, which is flattened down at the hinge forming there a lance oval area. There is a prominent tubercle at the front of the hinge surrounded by a shallow groove. The margin is gradually rounded from the front, and projects somewhat at the posterior end, whence the posterior cardinal curve goes directly upward to the back of the hinge.

Sculpture. The surface is marked by close set granulations, that become finer toward the hinge-line and the ocular tubercle; at the posterior quarter of the valves the granulation graduates into a series of subparallel anastomosing ridges.

Size. Length 3½ mm. Width 2½ mm." Depth ¾ mm.

Horizon and locality. Found in Assise E. 3 *e.* of the Upper Etcheminian, Dugald Brook, Escasonie, Cape Breton.

"Distinguished from *Aparchites conchiformis* of the Protolenus Fauna, by its smaller size and prominent tubercle; and from *A. secunda* by the tubercle and the coarser ornamentation," as well as by the angulated projection at the end of the valve.

An additional example of this species from the bed in which the original was found, and three others from a layer about a foot lower in the measures, give additional information of the species.

These examples are wider than the type. The ocular tubercle in this species is a little off from the hinge-line. The cardinal slopes are long and the anterior marginal slope is somewhat straightened.

The following are measurements of some valves:—

right	valve,	length	3¼	mm.,	width	2¼	mm.,	depth	¾	mm.
"	"	"	3¼	"	"	2¼	"	"	1	"
"	"	"	3	"	"	2	"	"	1	"
"	"	"	3	"	"	2¼	"	"	1	"
"	"	"	3½	"	"	2½	"	"	1	"
carapace		"	3	"	"	2¼	"	"	2	"

MUTATIONS.

In the lower Etcheminian Fauna some forms occur which may be referred to this species as mutations.

Assise E. 1. b. mut. *obesa,* n mut.

A broader and more tumid form than the type. The hinge-line is three-fifths of the length of the valve and there is a tubercle at the posterior end of the hinge-line The ocular tubercle is prominent and enclosed by the fur- row; a row of low and obscure tubercles runs curving from the ocular tubercle to the lower angle of the valve

Sculpture. The surface is marked by a fine punctation, and by anastomosing ridges on the posterior half of the valve; a diagonal band of these ridges runs from the ocular tubercle, diagonally backward and downward to the lower part of the anterior margin.

Size. Length 3mm, width 2½mm, depth two valves together 1½mm.

Assise E. 1. c. A form occurs here which is flatter than the preceeding and smaller.

This form differs from the young of *Bradorona observator* of the lower fauna in the deeper furrow around the tubercle, and in the rounder base of the valve; hence we have associated it with *B. vigilans*

Assise E. 1. d. An imperfectly preserved right valve was obtained here from beds of feldspathic sandy shale. It is considerably smaller than the type, and the surface is rough and dull from corrosion.

Size. Length of a valve 2½mm., width 1¾mm., depth ½mm.

BRADORIA RUGULOSA, Pl. II., figs. 3 *a* to *d*.

Bradoria rugulosa, n. sp. Nat. Hist. Soc. N. B. Bull. iv. p. 205. pl. iii, figs. 3 *a* to *d*.

"A suborbicular species of which only the right valve is known. Tubercle rather prominent, some distance below the anterior end of the cardinal line; this line is nearly straight and about half of the length of the valve. There is a faint furrow behind the tubercle. A narrow obscure marginal rim appears at the back of the valve.

Sculpture. The lower slope and the posterior half of the valve are covered with anastomosing ridges, concentric to the upper front part of the valve ; toward the top and front of the valve these ridges become obscure aad the surface of the valve is granulated.

Size Length 2¾ mm., width" 2½ mm., depth less than ½ mm.

Horizon and locality. In assise E. 3. *e.*, Upper Etcheminian Fauna, Dugald Brook, Escasonie, Cape Breton Rare.

" This little species is easily distinguished from others of the genus by it orbicular form and rugulose surface which is like that of certain trilobites."

MUTATION.

A small right valve of the form of this is found in Assise E. 1 *c*. Lower Etcheminian, at Dugald Brook. The punctation is fine and distinct, and the rugulose surface is seen only near the margin of the valve.

BRADORIA ? ORNATA, n. sp. Pl. II, figs. 4 *a* to *c*.

The valves in this species are rather flat and are rounded to the hinge and lower margin, but not much to the ends.

Only one example known, which is supposed to be a right valve.

Suboval with a long hinge-line, about three quarters of the length of the valve. Anterior cardinal curve short, posterior longer. Anterior marginal curve long, rounded; posterior shorter, rounded forward. The valve is more tumid in the cardinal third, and rounded to the hinge, where there is a low narrow ridge. A thread-like marginal fold is visible in some parts of the margin.

In this species there is no definite ocular tubercle, but a group of several small tubercles on a slight elevation, occupy its place. The ocular furrow is shallow, and close to the front of the hinge, and extends downward opposite the anterior cardinal curve.

Sculpture. The surface is covered with distinct pits, the spaces between which become inosculating ridges, subparallel to the length of the valve, but tending downward in the direction of the front of the valve; towards the hinge line the pitting is very minute.

Size Length $2\frac{1}{4}$ mm., width $1\frac{1}{2}$ mm., depth of a valve nearly $\frac{1}{2}$ mm.

Horizon and locality. Assise E. 1. *c.* Lower Etcheminian Fauna, at Dugald Brook.

The sculpture, something like that of an Entomis or a Kerbya but finer, separates this little species from the others.

ESCASONA, n gen.

A few forms which cannot be referred to any genus of the Eopalæzoic are present at two horizons in the Etcheminian. The typical form is in one of the highest beds of the Upper Etcheminian. It is short and high and the slight eminence which appears to indicate the ocular tubercle is close to the hinge. There is a long slope from the hinge toward the middle of the valve, it thus resembles Beyrichona; but it does not have the two strong furrows or pits near the hinge which characterize that genus; nor is the slope from the hinge so long. Though tumid in the upper third of the valve this form cannot be classed with Schmidtella, because the slope in the upper third of the valve is not bent down abruptly to the hinge, as in that genus; and furthermore the outline of the valve is that of Beyrichona and Bradorona, and not the round valve of Schmidtella. I refer to this genus *Beyrichona ovata* of the Protolenus fauna. The typical characters of the genus are in the following species, *E. rutellum.*

ESCASONA RUTELLUM, n. sp. Pl. figs. 5 *a* to *c*.

A broad tumid species. Hinge two-thirds of the width of the valve. Anterior cardinal curve obsolete; posterior one half of the length of the hinge, anterior marginal curve long, arched; posterior shorter, nearly straight, lower end of the valve obtusely pointed.

Highest point of the valve one-third from the hinge and two-fifths from the posterior margin. The ocular tubercle is small, close to the hinge and some distance from the anterior end. The posterior slope of the valve is flattened. The cardinal slope of the surface of the valve has a broad shallow furrow extending down nearly to the highest part of the valve. The arched anterior sloped surface of the valve is evenly curved down to the border.

Sculpture.—The surface of the shell has been corroded, and the pitted surface is obscure.

Size.—Length, 3 mm; width, 3¾ mm; depth, 1½ mm.

Horizon and Locality.—Assise E. 3 *f.*, Upper Etcheminian, at Gillis' Indian Brook. Scarce.

ESCASONA (?) VETUS, n. sp. Pl. II., figs. 6 *a* and *b*.

This form, represented by a right (?) valve, has a more rounded surface than the type, and the valve is flatter. No ocular tubercle is determinable. The hinge line is very long (sixth-sevenths of length) and there is a shallow furrow extending from it on the cardinal slope of the valve. The valve is most tumid toward the posterior (?) side; and the ventral angle is vertically behind the end of the cardinal line. A broad thickened band runs around the supposed posterior margin.

Sculpture.—The shell is minutely pitted, but it is mostly decorticated.

Size.—Length, 3 mm.; width, $3\frac{1}{2}$ mm.; depth, $\frac{3}{4}$ mm.

Horizon and Locality.—Assise E. 1 *d.* Lower Etcheminian, at Boundary Brook.

ESCASONA (??) INGENS, n. sp. Pl. II. figs. 7 *a* to *c*.

Only one valve known. The unusual form agrees with none of the other genera of the Etcheminian Ostracods. It appears to be a left valve and is so described here. The outline is obliquely subtriangular and somewhat wider than long.

The hinge line is three-quarters of the length of the valve; a shallow furrow runs parallel to the hinge, and near it for two-thirds of the length of the valve. No ocular tubercle could be detected, but at what appears to be the posterior upper angle of the valve is a small tubercle. The anterior cardinal curve is short and nearly in the direction of the hinge; the posterior is wanting. The anterior marginal curve is long and strongly arched; the posterior is shorter and less arched, abruptly rounded below, and at a right angle with the hinge line. The valve is highest at the middle, gently arched toward the hinge, and to the lower margin of the valve, and more abruptly towards the anterior margin. A faint ridge or swelling runs along the back of the valve near the margin. Lower angle of the valve bluntly rounded. Traces of a narrow marginal fold are preserved in some places.

Sculpture.—The surface is corroded, and only in a few places can a fine punctation be seen.

Size.—Length, 6 mm.; width, $6\frac{1}{2}$ mm.; depth, $1\frac{1}{4}$ mm.

Horizon and Locality.—In a fine gray shale, containing grains and lumps of calcium phosphate, included in the Coldbrook volcanic rocks at Dugald Brook, Escasonie. Scarce.

This ancient Ostracod has the outline of a Beyrichona, but there is no flattened cardinal area of the valve, nor any trace of the deep muscle-pit of that genus. It is separated from Bradoria by the absence of ocular tubercle and posterior cardinal slope. It is provisionally placed in Escasona, though lacking the high elevation of the cardinal third of the valve, peculiar to that genus.

INDIANA, n gen.

Two forms of Ostracods of the Etcheminian Fauna differ from any of the preceeding by their marked oval form and do not seem to fall into any of the later genera. The author has heretofore referred resembling forms to Aparchites and Primitia, but omitting from consideration the large size of most of the Basal Cambrian species, they also have usually a well developed ocular tubercle, or the rudiments of one.

In a decorticated example there is a faint muscle mark, where the muscle scar is placed in Bradoria and Bradorona, but it projects less toward the middle of the valve than in those.

The genus consists of large to medium-sized Ostracods, oval or ovate in form, the outline somewhat straightened along the hinge, somewhat sharply rounded at the anterior end, more broadly at the posterior. A ventral angle is scarce traceable, and the greatest fulness is in the posterior half of the valve. The valves are evenly rounded, and highest about the middle. An ocular tubercle, or traces of one, can usually be seen in the upper anterior region of the valve.

Length of the known specie, 3 to 6 mm.

Range.—Through the Etcheminian and Protolenus Faunas.

Besides the species described below the following appear to belong here :

Primitia pyriformis. † } Both of the
P.—— (?) fusiformis. * } Protolenus Fauna.

Aparchites (?) robustus† also of that fauna comes near this group.

This genus is seemingly different from Nothozoe of Barrand. Nothozoe is an oval fossil occurring in the Ordovician of Bohemia, which the above author has referred doubtfully to the Ostracoda. The size, however, is much greater than that of the fossils we are dealing with here‡ and no ocular tubercle has been recognized. For these reasons, as well as on account of the obscurity of the characters at Nothozoe, it seems inadvisable to use this name for the Etcheminian species described below.

Equal objections may be taken to the referring of the Cape Breton species in question to the genus Primitia, or to Aparchites, which hitherto the author has used for the Lower Cambrian forms. The species of these genera are small, and the absence of an ocular tubercle in one, and the presence of a median sulcus in the other, are further distinctions from the species which the author has referred to Indiana. Few species of the genera Primitia and Aparchites attain a size in which the area of the valve is a tenth that of the shells referred to this genus.

INDIANA OVALIS, n. sp. Pl. I, fig. 8 *a* to *c*.

This species is ovate, broader behind than in front. Hinge line about one half of the length of the valve, Cardinal curve of moderate length. Anterior marginal curve long, arched, posterior short, more strongly arched.

† Roy. Soc. Can. Trans., vol. iv., sec. iv., p. 132, pl. i. figs. 3 *a* to *c* 1 and 4 *a* to *c*.

* N.Y. Acad. Sci., Trans. vol, xiv., pp. 237, pl. vii. figs. 8 *a* and *b*.

‡ Individuals of *Nothozoe pollens* (Syst. Silur. Bohm, vol. i., Supp. p. 536 have an area of valve 70 times greater than the largest species of Indiana.

No marginal furrows seen. Ocular tubercle close to the hinge line; a narrow diagonal furrow behind the eye extends to the lower end of the anterior marginal curve.

Sculpture.—Along the lower margin are fine anastomosing ridges; the decorticated part of the valve shows the lower margin of a semi-circular muscle scar, directly behind the ocular tubercle, near the hinge line. Another example of the valve with the surface somewhat corroded shows small pits and also anastomosing ridges on the surface.

Size.—Length, 4½ mm.; width, 3¼ mm.; depth of a valve, 1 mm. Another example is 3½ mm. wide.

Horizon and Locality.—Assise, E. 1 *e*. Lower Etcheminian at Dugald Brook. Scarce.

A form similar to this in size, though proportionately wider, occurs in the same assise; and another smaller, broader and flatter, is found is found in the assize E. 3 *e* Upper Etcheminian, at the same brook.

The following are dimensions of some valves:

E. 1 *e*. left valve, length 4½ mm. width, 3¼ mm., depth, 1mm.
E. 1 *e*. carapace, " 4½ mm. " 3½ mm., " 3¼mm.
E. 3 *e*. left valve. " 4½ mm. " 3 mm., " 1 mm.

Xestoleberis, Sars ('65), as represented by Prof. T. Rupert Jones' species *S. Wrightii*, from the Ordovician of Kildare, Ireland, is like this in form, but is more tumid, and is not shown to possess an ocular tubercle.

Mutation PRIMA, n. mut. Pl. II., 9 *a* to *c*.

A form resembling this species, but longer and larger, is found in the gray shale of the volcanic rocks. The example is a complete carapace, and the valves are crushed somewhat and displaced. There appears to be an ocular tubercle near the anterior end, and the fullest part of the valves is in the lower half.

Sculpture.—The surface is corroded, but there are traces of a fine punctation and of longitudinal striæ on the middle part of the valve.

Size.—Length of a carapace, $5\frac{1}{2}$ mm.; width, $3\frac{1}{2}$ mm.; depth, $2\frac{1}{4}$ mm.

Horizon and Locality.—In fine gray shale in the midst of the volcanic rocks of the Coldbrook group at Dugald Brook. Scarce.

INDIANA LIPPA, n. sp. Pl. II., figs. 10 *a* to *d*.

Hinge line more than half of the length of the valve.
Cardinal curves of moderate length; anterior marginal
curve twice as long as the posterior, convexly arched. A
very faint elevation in the position of the ocular tubercle;
and a very shallow depression behind it. There is a thick-
ened and slightly elevated band all around the margin,
except at the hinge.

Sculpture.—The surface has been corroded, but there is
a fine and rather distant punctation showing on one
example; this becomes very fine towards the hinge-line,
where anastomosing ridges are developed, running off
toward the posterior slope of the valve.

This species differs from the type of the preceding in
its more elongate form, greater plumpness and obscure
ocular tubercle.

Size.—Length, $4\frac{1}{2}$ mm.; width, $2\frac{3}{4}$ mm.; depth, 2 mm.

Horizon and locality.—Assise E. 3 *f*, Upper Etchemin-
ian, at Dugald Brook. Infrequent.

SCHMIDTELLA.

The two species referred to this genus are provisionally
so placed, because they are tumid toward the hinge, and an
ocular tubercle has not with certainty been observed. The
broad valve, somewhat pointed below, however, is not a
usual character of Schmidtella, and the valves are larger
than is usual in that genus. If the tubercle were present
the following species might be included in Bradorona

SCHMIDTELLA (?) PERVETUS, Pl. II, figs. 11 *a* to *c*.

Schmidtella ? pervetus, n. sp. Nat. Hist. Soc. N.B. Bull, vol iv., p. 206, pl. iv., figs. 3 *a* to *c*.

"Only the right (?) valve is known, [others found since.] The valve is moderately arched and without furrows, and its greatest fullness is in the upper half. The hinge-margin, which is more than half of the length of the valve, is straight and is formed by an infolding of the edge, which is without a furrow. No marginal fold was observed.

Sculpture.—The surface is covered with minute pits, closely placed; the raised spaces between the pits become so prominent on the lower part of the valve that the surface seems tuberculated, rather than pitted; toward the lateral and the lower edges these tubercles are arranged in rows, so that there the valve seems covered with obscure ridges parallel to the margin. At the opposite side of the valve, towards the hinge-line, the pits become very fine, and the surface of the valve has a shining appearance.

Size.—Length, 3 mm.; width, 2½ mm."; depth, 1 mm.

Horizon and Locality.—In Assise E. 3 *e*. of the Upper Etcheminian, Dugald Brook.

Some examples from the original bed show a valve highest in the middle, and with a hinge-line half of the length of the valve. There are traces of a narrow marginal fold.

"This species differs" from *Bradoria rugulosa* in its coarser ornamentation and in the broader curve of the lower margin. "From *S. cambrica* of the Protolenus Fauna it differs in the less protuberant centre of the valve and the narrower and straighter infolded border at the hinge-line. The marginal fold is also more distinct in *S. cambrica*, which does not have the concentric marginal ridges of this species."

Mutation CONCINNA, n. mut.

Highest part of the valve about two-fifths from the hinge; evenly sloped to the margins, except that the anterior side is somewhat more turgid than the posterior. Hinge line about half of the length of the valve. A very narrow fold runs around the margin.

Sculpture.—Surface with a fine but distinct punctation that develops anastomosing ridges near the margins.

Size.—Length, 2¼ mm.; width, 2½ mm.; depth of a valve, ¾ mm.

Horizon and Locality.—Assise E. 1 *d.*, Lower Etcheminian, at Boundary Brook, scarce.

This mutation is smaller and rounder than the type.

SCHMIDTELLA ACUTA, Pl. II., figs. 12 *a* to *c*.

Schmidtella acuta, n. sp., Nat. Hist. Soc. N.B., Bull vol. iv. p. 206, pl. iv., figs. 4 *a* to *c*.

"Valves tumid. Hinge line somewhat more than half of the length of the valve, marked by a narrow fold and furrow that extends most of its length. Valves about as wide as long, somewhat acutely pointed at the lower margin. A narrow marginal fold extends along one side of the valve to the pointed end. Greatest protuberance of the valve in the upper half; toward the hinge the curve of the surface of the valve is turned somewhat abruptly inward toward the cardinal line."

This species has a small ocular tubercle.

"*Sculpture.*—The surface is smooth in appearance and somewhat shining, but under the lens is seen to be covered with minute pits or granulations, uniformly distributed."

Size.—Length, 2½ mm.; width, 2¼ mm.; depth, nearly 1 mm.

Horizon and Locality.—In Assise E. 3 *e* and *f*, Upper Etchemínian, at Dugald Brook. Frequent.

The following are measurements of the valves of this species:

E. 3 *e*, left valve,	length	2¼ mm,	width	2¼ mm.,	depth	½ mm.
E. 3 *e*, "	"	"	2 mm,	"	1¾ mm.,	"	½ mm.
E. 3 *e*, right "	"		2½ mm.	"	2¼ mm.,	"	¾ mm.
E. 3 *f*, "	"	"	2¼ mm.	"	2 mm.,	"	½ mm.

This species by its smooth surface and pointed form recalls the genus Beyrichona of the Protolenus Fauna; but it has not the broad flattened area, near the hinge which marks that genus, on the contrary it is there most prominent; this feature belongs to the genus Schmidtella.

"From *S. pervetus* this species is distinguished by its finer ornamentation and pointed lower margin; and from *S. cambrica* of the Protolenus fauna by its smoother surface and narrow fold at the cardinal line. No Silurian Schmidtella has the pointed valve of this species."

ST. JOHN, N.B., CANADA,
December, 1901.

EXPLANATION OF THE PLATES.

PLATE I.

Figs. 1 to 6.—Diagrammatic figures of genera to show important character referred to in the text—*o*, ocular tubercle—*m*, scar of adduct or muscle—*c*, cardinal or hinge line—*a*, anterior cardinal curve—*b*, posterior cardinal curve—*e*, anterior marginal curve—*d*, posterior marginal curve—*v*, ventral margin.

Fig. 7.—*Leperditia* (? ?) *rugosa*, n. sp.—*a*, right valve, side view—*b*, same from the front—*c*, same from the hinge. All mag. $\frac{4}{1}$, U.E.* See p. 443.

Fig 8.—*Bradorona perspicator*, n. sp.—*a*, left valve, side view—*b*, same from behind—*c*, same from the hinge. All mag. $\frac{4}{1}$—*d*, a portion of the shell further mag. ($\frac{15}{1}$) L. E. See p. 444.

Fig. 9.—*B. perspicator*, mut. *maxima*, n. mut.—*a*, right valve, side view—*b*, same from the front. Both mag. $\frac{4}{1}$, L. E. See p. 445.

Fig. 10.—*B. perspicator*, mut. *major*, n. mut.—*a*, right valve, side view—*b*, same from the front. Both mag. $\frac{4}{1}$, U. E. See p. 446.

Fig. 11.—*B. perspicator*, mut. *magna*, n. mut. *a*, right valve, side view—*b*, same from the front. Both mag. $\frac{4}{1}$, L. E. See p. 446.

Fig. 12.—*Bradorona spectator*, n. sp.—*a*, left valve, side view—*b*, same from the front—*c*, same from the hinge—*d*, mould of the upper front corner of a right valve showing ocular tubercle and muscle scar. All mag. $\frac{5}{1}$, L. E. See p. 447.

Fig. 13.—*B. spectator*, mut. *spinosa* n. mut.—*a*, left valve, side view—*b*, same from the front. Both mag. $\frac{5}{1}$, L. E. See p. 448.

Fig. 14.—*B. spectator*, mut. *æquata*, n. mut.—*a*, left valve, side view—*b*, same front view. Both mag. $\frac{5}{1}$, U. E. See p. 448.

Fig. 15.—*Bradorona observator*, n. sp.—*a*, left valve—*b*, same from the front—*c*, same from the hinge. All mag. $\frac{5}{1}$, L. E. See p. 448.

Fig. 16.—*B. observator* var. *benepuncta*, n. var.—Carapace partly opened, the valves laterally foreshortened. Mag. $\frac{5}{1}$, L.E. See p. 449.

Fig. 17.—*B. observator*, mut *ligata* n. mut.—Left valve, side view U.E. See p. 451.

* U. E. and L. E. indicate Upper and Lower Etcheminian respectively.

Plate II.

Fig. 1.—*Bradoria scrutator*—*a*, left valve, side view—*b*, transverse section—*c*. longitudinal section. All mag. $\frac{8}{1}$, U.E. See p. 452.

Fig. 2.—*Bradoria vigilans*—*a*, right valve, side view—*b*, outline from front—*c*, outline from the hinge. All mag. $\frac{8}{1}$, U. E. N.B.—The ocular tubercle is too near the hinge line in figs. 2 *b* and 2 *a*. See p. 454.

Fig. 3.—*Bradoria rugulosa*—*a*, right valve, side view—*b*, outline from front—*c*, out line from hinge line. All mag. $\frac{5}{1}$—*d*, part of the shell further enlarged ($\frac{10}{1}$) to show sculpture, U. E. See p. 456.

Fig. 4.—*Bradoria* (?) *ornata*, n. sp.—*a*, right valve, side view—*b*, outline from the front—*c*, outline from the hinge. All mag. $\frac{7}{1}$, L.E. See p. 456.

Fig. 5.—*Escasona rutellum*, n. sp.—*a*, right (?) valve, side view—*b*, same front view—*c*, same, from the hinge. All mag. $\frac{5}{1}$, U. E. See p. 458.

Fig. 6.—*Escasona* (?) *vetus*, n. sp.—*a*, right (?) valve—*b*, same from the hinge. Both mag. $\frac{5}{1}$, L. E. See p. 458.

Fig. 7.—*Escasona* (??) *ingens*, n. sp.—*a*, left (?) valve—*b*, same from the front—*c*, same from the hinge. All mag. $\frac{4}{1}$. Coldbrook terrane. See p. 459.

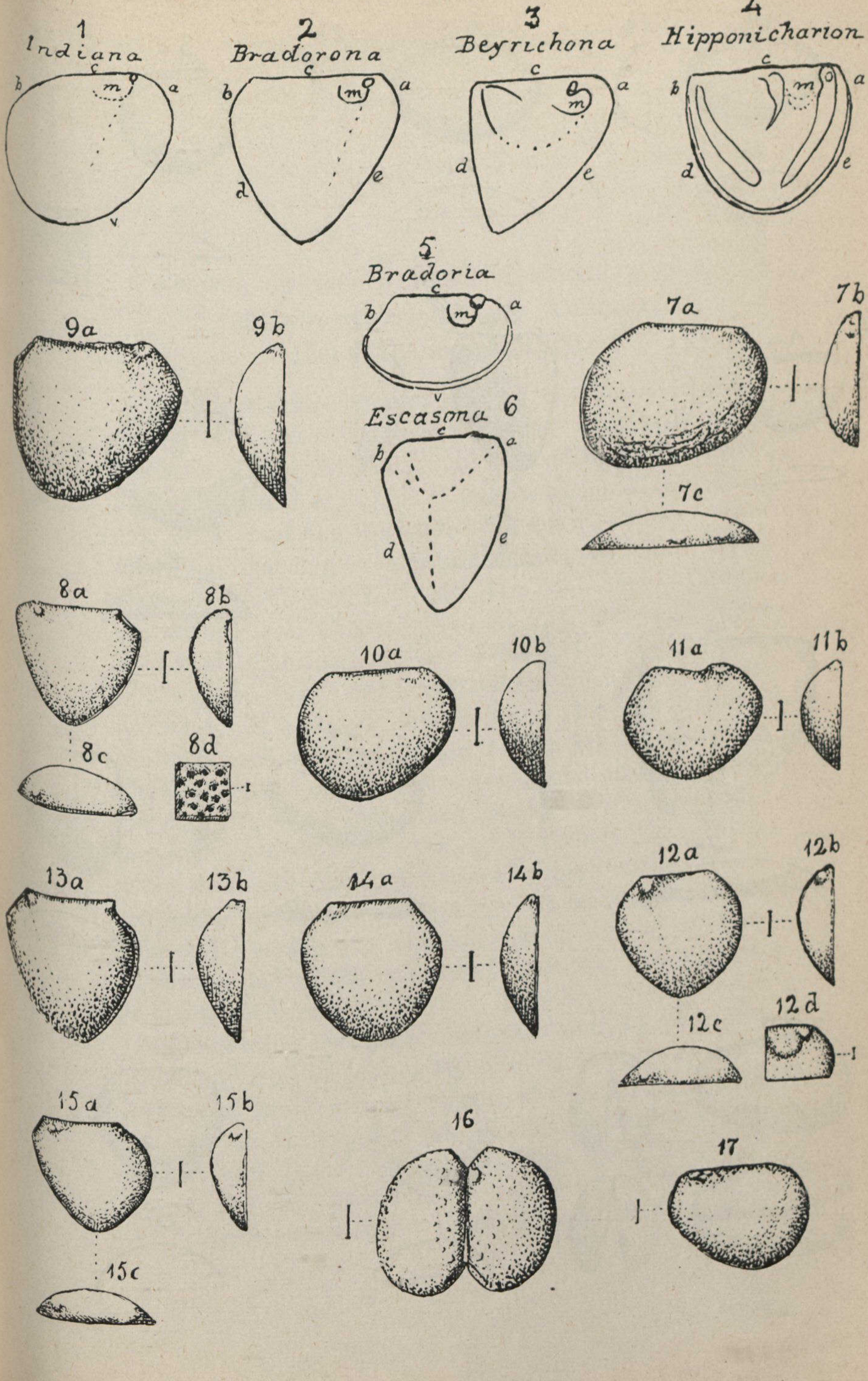
Fig. 8.—*Indiana ovalis* n. sp.—*a*, right valve, side view—*b*, same from the front—*c*, same from the hinge. All mag. $\frac{5}{1}$, L. E. See p. 461.

Fig. 9.—*I. ovalis* mut. *prima*, n. mut.—*a*, right valve, side view—*b*, same from the front—*c*, same from the hinge. All mag. $\frac{4}{1}$. Coldbrook terrane. See p. 462.

Fig. 10.—*Indiana lippa*, n. sp.—*a*, carapace, right side—*b*, same from the hinge—*c*, same from the front—*d*, same from behind. All mag. $\frac{4}{1}$, U. E. See p. 463.

Fig. 11.—*Schmidtella* (?) *pervetus*—*a*, right (?) valve, side view—transverse section—*c*, longitudinal section. All mag. $\frac{6}{1}$, U. E. See p. 464.

Fig. 12.—*Schmidtella acuta*—*a*, right (?) valve, side view—*b*, transerse section—*c*, longitudinal section. All mag. $\frac{7}{1}$, U. E. See p. 465.


1
Indiana
2
Bradorona
3
Beyrichona
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Escasona 6
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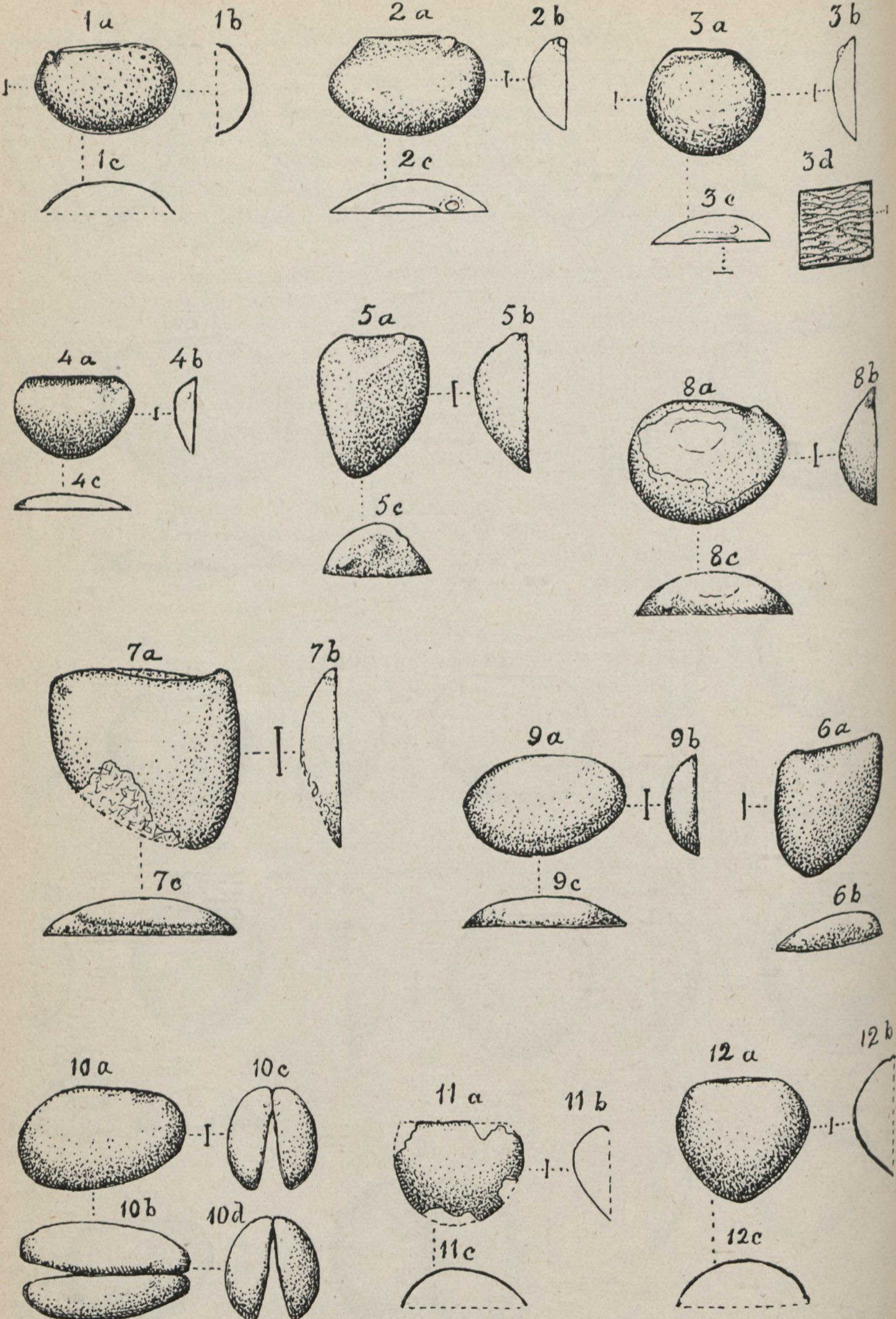
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Notes on the Albany Meeting of the Geological Society of America, Held December, 1900.

The thirteenth Winter meeting of the Geological Society of America was held in the city of Albany, N.Y., during the 27th, 28th and 29th days of December, 1900, under the Presidency of Dr. G. M. Dawson, C.M.G., F.R.S., etc., Director of the Geological Survey of Canada. The following Canadian geologists were present:—Dr. G. M. Dawson, Dr. Robert Bell, Mr. Wm. McInnes, B.A., and the writer, from Ottawa; Prof. A. P. Coleman, Toronto; Prof. F. D. Adams and Mr. O. E. LeRoy, M.A., of Montreal.

The papers read and the discussions which they elicited proved to be unusually interesting, so that the meeting can well be said to have been one of the most successful held The presidential address was not delivered until Saturday morning, December 29th, when Dr. Dawson gave a comprehensive synopsis of the Geology of British Columbia, in which he discussed the relations and genesis of the various geological formations constituting the Laramie Geosyncline to the east of the Archæan axis, as well as of those on the west side of the same axis constituting the Western or Pacific Geosyncline.

The following are abstracts of some of the papers presented and read by Canadian geologists, bearing upon the Geology of the Dominion. These abstracts prepared by the various authors give an excellent summary of the scope of each paper. A few additional notes deemed of interest are also inserted by the writer.

1. "*Experimental Work on the Flow of Rocks recently*

carried out at McGill University," by Prof. Frank Dawson Adams, Montreal, Canada.

"A preliminary paper on this subject was read before the Geological Society at the Montreal meeting in 1897. Since that time the work has been continued and additional results have been obtained. The deformation of marble has been chiefly studied. The rock has been submitted to pressure under conditions which reproduce those obtaining in the deeper portion of the earth's crust. The deformation has been carried out not only when the rock is dry and at the ordinary temperature, but also when it is heated to 300° C. and 400° C. Also when at 300° C. in the pressure of water. Deformed at a temperature of 300° C. or 400° C. the movements which take place in the rock differ from those which are observed when it is deformed at the ordinary temperature. They are identical with those which are observed in the 'flow' of metals under compression."

The experimental methods were carefully described, and the results obtained illustrated by means of lantern slides and specimens.

Dr. Adams's paper was discussed by Prof. G. K. Gilbert, Prof. W. Morris Davis and Prof. N. S. Shaler.

2. "*The Laurentian Limestones of Baffinland,*" by Dr. Robert Bell, Ottawa.

"The discovery of great quantities of crystalline limestones in Baffinland was announced in the writer's summary report of explorations for 1897. The geographical position and physical aspect of the region is then described. General character of the Laurentian in Hudson Straits. The rocks of the north side are newer or Upper Laurentian as far as known, and differ from those on the south shore. Regularity of strike and dip. Enormous development of crystalline limestones in southern Baffinland. Their general characters. Great thickness of the beds, some of them being over a mile and running regularly for long distances. Evidently stratified aqueous deposits. Questions as to the origin of such limestones. The associated rocks and minerals. Owing to the absence of trees the limestones are conspicuous in the landscape. Not more eroded than the gneisses. Comparison with the Laurentian limestones elsewhere. Former physical conditions and the older and newer glaciations of Baffinland as affecting the limestones. The existing glaciers there." This paper was illustrated by lantern slides.

3. "*Marine and Fresh-water Beaches in Ontario,*" by Prof. A. P. Coleman, Toronto, Canada.

"Marine deposits, often rich in shells and other fossils, are widely found east of Brockville and Smiths' Falls, in the valleys of the Ottawa and St. Lawrence. They occur at higher levels toward the north-east and east than toward Brockville; they include trees and other forms indicating a climate like that of to-day, and are all evidently post-glacial. The shells occur in clay sand and also coarse gravel. Higher beaches such as the Iroquois, Warren, etc., contain only fresh-water shells if any. Still higher beaches, such as those reaching 1,400 to 1,600 feet above sea level in the highlands between Georgian Bay and Lake Huron, and the beaches found above 1,400 between Lake Huron and Missinaibi, and at the same level on the Hudson Bay watershed north-west of Sudbury, have not yet been found to contain shells, although if marine there must have been complete and widely opened connection with the sea. The wide gravel tearaces on the watershed mentioned contain numerous and large kettle-shaped lake basins, sometimes without outlets, suggesting that they were formed by the burial of large blocks of ice at the border of the Laurentian ice sheet, and hence in ice dammed waters."

In the discussion which followed this paper, Messrs. F. B. Taylor, N. H. Winchell, W. M. Davis and the writer took part.

4. "*The Geology of Rigaud Mountain, Province of Quebec, Canada,*" by Mr. Osmond Edgar LeRoy, Montreal, Can. Introduced by Prof. F. D. Adams.

"The chief topographic feature of the palæozoic plain of Central Canada is a series of hills which occur in the district about Montreal. These are of igneous origin and follow a line of disturbance which is almost at right angles to the trend of the Notre Dame mountains. Rigaud is the most western of the series. It consists of an area of hornblende syenite, which is pierced on its northern flank by a quartz syenite porphyry. The field relations of all the hills with the exception of Rigaud shew them to be of post-Silurian age. In the case of the latter the contact with the Palæozoic is wholly concealed by drift. The object of the research was to ascertain if a genetic connection could be established between Rigaud and the other hills to the east. Investigation shows that it is probably not so connected, but a definite conclusion cannot be reached until a more extended study is made of the rest of the range."

Profs. N. S. Shaler, H. P. Cushing, F. D. Adams and Mr. H. M. Ami took part in the discussion, in which both the rock of the mountain itself and the Pleistocene deposits were taken up.

5. "*The Knoydart Formation in Nova Scotia*"—*a bit of* "*The Old Red Sandstone*" *of Europe,*" by Dr. H. M. Ami, Ottawa, Can.

"The presence of such genera as *Pteraspis, Pterygotus, Onchus, Psammosteus* and *Cephalaspis,* in the red marls, shales and volcanic ash-beds of McArras Brook in Antigonish and Pictou Counties, Nova Scotia, indicate the base of the "Old Red Sandstone" of Great Britain. The paper dealt with the relations, palæontological and stratigraphical of this important formation in the sequence of Devonian strata in Eastern Canada. The result of observations made by Mr. Hugh Fletcher of the Canadian

Geological Survey, as published on this subject, together with important notes by Mr. A. Smith Woodward and Dr. Henry Woodward of the British Museum on some of the fossils discussed will be embodied in the paper." Thə word *Knoydart* is pronounced as if spelt Krodiart.

In the discussion following this paper Profs. C. D. Walcott, H. S. Williams, N. S. Shaler and W. M. Davis took part.

Regarding the relations of this Eo-Devonian formation and the underlying series of Silurian strata at Arisaig, the writer was induced to make a preliminary statement in the course of the discussion as to the four divisions into which he is for the present classing the Silurian formations of Antigonish County adjacent to the strata of the Knoydart formation. These are in descending order as follows:—

IV. THE STONEHOUSE FORMATION. Consisting of red shales and mudstones, holding an abundant lamellibrachiate fauna with *Grammysia Acadica*, Billings as an horizon marker, also interstratified bands of limestone holding trilobites, ganterogoda and brachiopoda. This is the formation called "Lower Helderberg" by Mr. H. Fletcher and other geologists. Neither the fauna nor the character of the strata warrant the correlation of this formation with the Lower Helderberg. In character, it more closely resembles the Ludlow of England than any other series of strata.

III. THE MOYDART FORMATION. Consisting of light greyish-green fine grained and heavier bedded siliceous limestones, holding brachiopoda, gasteropoda, etc.

II. THE MCADAM FORMATION. Consisting of deep gray or black impure shale and mudstones, holding a lamellibrachiate and graptolitic fauna, with here and there an intercalated lenticular sheet or bed of limestone with brachiopoda in abundance.

I. THE ARISAIG FORMATION. Consisting for the most part of hard, compact light yellowish grey rusty and greenish colored sandstones or siliceous rock and shales, holding corals, trilobites, brachiopoda.

An additional note brought out by this paper in the discussion was the fact that in Eastern Canada, not only in the Silurian or in the Devonian, but also in the Cambrian and Devonian as well as in the Carboniferous, it was necessary to introduce a dual formational scale in order to classify the sediments. The Stonehouse formation, for instance, whilst occupying a position well up in the Silurian, was quite distinct from the Silurian formations of Ontario or New York as well as of other parts of Canada and the United States, and could in no sense be used to replace the term Lower Helderberg, being esentially distinct.

There were other papers of special interest to Canadian geologists. (1) Mr. F. B. Taylor "*On the Galt Moraine and the ice-dam which produced them,*" in which the author delineated the courses and structure of the morainic belts recently examined by him in the Huron-Erie Peninsula of Ontario. (2) Prof. H. S. Williams on "*Points involved in the Silurian-Devonian Boundary Question.*" This paper was expected to lead to a lively and interesting discussion, but the author wisely eliminated all doubtful or controversial points which are now pending investigation. The means by which a settlement of the questions at issue may be effected were also discussed. (3) Messrs. Henry Kümmel and Stuart Weller on "*The Palæozoic Limestones of the Kittaniny Valley, N.J.*" (4) Prof. August F. Fœrste on "*The Niagara group along the Western side of the Cincinnati anticline.*" (5) Prof. N. H. Winchell on "*Glacial Lakes of Minnesota.*" (6) Prof. W. M. Davis on "*An Excursion to the Colorado Canyon,*" and other papers by him. (7) Prof. H. P. Cushing on "*Origin and Age of an Adirondack augite-*

syenite." This paper led to considerable discussion, in which some of the petrographical geologists present enunciated the general principle that in the great Archæan complex many of the limestones and gneissic bands may be altered sedimentaries. (8) Prof. S. L. Penfield's paper, "*Stereoscopic Projection in Map Construction*" was a most important contribution both for geographers, mineralogists and petrographers.

H. M. AMI.

OTTAWA, January, 1901.

PROCEEDINGS OF NATURAL HISTORY SOCIETY.

ANNUAL MEETING.

The Natural History Society made a new departure this year in inaugurating its season's monthly meetings. It held a conversazione on the evening of Monday, October 28th, 1901, which proved a pleasant and successful function. The meeting took this form especially in honour of Lord Strathcona and Mount Royal, and at the same time afforded the members of the society an opportunity of meeting him for the first time since he was elected Honorary President, in succession to the late Sir William Dawson, and was elevated to the peerage.

The guests were received by the president and Council of the Society. The hall and library were tastefully decorated, and the museum was lighted up with electricity, exhibiting its valuable and varied contents to advantage. The Microscopical and Entomological Societies very kindly united with the Natural History Society in entertaining the guests, and sent interesting exhibits.

Professor MacBride, the President, delivered his inaugural address, which is given below, and he was followed by Lord Strathcona, who called attention to the long, interesting and useful career of the Society, mentioning the names of distinguished office-bearers and members who had adored the Society during the seventy-four years of its existence. Indeed, he said he knew well personally the first president of the Society, and referred to the special services rendered to the Society and to the cause of Science in general by his predecessor in the Honorary Presidency, Sir William Dawson. He concluded with assuring the Society of his continued interest in its work, even although he, so long as he occupied his present public position in another country, might not be able to take such part personally in its proceedings, as he might desire; but he would be glad to help in such ways as he could. Principal Peterson, of McGill University, and Rev. Canon Archambault, of Laval University, also briefly adressed the assembled friends of natural science. Afterwards the guests were introduced to Lord Strathcona and Mount Royal.

INAUGURAL ADDRESS OF THE PRESIDENT OF THE NATURAL HISTORY SOCIETY OF MONTREAL, *October, 1901.*

I feel myself doubly honoured to-night, not only on acount of the high office to which this ancient society has thought fit to elect me, but also by the presence of such a distinguished company, including the High Commissioner, who may be said to be the ambassador of Canada to the Imperial throne.

I feel it a heavy responsibility to undertake to address such an audience, and, therefore, I have avoided as the subject of this address any technical subject, and have chosen rather to say a few words to you on the value of the study of Natural History in general and the aims which in particular the Montreal Society sets before itself. We Canadians are above all a practical people and our tasks in the immediate future lie not so much in attempts to solve the riddle of existence, which as a rule we are content to leave to the members of older civilizations, as in the development and utilization of the vast natural resources which Providence has bestowed upon us, and in the building up of a strong, healthy national life. If the study of Natural History is to be regarded as anything better than a hobby, such as, for instance, stamp collecting, it must be shown to have some relation to the objects which, I venture to think, are in the minds of most Canadians of immediate and pressing importance. In the few minutes which I shall detain you, I shall endeavour to prove to you that this is so.

We must first of all define the scope of Natural History. It is usually held to denote merely the study of animals and plants, but in its original signification it denotes the study of all surrounding nature, inanimate as well as animate. Thus it corresponds to the old meaning of the work Physics, which, as used by the Greeks, comprised all natural knowledge. Just as the scope of Physics has been gradually limited until it is confined to the study of light, heat, sound, electricity and mechanics, so Natural History has come to mean the study of living nature. In Montreal, however, the term is employed in a more generous sense, and an important section of the Society is interested in the structure of the rocks and their arrangement in the crust of the earth.

Now the study of Geology needs no defence from me. The man in the street understands at once its close and intimate connection with the development of those mineral resources which form such an important part of Canada's wealth. On the other hand, the study of plants and animals is often regarded in the light of an amiable hobby of no practical use.

Now whilst it is true that any study may be pursued as a hobby, and that no study which is pursued in a dilettante fashion is ever likely to lead to important results, yet nothing could be further from the truth than to imagine that the systematic study of zoology and botany is without practical importance.

In order to realize this let us try to picture to ourselves in what relation our lives stand to the lives of the animals and plants which form the subject matter of the sciences of botany and zoology, in a word, of biology.

When the pioneers of civilization reach an unsettled country, they find it covered with certain kinds of vegetation and inhabited by certain species of animals. This population of plants and animals represents the balance which has been arrived at as the result of a long struggle between the various species, each trying to cover the whole ground for itself. Though this balance no doubt alters slowly in the course of ages, yet from the observation of the vegetation which covers long deserted human habitations such as the ruined temples in Mexico, we conclude that when the land has been cleared and then abandoned, so that the struggle recommenced under the same conditions, it leads to the same results, for the proportion of the species in such spots is the same as that obtaining in the surrounding virgin forest.

The population, therefore, of unsettled land represents the state of affairs which Nature is for ever trying to bring about, and which man when he clears and cultivates land alters. It follows that the position of the civilized settler is one of unceasing war against Nature; he maintains an artificial garrison, one might almost call it, of cultivated plants and domestic animals, in the face of a large opposing force of wild plants and wild animals which he is dispossessing of their territory and which are constantly seeking to regain it.

Under these circumstances, it is obvious that the first condition of success would be as complete a knowledge as possible of the habits and powers both of the garrison which the farmer is seeking to maintain, and of the hostile foes he is fighting against. Occasionally, however, still another danger threatens the settler. He may inadvertently augment the hostile forces by introducing powerful enemies from other lands. Plants and animals trained in the fierce struggle that obtains in Europe and Asia often spread to an enormous extent when introduced into the smaller continents, such as America and Australia, as the following instances will show.

With a view of providing themselves with sport some Australian colonists imported rabbits. To-day thousands of acres of land have been rendered useless for cattle by the descendants of these rabbits, and hundreds of thousands of dollars have been spent in the attempt to keep the race of rabbits within bounds. The sentiment of some Scotch colonists induced them to send home for some thistle-seed. It flourished only too well in Australia, but with dire results for cultivation. The English sparrow, as everybody knows, has worked great destruction amongst our native song birds, and one has only to see in the spring the fields in the Island of Montreal covered with the English ox-eye daisy to realise the danger of introducing European wild plants into this country.

Once indeed a visitor from the New World turned the tables on the Old World population. The common water-weed of the St. Lawrence, Anacharis, was cultivated in a tank in the Botanical Garden at Cambridge, England, where it flourished luxuriantly. The professor of botany, with a carelessness unworthy of his calling, gave orders that some of it should be thrown into the brook which ran outside the garden. This was done, and the Anacharis grew luxuriantly in the brook, from which it reached the river Cam, and from thence the network of canals which traverses the eastern part of England. In these sluggish waters it increased to such an extent as to render navigation almost impossible, and hundreds of pounds had to be spent in the endeavour to keep it within bounds.

But the practical applications of Natural History are far from being exhausted by their utility to the farmer and cattle-breeder. Man himself is part of the garrison maintained by constant struggle against surrounding foes; he is the subject of attack by minute plants and animals of all kinds, which find in his body a fertile field for their development, with the results of disease and death to him. Our heathen ancestors attributed disease to evil spirits and magic; our more immediate progenitors to climatic conditions, dust of comets, and I know not what else. Only in recent times has it gradually dawned upon us that disease is merely the outward and visible sign of the conflict which outside Nature is waging with us, the highly cultivated and somewhat abnormal product.

But whilst many would be ready to admit that a study of zoology and botany was of importance to the experts at the Experimental Farm at Ottawa, and to the specialists who devote themselves to the study of disease, they would probably be inclined to doubt whether such study as is pursued by a society like our own would be likely to help either the farmer or the doctor.

Against this position there are the strongest arguments to urge. It is a remarkable fact that the discoveries which are of the greatest use to the human race have hardly ever been made by direct search for them. They have come as the indirect result of the pure search for knowledge.

"Seek ye first the kingdom of God and its righteousness and all these things shall be added unto you." That is a truth which applies in other spheres than that of religion. The man who says to himself, "Go to now, let us discover something useful," rarely discovers anything. The inventor is the man who applies the principles discovered by the student of pure science, so that if the study of pure science were to be discouraged, the practical applications would soon cease also. This may seem to some of my hearers rather a bold statement. I think, however, that I can justify it by giving a few examples :—

Take a discovery that is exciting the greatest interest at the present time, and that promises results of the most far-reaching importance, viz., wireless telegraphy. Let us trace the apostolical succession, to borrow a term from theology, of the idea which underlies this discovery. Thirty or forty years ago, the great Cambridge physicist, Clerk Maxwell, one of the greatest and most penetrative of the geniuses who have filled the chairs of that ancient University, was engaged in determining the value of the electrical unit. As many of my hearers are aware, there are two ways of doing this : we can estimate either the push that an electric charge exerts on another similar charge, or else the pull that an electric current effects on a magnetic needle. In this way, two different values for the unit are arrived at, and the relation between them, or to put it more simply, the number obtained by dividing the one by the other, gives the velocity of light in centimetres per second. This remarkable result suggested to Clerk Maxwell that that mysterious thing called electricity had something to do with the ether which fills all space and transmits the vibrations which we call light, and he thereupon constructed his famous electro-magnetic theory of light, which conceives light to consist of vibrations not of a comparatively gross material like ordinary matter, but of electricity itself.

This theory received at first little support from the German physicists, who are inclined to scoff at every idea that is not of German origin. Amongst a crowd of scoffers, however, one open-minded enquirer was found, who said to himself: "If Clerk Maxwell is right, I ought to find that if I start artificial electric vibrations they will propagate themselves like light waves." This man's name was Hertz, and he promptly set about producing electrical waves, purely with a view of testing the truth of Maxwell's theory. He had many difficulties to overcome before he succeeded in producing them in sufficiently rapid succession, but this was at last accomplished and Maxwell's theory triumphantly vindicated. The electric vibrations comported themselves like light—it is true that a stone wall was as transparent for them as a sheet of glass is for ordinary light, but they were reflected by a metal plate and could be brought to a focus, etc., etc. Now this invisible light, as we may call it, is what Marconi and others have employed in their so-called wireless telegraphy, but without Maxwell and Hertz, it would have remained undiscovreed to this day.

But to come closer to Natural History. There has, I suppose, been no discovery in recent years which promises greater benefit to men than that of the cause of malaria, and the manner in which the disease is transmitted from one patient to another.

I suppose you are all aware that this dreadful disease, which is one of the chief causes which prevent our race leading a healthy life in the tropics, is due to a minute parasite which inhabits the cells of the blood, and which is carried from one person to another by a certain species of mosquito. If one, therefore, goes to the most fever-stricken districts of the tropics and avoids the mosquitoes, one can escape the disease. One of my Cambridge friends, J. S. Budgett, Esq., made two visits to the River Gambia in West Africa in successive years. On the first occasion the manner of the transmission of the malaria infection was still unknown, and Mr. Budgett contracted the disease and suffered severely from it during his stay in Africa, and after his return to England. On the second occasion, the mosquito had been declared to be the source of infection and Mr. Budgett took precautions, in fact he lived and moved and had his being under a mosquito-netting, with the result that he escaped the disease entirely.

The history of this great discovery may be outlined as follows :—About thirty years ago, a zoologist, Lankester, discovered a parasite in the blood-cells of the frog. No notice was taken of his discovery at the time ; but the parasite was re-discovered ten years afterwards by a physiologist called Gaule, who, however, being unacquainted with natural history failed utterly to recognise the parasite as animal. Lankester then repeated his observations and pointed out that the animal, which he called Drepanidium ranarum belonged to a class which had been previously studied by zoologists, and the outlines at least of whose development was known. When doctors, however, commenced to study malaria they were convinced that it was due to a bacillus,(that is to say, to one of the minute moulds which are the cause of so many diseases, and when a French surgeon, Laveran, described parasites in the blood-cells of malarial patients similar to Drepanidium ranarum, his discovery was regarded with scepticism. Even those who accepted these animals as the cause of the disease were utterly at a loss to explain how it was communicated. An Indian observer, Dr. Ross, however, working on birds, which were known to suffer from the presence of a parasite in their blood-cells, found that it produced germs very similar to germs found in mosquitoes. Then it was shown that some mosquitoes carried germs similar to those produced by the human blood-parasite, and, finally, an Italian zoologist, named Grassi, pointed out that it was one particular kind of mosquito only which carried these germs, and thus the whole problem has been narrowed down to this—how are we to fight the mosquito? To solve this a thorough knowledge of its habits and life-history is necessary, and this the natural historian has supplied. Thus, Natural History showed the way in the beginning at every step a knowledge of zoology was required. But we can go further still—our whole conception of the relation between patient and disease is founded on zoological observations. The modern treatment of disease differs from the older in the recognition of the comparatively small value of drugs. In olden days, even so recently as my own childhood, one was dosed with horrid mixtures of drugs in the belief that it was possible to act directly on the disease. Now the position of the modern doctor is almost identical with that of Macbeth, "Throw physic to the dogs—I'll none of it!" He knows that drugs have their uses as temporary expedients in emergencies, just as everyone knows the value of alcohol when given to a person about to faint, but he knows also that the disease is a pitched battle fought between the invading germ and the white blood-cell of the patient, and this all-important fact was first discovered by a Russian zoologist, Metschnikoff, who observed the fight going on under his own eyes in the body of a transparent water flea.

I shall not weary you by giving you further examples of the way in which the whole modern science of medicine, as distinct from surgery, rests on a basis of biology ; how at every step it is confronted with biological problems and must ever look to zoology and botany for help in its progress. In a word, biology bears the same relation to medicine and to agriculture as mathematics and mechanics do to engineering.

Turning now from the general utility of the study of Natural History to the special value of a society such as ours, I may remark that a Natural History society has two functions, a general and a special. The general lies in the encouragement of the study of Nature, which it gives through the opportunities it affords of allowing naturalists to meet one another and to keep alive the sacred fire of enthusiasm in each other's breasts, and in the enlightenment which it spreads by public lectures, and other means.

This is an important duty, for if even an elementary knowledge of natural history were more widely diffused we should be freed from much dense ignorance on subjects affecting our welfare. Two of these have come under my own notice, and they will show what ignorance will lead to. An evening paper in this city published diagrams of a number of "microbes" found in the Montreal reservoir as a proof of the horrid condition of the water. Now, I do not deny that our water is far from being what it ought to be, but all the animals reproduced in the journal are normal inhabitants of healthy spring and brook water.

Again, a case was brought under my notice where a cow doctor was going around in Eastern Ontario professing to cure animals suffering from an inflammatory affection of the nose and mouth. He applied an emulsion made, I believe, with linseed, and got out what he called the "worms," which caused the disease. These worms when submitted to me, I found to be nothing more than the tiny seedlings of the flax which had been squeezed out of the seeds used to form the emulsion.

But the special function of the local Natural History society I regard as considerably more important than the general, and it is this, to acquire an accurate knowledge of the plants and animals which live in our immediate neighbourhood, and to maintain a museum which shall not be a mere storehouse of curiosities, but which shall enable any visitor to see at a glance the flora and fauna of the surrounding country. Before any problem affecting the relation of animals to man can be attempted, we must know the species with which we have to deal. In the great Zoological Station at Naples large sums have been expended by the director in getting accurate lists of the species of animals and plants living in the Bay of Naples published. Now this is work which a local Natural History society can do better than any other agency, if it sets to work in a systematic manner. Our former President, Dr. Campbell, has in this respect shown us all a good example by his untiring labours in producing a complete list of the plants found in the vicinity of Montreal. I only wish that his example had been more widely followed by those members of the society who are devoted to the study of animals, for our knowledge of the local fauna is still wofully incomplete. England has been specially prolific in good natural historians. Few of them were professional zoologists; most of them had only a comparatively limited leisure to devote to the subject, and yet German specialists have to turn to their work as the foundation for their special biological researches. Spence-Bate, whose knowledge of the Crustacea was unrivalled, was a dentist in Plymouth, and amongst the greatest living authorities on the British fauna may be mentioned two Anglican clergymen, Norman and Stebbings. But we need not go to England. You are surely all of you familiar with that wonderful collection of shells stored in the cases of the Redpath museum. That collection, the duplicate of which has been presented to the British Museum, is the work of a former honoured citizen of this city, and member of this society, Dr. Carpenter, who pursued the calling of a schoolmaster.

Having made a tolerably accurate list of the animals and plants of the neighbourhood, the next thing is to study them in their relation to one another, in a word, to make out their life history and their habits. And here there is an endless field for open-air work of the most entrancing kind, and this is the kind of work on which scientific agriculture directly rests. I often wish that I could give the future farmers of our country a short course in Natural History at McGill, so as to open their eyes to the nature of their biological surroundings, provided that a sojourn at the University would not make them wish to desert farming in order to join the ranks of the overcrowded professions.

In England the University of Cambridge, ever in the van of scientific teaching, has already instituted courses in biology and chemistry leading to a diploma in agricultural science.

The great secrets of successful work in natural history are perseverance and concentration. In this study, as in every other occupation, it is only the man who keeps steadily at it year after year who ever achieves anything. But concentration is of equal importance. The animal kingdom is such an enormously wide field, that unless the energies of the natural historian are confined to one small part of it they are dissipated and wasted. We want to be specialists in this society ; we want not merely those who take a more or less active interest in Natural History as a whole, but we want also the special student of insects, the lover of shells, the sportsman who knows all about game birds, and so on. There is no fear that the man who makes a specialty of one branch will find it dull to listen to the record of the observations of the students of another department. Any honest study of even a small part of the field rouses far more interest in the field as a whole than a hazy and languid study of general zoology. And here perhaps I may make a suggestion or two with regard to our field work. It is one of the great disadvantages of our society that owing to the peculiarity of our Canadian climate, the time when we hold our meetings is just the time when we can do no out-of-doors work. The summer before last I was privileged to take part in some of our excursions, and the defect which struck me most about them was the absence of definite aim. It seems to me that we should know what we are going to look for before we start, else we are not likely to accomplish anything. We should go out in search of flowers, or of insects, or of shells, but not of everything together. After all, however, the work that is really important in this line is done by each for himself, and our great need is the accession of more young enthusiasts to our ranks. Let us hope that in the future all who have any love for any department of Natural History will be drawn to a society where they shall meet with sympathy and support.

THE NATURE AND DEVELOPMENT OF ANIMAL INTELLIGENCE: —By WESLEY MILLS, M.A., M.D., D.V.S., F.R.S.C., Professor of Physiology in McGill University, Montreal, Canada. London, T. Fisher Unwin, Paternoster Square, 1898.

Few men possess such eminent qualifications for dealing with the subject treated of in this volume as Dr. Wesley Mills possesses. To begin with, he is well known as the friend and protector of all animals. An ancient poet-philosopher took credit to himself that he counted nothing relating to man foreign to him. The range of Professor Mills' interest and sympathies is vastly more comprehensive; it embraces everything that lives. To him no bird or beast is an object of indifference. And this is a prime qualification for one who would interpret animal life. To understand them one must love them, as indeed love is the true organ of man's perception and his interpretation of the entire field of his observations. It is inconceivable that any one who is repelled by the lower creatures, or to whom their welfare is a matter even of indifference, could ever do them justice in any opinion he formed of them. Longfellow ascribes the remarkable skill in various kinds of woodcraft of his Indian hero, Hiawatha, to the tenderness of his sympathies with the tenants of the forest; in consequence, they readily yielded up their secrets to him. He "learned of every bird its language; where they built their nests in summer; where they hid themselves in winter." According to this law, animal nature must be an open book to Dr. Wesley Mills.

Then our author loves truth above all things. This disposition is manifest throughout the treatise before us. How earnestly he plans, and how patiently he waits and works to get at the truth. The scientific spirit is his pre-eminently. Nothing is taken for granted, and no detail is deemed unimportant in his observations on the development of the intelligence of the animals under study. In no portion of this book is his love of truth more conspicuously shown than in the correspondence regarding instinct, with which it closes. Dr. Wesley Mills is well known to be an evolutionist in a general way; but he evidently prefers facts, and is prepared to cling to them rather than to any hard and fast theory of evolution. If the theory will not square with the facts, so much the worse for the theory.

Dr. Mills' devotion to science is exhibited not only in the time and patient labour he has bestowed upon it, but also in the expenditure to which he has gone in its interest. It was Agassiz who said that he had not time to make money. But Prof. Wesley Mills is not only indifferent to the making of money, which he deems an aim beneath a philosopher; what little he has or earns he spends largely on the prosecution of scientific investigations. These long continued observations on animals could be carried on only at great expense: but he has borne it willingly, and how could filthy lucre be laid out to better purpose? And he is amply repaid by the results achieved; no chapters in human biography are more interesting than his diaries of dogs and cats, and squirrels, and rabbits. What he does not know of dogs especially is not worth knowing.

The main thesis he sets out to establish is that brute creatures have mind; and he has undoubtedly made it good. Of course, this is no new claim put forth on behalf of the lower creation. Long ago, unthrifty people were sent to the ants to learn lessons of prudence; mental qualities being predicated of them which the sluggard was to emulate. Virgil and Ovid wrote about the domestic bee in a way which showed what high mental qualities that active little creature possessed. No one of an observing turn of mind who has had much to do with domestic animals will deny them the possession of reasoning powers. As the author properly maintains, most of the lower creatures in some one or more particulars, show greater mentality than man himself. The faculty of memory is specially highly developed in several of them. Whether there is any means by which the different genera can hold intercommunication or not, there can be little question but that there are signs and sounds employed by which the same species can hold converse together—the equivalent of speech among men. Rev. James George, D.D., Professor of Mental and Moral Philosophy in Queen's College, Kingston, when the writer was a student in that institution, nearly fifty years ago—a most original thinker and an inspiring teacher—did not hesitate to give forth that the brutes have mind; no matter what consequences the admission might lead to, and this before "The Origin of Species" was written. But he went beyond allowing them to be possessed of mental faculties, although he held that such capacities were hedged about by their "life in sensuism," to use his own phrase; he claimed for many of them high degrees of intelligence, and used to entertain his students by relating to them the results of his own observations and experiments with bees, ants and other creatures, carried on much in the same way as those of Dr. Wesley Mills. He especially maintained that all creatures have a language of their own. And who that has heard a squirrel or catbird scold, or a sentinel crow give warning to the flock he belongs to of the approach of a gunner, can doubt that they have a most effective capacity of utterance?

Prof. Mills' second thesis is that the hereditary mental capacity of the lower animals, which usually goes by the name of instinct, is capable of great expansion, from the moment of the creature's birth until the time it has reached its full growth and maturity. The series of observations he has recorded go to show that while certain tokens of the possession of power for gaining sustenance are exhibited from the first, there is a rapid development of intelligence in the way of experimental knowledge, on the part of each individual. Of course, such acquirements as any animal makes by experience, have relation to the sphere it fills in the total sum of being. Each species has its own functions and displays its characteristic capacity and applies its intelligence in attaining those functions, and whilst the individual species learn from each other, by imitation and otherwise, they do not seem to take lessons from beyond the limits of their own kind, unless, indeed, domestic animals generally are helped upward in the scale of being, as our author hints at, by their contact with man.

At the same time, Dr. Mills has given instances in which individuals have risen higher in intelligence than the ordinary level of their species. Any one who has taken note of the cats and dogs with which he has been acquainted, to go no further, must have marked great differences in their capacity, and in the degree of intelligence which they reached. In herds of cattle, too, there is often one cow that has a power of initiative that gives her pre-eminence, and often makes her exceedingly troublesome. It may be that it was by accident that she first learned to open the gate leading to the cabbage garden; but once having acquired such knowledge, it becomes hard to keep the "breachy" animal out of mischief. The same is true of horses in breaking down fences with their bodies, or in learning to jump the fences to get at the oats beyond.

All this is conceded; but whether the offspring of such smart animals inherit the advanced position reached by their sires and dams, and thus in time an elevation above the old level is attained by a whole family, is a moot point. The Darwinians would call such clever individuals the "fittest" among their contemporaries; but whether they have any special advantages in the struggle of existence, and thus are "selected" by nature, can scarcely be regarded as established by proof. But Dr. Mills may claim to have established by proof that inherited capacities and acquired knowledge must be regarded as co-ordinate factors in the development of general animal intelligence.

An interesting side issue has been raised in this volume. It grows out of the demonstration of the superior energy and earlier catering power of mongrels, as compared with pure bred animals. Does this also hold of the human race? Are we in this way to account for the characteristic qualities of the Englishman of to-day? Has he, too, acquired by the mingling of the blood of many nations in his veins, activity and catering force at the expense of modesty and gentleness?

R. C.

PROBLEMS AND POSSIBILITIES OF SYSTEMATIC BOTANY.—Address of Benjamin Lincoln Robinson, Ph.D., Retiring President of the Botanical Society of America, delivered before the Society, August 28th, 1901. Reprinted from "Science," Vol. xiv., No. 352.

In this comprehensive address, Dr. Robinson touches on some of the most important practical matters requiring to-day the attention of botanists. His experience as Professor of Botany and Curator of the Gray Herbarium, Harvard University, must have impressed upon him the lack of uniformity and the absence of the precision in the manner of dealing with specimens, on the part of his correspondents; and he invites botanical workers everywhere to co-operate in securing the best systematic results. He attacks the prevailing desire to erect new species, and criticises, perhaps not too severely, the looseness of description too often furnished by those claiming to have discovered such species. As a partial remedy for the wordy analyses with which he finds fault, he would not be averse to seeing the adoption in America of the use of Latin for the purpose of plant description, as that language lends itself more readily than English does to terseness and clearness of expression, as seen in European treatises on Botany, in which it is used. Diligent field-work, he holds to be the great desideratum for accuracy in systematic determinations; the accumulation and careful comparison of specimens alone can secure true scientific results.

R. C.

NOTES ON A COLLECTION OF CRATÆGUS MADE IN THE PROVINCE OF QUEBEC NEAR MONTREAL.—By Charles S. Sargent. Reprinted from "Rhodora," Vol. 3, No. 28, April, 1901.

NEW OR LITTLE KNOWN NORTH AMERICAN TREES. III.—By Charles S. Sargent. Reprinted from the "Botanical Gazette," Vol. xxxi., April, 1901.

The former of these pamphlets is of special interest to those occupied with the Natural History of the District of Montreal. Anything bearing on trees or shrubs proceeding from the pen of Professor Sargent, is sure to be of value; and when he writes of the native thorns of the continent, a subject which he has made his own, his conclusions will be received with the deference accorded to an expert. The first thing we note, in connection with this paper, is the fact that the collection of Crataegus on which the notes are based, was made by Mr. J. G. Jack, a name honourably associated with the plant life of this province. We are glad that Mr. Jack does not forget his old home, although winning his bread under another flag; and that he patriotically desires to have the flora of his native Chateauguay and its neighbourhood made generally known. The next thing we have to remark is the advance made in the views of the author of this monograph. He now admits to the dignity of a species series of plants which as late as 1889, when the 6th edition of "Gray's Manual of the Botany of the Northern United States" was issued, he is represented as classing as mere varieties; for the list of the crataegus species contained in that work, pp. 165-67, is given as characterized by Prof. C. S. Sargent. This advance movement is in obedience to the prevailing tendency among men of science to multiply species; although there are some of conservative temper to oppose it. A series of plants, separated from other members of its genus by a quality or qualities easily discernible, constant, and perhaps functional, it is now usual to erect into a species. Prof. Sargent has found such differences in the collection of Crataegus from the neighbourhood of Montreal, furnished by Mr. Jack, as satisfy him that the number of species, hitherto recognised, in this part of the continent, is much too limited. Several of these were probably entirely new to him, while as to others, the result of longer experience and the use of wider opportunities of observation have given greater clearness of vision and more confidence in his own convictions, enabling him to announce his new determinations without hesitation. Nothing else can take the place of comparison of a large number of specimens, in the differentiation of species. Whether all the conclusions of Prof. Sargent, put forth in this brochure, be accepted or not, he has earned the gratitude of the botanists of this district. Any one who has made a collection of the hawthorns of the Island of Montreal and its neighbourhood, as the writer has done, has felt how inadequate was the list of Crataegus given in Macoun's Catalogue, and the description of species in Gray's Manual, or in the more recent publication of Britton and Brown, to embrace all the well marked differences of the specimens he obtained. All collectors will welcome this enlarged list. The first person to call attention to the large variety of Crataegus growing on the adjacent banks of the St. Lawrence, was Dr. T. J. W. Burgess, Medical Superintendent to the Hospital for the Insane at Verdun. Many years ago, he declared that there were not fewer than twelve well defined species to be found within a mile or two of Verdun ; and the one regret his friends now feel is that he did not proceed at once to describe them, as they urged him to do. He pleaded lack of time then, and now he is anticipated in this work by Prof. Sargent. But although we should have naturally enough been glad if a local naturalist had been the first to communicate to the world substantially what is now published by the Director of the Arnold Arboretum, science fortunately knows no national boundaries, and is not bound up with the claims to distinction of those who labour in its domain.

Accepting Prof. Sargent's catalogue of the Crataegus family of this province, we find him crediting it with twenty distinct species of native hawthorns, where Macoun allowed only five species and three varieties. They are collected into eight groups—Crus-galli, Punctatæ, Molles, Flabelletæ, Tenuifollæ, Dilitatæ, Tomentosæ, and Coccineæ. Six of the species are minutely described in this pamphlet,—*Crataegus suborbiculata, C. Canadensis, C. anomala, C. densiflora,* *C. Laurentiana* and *C. integriloba*. The rest had been described in previous issues of the "Rhodora," or in other publications.

The conjoint labours of Mr. Jack and Prof. Sargent in this connection cannot fail to give a fresh impetus to the local study of this interesting genus, especially as it is intimated in this paper that there are probably other species in the district remaining yet to be found and named.

Prof. Sargent's second pamphlet is of less interest to the botanists of Canada, perhaps, but is of equal importance as a contribution to the Natural History of this continent. In it he describes thirteen species of Crataegus to which he calls attention as "new or little known American trees." The majority of these were found in the States of Arkansas, Missouri and Texas, although one of them, *C. pedicellata*, is credited to Rochester, N.Y. The special point of interest to science in both brochures is the apparent sensitiveness to environment of the Crataegus family. This group of plants is now known to be represented by a much greater variety than was formerly assumed. Whether they are all to be counted distinct species or whether some of them are to be regarded rather as crosses between species hitherto acknowledged, it must be left to further observation in the future to determine.

Professor Sargent also describes in this paper, BETULA ALASKANA, a new species of Rocky Mountain birch, nearly allied to the *Betula papyrifera* of the east, and also BETULA OCCIDENTALIS HOOKER of the same region as well as a new species of Cypress, CYPRESSUS PYGMÆA, the habitat of which Mendocino County, California.

R.C.

A REVISION OF THE GENERA AND SPECIES OF CANADIAN PALÆOZOIC CORALS: *The Madreporaria Aporosa and the Madreporaria Rugosa.*—By Lawrence M. Lambe, P.G.S., Assistant Palaeontologist.

This is part of Vol. IV. of the Contributions to Canadian Palaeontology, furnished by the Geological Survey of Canada and published by the Government. It is an ideal work of its kind which cannot fail to win for Mr. Lambe a still higher reputation as a careful and skilful palaeontologist. In this volume he has described ninety-five species and two varieties, ninety-seven in all, embraced in twenty-four genera. The localities in which these fossil corals were found, the dates and the names of the collectors are given, and we are glad to see some of the names of members of the Geological Survey staff honoured by being chosen to designate species,—Richardson, Bell, Dawson, Whiteaves and Macoun,—as well as those of foreign geologists. The work is illustrated by eighteen admirable plates, in which sixty-nine of the species are described in side views and sections.

ADDRESSES.—By D. C. MacCallum, M.D., M.R.C.S. Eng., Emeritus Professor of Midwifery and Diseases of Women and Children, McGill University. Montreal, Desbarats & Co., Printers, 1901.

This tastefully got up volume of 170 pages contains seven addresses delivered at different times by Dr. MacCallum during the course of his long and honoured career as a Professor in McGill College, and a practising physician in this city. It is dedicated to the memory of two of his former colleagues, Dr. George W. Campbell and Dr. R. P. Howard. All old time citizens and friends of McGill will be glad to possess a copy of this book. One feature of interest in it is that it carries the memory back to the days when the Medical Faculty had its quarters in the modest building which it occupied in Coté Street, but when it laid the foundations of that high reputation as a school of medicine which it still maintains in a more commodious and impressive environment. All who knew Doctors Campbell and Howard will appreciate the desire of Dr. MacCallum to do them honour ; for they were professional gentlemen of the highest mark, whose name is held in loving remembrance both by their former patients and by those who were students under them. And Dr. MacCallum was worthy to be associated with men of their eminence, as these addresses amply prove. They bear evidence of the widest culture. While Dr. MacCallum has clearly done a great deal of thinking of his own, this volume shows that he has been at great pains to familiarize himself with what other great thinkers have said and written, and he has given his students the benefit of the whole. Dr. MacCallum's outlook for medical men is a very wide one. The loftiest ideals were held up before the young men both entering upon their studies and commencing their professional career. Truth, honour, humanity, self-sacrifice, devoutness, loyalty, these were the sentiments appealed to as those which befitted men practising the noble healing art.

And as the matter of this book is admirable, so its style is attractive, having a decided literary flavour which makes it delightful reading. Nor it it without its interest to students of Natural History, as it contains a fitting tribute to Dr. Holmes, at one time Dean of the Medical Faculty of McGill, the founder of the gold medal which bears his name, which is the coveted prize of the graduating class in Medicine, but who is known specially among botanists as one of the Canadian pioneers of that science, he having made, eighty years ago, the first large collection of the plants to be found in and around the district of Montreal. This collection, which was tolerably complete at the time, he bequeathed to McGill University, and it is still of the highest interest and value, even with all the advancement which botany has made since his day. Dr. Holmes was also one of the warmest friends and most active spporters of the Natural History Society of Montreal.

R. C.

ABSTRACT FOR THE MONTH OF JULY, 1901

Meteorological Observations, McGill College Observatory, Montreal, Canada. Height above sea level, 187 feet. C. H. McLEOD, *Superintendent.*

DAY	THERMOMETER. †Mean.	Max.	Min.	Range.	*BAROMETER. †Mean.	Max.	Min.	Range.	‡Mean relative humidity.	WIND. General direction.	Mean velocity in miles per hour	Per cent. possible Sunshine.	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAY.
1	73.23	80.7	65.2	15.5	29.94	29.99	29.78	.21	66	W.	16.8	68	....	....	....	1
2	78.28	89.0	68.7	20.3	29.85	29.96	29.77	.19	80	S.W.	16.7	67	0.49	....	0.49	2
3	73.54	79.4	69.8	9.6	29.86	29.89	29.78	.11	59	N.W.	10.0	81	....	....	....	3
4	68.77	76.0	63.5	12.5	29.88	29.92	29.85	.07	68	W.	7.3	20	....	....	....	4
5	66.10	72.1	60.5	11.6	29.88	29.94	29.81	.13	51	E.	11.5	29	....	....	....	5
6	61.88	65.4	58.2	7.2	29.76	29.85	29.73	.12	91	E.	9.5	00	0.30	....	0.30	6
SUNDAY.... ... 7	62.56	72.0	56.1	15.9	29.76	29.86	29.72	.14	92	E.	10.0	17	0.64	....	0.64	7...........SUNDAY
8	62.85	71.5	55.1	16.4	30.03	30.13	29.86	.27	70	E.	11.5	66	....	....	....	8
9	68.42	79.2	56.0	23.2	39.11	30.16	30.05	.11	71	S.W.	5.5	78	....	....	....	9
10	70.38	77.0	64.3	12.7	29.94	30.06	29.85	.21	77	W.	13.7	27	0.00	....	0.00	10
11	67.70	73.6	63.1	10.5	29.99	30.09	29.85	.24	57	N.E.	12.2	89	....	....	....	11
12	69.02	79.8	58.0	21.8	30.19	30.22	30.09	.13	56	N.E.	5.8	99	....	....	....	12
13	71.98	83.3	59.5	23.8	30.18	30.24	30.11	.13	61	W.	9.2	89	....	....	....	13
SUNDAY........14	77.15	86.8	68.6	18.2	30.03	30.11	29.91	.20	65	W.	18.2	94	....	....	....	14...........SUNDAY
15	81.25	92.0	72.0	20.0	29.86	29.93	29.78	.15	61	W.	23.6	93	....	....	....	15
16	82.84	93.7	75.1	18.6	29.74	29.80	29.65	.15	59	W.	18.0	95	....	....	....	16
17	78.24	86.5	70.2	16.3	29.75	29.78	29.69	.09	70	N.E.	6.3	55	0.16	....	0.16	17
18	76.04	83.7	70.7	13.0	29.75	29.83	29.72	.11	66	N.E.	8.6	61	0.01	....	0.01	18
19	68.13	74.9	61.0	13.9	29.93	29.97	29.83	.14	57	N.E.	9.3	83	....	....	....	19
20	71.42	80.2	62.7	17.5	29.92	29.99	29.85	.14	57	W.	9.4	62	....	....	....	20
SUNDAY........21	76.27	87.1	67.7	19.4	29.69	29.85	29.61	.24	66	W.	22.8	35	0.00	....	0.00	21...........SUNDAY
22	74.54	84.3	68.8	15.5	29.80	29.89	29.65	.24	61	N.W.	11.8	82	....	....	....	22
23	72.95	83.4	63.0	20.4	29.94	29.97	29.89	.08	53	N.W.	11.9	72	....	....	....	23
24	59.62	69.0	55.0	14.0	29.93	30.01	29.87	.14	78	N.E.	10.1	05	0.13	....	0.13	24
25	61.19	70.1	53.7	16.4	30.04	30.08	30.00	.08	66	N.	8.0	48	....	....	....	25
26	63.55	72.1	53.8	18.3	30.12	30.16	30.07	.09	59	N.E.	7.4	95	....	....	....	26
27	67.52	76.0	56.0	20.0	30.13	30.20	30.04	.16	57	E.	4.1	15	....	....	....	27
SUNDAY........28	65.08	69.0	61.3	7.7	29.88	30.04	29.82	.22	90	E.	7.9	00	0.99	....	0.99	28...........SUNDAY
29	67.54	78.7	56.1	22.6	29.84	29.91	29.73	.18	72	E.	10.3	77	0.33	....	0.33	29
30	70.95	78.1	64.7	13.4	29.67	29.73	29.59	.14	87	W.	13.1	27	2.18	....	2.18	30
31	69.42	77.3	62.5	14.8	29.71	29.73	29.68	.05	75	W.	17.9	66	0.04	....	0.04	31
Means......	70.27	78.77	62.61	16.16	29.907	29.977	29.827	.150	67.7	W 22° 51′ N	11.56	57.9	5.27	....	5.27	..............Sums.
27 Yearsmeans for and including this month	68.89	77.36	60.83	16.54	29.897	....	......	.143	71.7	....	§ 12.96	¶59.14	4.290	....	4.290	27 Years means for and including this month.

ANALYSIS OF WIND RECORD.

Direction........	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	CALM.
Miles	302	1335	1250	193	227	549	3913	834	
Duration in hrs..	37	148	142	22	22	46	242	80	5
Mean velocity....	8.2	9.0	8.8	8.8	10.3	11.9	16.2	10.4	

Greatest mileage in one hour was 32 on the 15th.

Greatest velocity in gusts 34 miles per hour on the 21st.

Resultant mileage, 2,784.

Resultant direction, W. 22° 51′ N.

Total mileage, 8,603.

* Barometer readings reduced to sea-level and temperature 32° Fahrenheit.

† Mean of bi-hourly readings taken from self-recording instruments.

‡ Humidity relative, saturation being 100. Mean of observations at 8, 15 and 20 hours.

¶ 20 years only. § 15 years only.

The greatest heat was 93.7 on the 16th; the greatest cold was 53.7 on the 25th, giving a range of temperature of 40.0 degrees. Warmest day was the 16th. Coldest day was the 24th.

Highest barometer reading was 30.24 on the 13th; lowest barometer was 29.59 on the 30th, giving a range of 0.65 inches.

Minimum relative humidity observed was 39 on the 12th.

Rain fell on 12 days.

Thunderstorms on the 2nd (two on the 2nd), 7th, 17th and 18th.

ABSTRACT FOR THE MONTH OF AUGUST, 1901

Meteorological Observations, McGill College Observatory, Montreal, Canada. Height above sea level, 187 feet. C. H. McLEOD, *Superintendent.*

DAY	THERMOMETER. † Mean.	Max.	Min.	Range.	* BAROMETER. † Mean.	Max.	Min.	Range.	‡ Mean relative humidity.	WIND. General direction.	Mean velocity in miles per hour	Per cent. possible Sunshine.	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAY.
1	62.28	65.0	58.3	6.7	29.83	29.92	29.73	.19	80	W.	12.5	19	0.00	....	0.00	1
2	65.77	72.1	59.0	13.1	29.89	29.94	29.81	.13	74	W.	9.1	51	....	....	....	2
3	66.65	74.1	59.5	14.6	29.81	29.85	29.79	.06	79	W.	11.5	27	0.04	....	0.04	3
SUNDAY.... 4	68.57	77.0	61.0	16.0	29.94	30.06	29.85	.21	60	N.	9.2	94	....	....	....	4..........SUNDAY
5	65.75	73.4	58.3	15.1	30.17	30.21	30.06	.15	59	N.W.	7.5	88	....	....	....	5
6	66.48	75.4	55.5	19.9	30.24	30.28	30.18	.10	64	S.E.	8.1	35	....	....	....	6
7	61.97	67.1	58.2	8.9	29.92	30.18	29.79	.39	94	W.	13.4	00	1.11	....	1.11	7
8	66.42	77.0	59.2	17.8	29.82	29.88	29.72	.16	83	W.	15.5	64	0.05	...	0.05	8
9	63.23	72.6	57.0	15.6	30.01	30.05	29.83	.22	69	W.	10.9	58	0.04	....	0.04	9
10	59.92	66.0	55.7	10.3	29.80	30.03	29.71	.32	99	N.E.	10.8	00	1.33	....	1.33	10
SUNDAY........11	61.32	66.0	56.1	9.9	30.01	30.10	29.79	.31	67	N.E.	6.7	36	....	....	....	11..........SUNDAY
12	65.42	73.7	57.0	16.7	30.07	30.10	30.03	.07	75	N.	5.0	47	....	....	....	12
13	68.85	78.3	58.3	20.0	30.09	30.13	30.05	.08	76	W.	8.7	82	....	....	....	13
14	72.46	82.0	61.0	21.0	29.99	30.07	29.93	.14	73	W.	10.1	86	....	....	...	14
15	71.41	78.7	65.0	13.7	29.85	29.93	29.75	.18	81	W.	13.0	08	0.00	....	0.00	15
16	68.57	74.8	64.2	10.6	29.86	29.94	29.75	.19	70	N.W.	17.9	77	....	....	....	16
17	70.08	79.0	61.1	17.9	29.91	29.95	29.85	.10	73	N.W.	18.3	76	0.00	....	0.00	17
SUNDAY........18	63.32	71.2	57.0	14.2	30.08	30.13	29.92	.21	63	N.E.	9.4	88	....	....	....	18..........SUNDAY
19	66.85	77.8	55.0	22.8	30.11	30.17	30.04	.13	70	E.	7.2	74	....	....	....	19
20	67.51	72.0	64.0	8.0	30.05	30.07	30.02	.05	94	E.	5.4	07	0.28	....	0.28	20
21	68.83	79.0	61.5	17.5	30.09	30.15	30.06	.09	78	E.	7.8	41	....	....	....	21
22	71.12	84.7	60.6	24.1	30.05	30.10	30.01	.09	90	W.	11.0	54	0.12	....	0.12	22
23	74.70	83.5	69.5	14.0	30.00	30.06	29.94	.12	88	W.	12.9	33	0.87	....	0.87	23
24	68.86	73.8	65.1	8.7	30.03	30.11	29.95	.16	79	W.	15.3	03	0.02	....	0.02	24
SUNDAY........25	68.44	75.0	63.0	12.0	30.09	30.13	30.05	.08	68	N.W	7.3	80	....	....	....	25..........SUNDAY
26	69.12	76.7	62.2	14.5	30.06	30.10	30.02	.08	69	N.W.	6.5	63	....	....	....	26
27	69.25	78.0	60.6	17.4	30.11	30.16	30.05	.11	75	E.	4.9	85	....	....	....	27
28	70.66	80.0	61.7	18.3	30.15	30.21	30.11	.10	68	E.	6.5	74	....	....	....	28
29	74.26	81.7	65.4	16.3	30.03	30.11	29.94	.17	67	N.W.	16.4	76	....	....	....	29
30	68.24	73.9	64.6	9.3	29.90	29.94	29.88	.06	85	W.	9.4	04	0.24	....	0.24	30
31	59.19	64.6	56.6	8.0	29.98	30.00	29.92	.08	96	N.	13.0	00	1.34	....	1.34	31
Means......	67.31	74.97	60.36	14.61	29.998	30.066	29.920	.146	76.0	W. 26° 29′ N.	§10.36	¶49.2	5.44	....	5.44	..............Sums.
27 Years means for and including this month	66.78	75.07	58.88	16.19	29.942	....	......	.133	73.5	....	12.16	*57.81	3.57	....	3.57	27 Years means for and including this month.

ANALYSIS OF WIND RECORD.

Direction........	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	CALM.
Miles	773	432	1049	185	88	155	3685	1340	
Duration in hrs..	80	47	151	20	8	10	306	120	2
Mean velocity....	9.7	9.2	6.9	9.2	11.0	15.5	12.0	11.2	

Greatest mileage in one hour was 24 on the 17th and 24th.

Greatest velocity in gusts was 36 miles per hour on the 8th.

Resultant mileage, 3673.

Resultant direction, W. 26° 29′ N.
Total mileage, 7,707.

* Barometer readings reduced to sea-level and temperature 32° Fahrenheit.

† Mean of bi-hourly readings taken from self-recording instruments.

‡ Humidity relative, saturation being 100. Mean of observations at 8, 15 and 20 hours.

¶ 20 years only. § 15 years only.

The greatest heat was 84.7 on the 22nd; the greatest cold was 55.0 on the 19th, giving a range of temperature of 29.7 degrees. Warmest day was the 23rd. Coldest day was the 31st.

Highest barometer reading was 30.28 on the 6th; lowest barometer was 29.71 on the 10th, giving a range of .57 inches.

Minimum relative humidity observed was 43 on the 6th.

Rain fell on 14 days.

Thunderstorms on the 8th, 10th, 22nd, 23rd, and two on the 30th.

ABSTRACT FOR THE MONTH OF SEPTEMBER, 1901.

Meteorological Observations, McGill College Observatory, Montreal, Canada. Height above sea level, 187 feet. C. H. McLEOD, *Superintendent.*

DAY	THERMOMETER. † Mean.	Max.	Min.	Range.	* BAROMETER. † Mean.	Max.	Min.	Range.	‡ Mean relative humidity.	WIND. General direction.	Mean velocity in miles per hour	Per cent. possible Sunshine.	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAY.
SUNDAY........ 1	63.71	70.4	57.7	12.7	30.02	30.05	30.00	.05	84	N.	10.6	39	....	....	....	1..........SUNDAY
2	68.47	75.2	62.0	13.2	30.00	30.02	29.98	.04	80	N.E.	6.2	52	....	....	....	2
3	68.77	77.0	60.0	17.0	30.07	30.12	30.02	.10	85	E.	6.4	66	....	....	....	3
4	73.39	81.0	66.0	15.0	30.01	30.06	29.97	.09	74	E.	17.2	85	....	....	....	4
5	73.73	81.5	65.8	15.7	30.07	30.12	30.00	.12	81	N.W.	8.5	78	....	....	....	5
6	76.29	83.0	70.2	12.8	30.08	30.14	30.03	.11	71	N.W.	16.1	93	....	....	....	6
7	71.97	81.7	56.2	25.5	29.93	30.03	29.80	.23	79	N.W.	17.3	94	0.84	....	0.84	7
SUNDAY........ 8	54.59	60.2	46.1	14.1	30.07	30.14	29.99	.15	60	N.W.	14.4	95	....	....	....	8..........SUNDAY
9	56.88	65.7	47.6	18.1	30.04	30.10	30.00	.10	73	W.	14.8	64	....	....	....	9
10	61.52	70.0	53.3	16.7	30.00	30.07	29.92	.15	63	W.	8.8	78	....	....	....	10
11	57.24	59.0	55.5	3.5	29.80	29.92	29.74	.18	91	S.E.	6.4	00	0.33	....	0.33	11
12	58.78	62.8	52.2	10.6	29.63	29.74	29.49	.25	94	N.	6.3	01	0.38	....	0.38	12
13	63.94	70.9	57.8	13.1	29.65	29.77	29.52	.25	74	N.W.	6.9	33	0.01	....	0.01	13
14	62.87	70.4	52.9	17.5	29.91	29.96	29.77	.19	76	W.	5.5	86	....	....	....	14
SUNDAY........15	62.97	68.5	56.2	12.3	29.73	29.96	29.59	.37	94	S	6.0	01	0.14	....	0.14	15..........SUNDAY
16	64.33	72.2	58.5	13.7	29.71	29.81	29.59	.22	77	S.W	19.5	79	0.06	....	0.06	16
17	54.92	56.7	52.3	4.4	29.78	29.81	29.71	.10	91	W.	14.2	02	0.42	....	0.42	17
18	54.16	60.8	48.3	12.5	29.93	30.02	29.78	.24	76	W.	13.4	73	0.13	....	0.13	18
19	50.78	56.5	46.7	9.8	30.16	30.31	30.02	.29	74	W.	9.6	41	0.07	....	0.07	19
20	48.78	56.0	39.6	16.4	30.19	30.31	30.01	.30	79	W.	5.7	31	0.02	....	0.02	20
21	51.75	57.7	46.8	10.9	30.09	30.19	30.00	.19	74	W.	14.7	91	0.02	....	0.02	21
SUNDAY........22	56.95	68.2	44.0	24.2	30.09	30.19	30.01	.18	74	W.	15.7	89	....	....	....	22..........SUNDAY
23	62.84	73.6	51.0	22.6	29.99	30.09	29.90	.19	72	W.	21.6	85	....	....	....	23
24	57.29	64.0	44.0	20.0	30.17	30.43	29.95	.48	60	N.E.	18.2	67	....	....	....	24
25	45.56	53.0	38.0	15.0	30.51	30.57	30.43	.14	64	N.	10.4	94	....	....	....	25
26	48.09	56.9	36.9	20.0	30.45	30.54	30.37	.17	69	E.	5.6	68	0.00	....	0.00	26
27	56.98	67.6	48.0	19.6	30.32	30.39	30.25	.14	76	S.W.	11.8	84	....	....	....	27
28	61.01	69.9	50.0	19.9	30.16	30.25	30.08	.17	75	S.W.	13.3	79	....	....	....	28
SUNDAY........29	64.28	66.7	58.0	8.7	29.85	30.08	29.56	.52	96	E.	11.3	00	1.53	....	1.53	29..........SUNDAY
30	57.92	64.5	49.3	15.2	29.87	30.09	29.56	.53	61	W.	19.7	50	....	....	....	30
Means......	60.36	67.39	52.36	15.02	30.011	30.109	29.901	.208	76.6	W.13° 28′ N.	§11.87	¶60.3	3.95	....	3.95	..............Sums.
27 Years means for and including this month	58.53	66.53	50.84	15.70	30.015	....	......	.185	76.2	....	12.81	53.90	3.30	....	3.30	27 Years means for and including this month.

ANALYSIS OF WIND RECORD.

Direction........	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	CALM.
Miles	640	487	595	237	139	973	3905	1568	
Duration in hrs..	64	52	60	24	19	69	290	129	13
Mean velocity....	10.0	9.4	9.9	9.9	7.3	14.1	13.5	12.1	

Greatest mileage in one hour was 34 on the 30th

Greatest velocity in gusts was 36 miles per hour on the 30th.

Resultant mileage, 4723.

Resultant direction, W. 13° 28′ N,
Total mileage, 8,544.

* Barometer readings reduced to sea-level and temperature 32° Fahrenheit.

† Mean of bi-hourly readings taken from self-recording instruments.

‡ Humidity relative, saturation being 100. Mean of observations at 8, 15 and 20 hours.

¶ 20 years only. § 15 years only.

The greatest heat was 83.0 on the 6th; the greatest cold was 36.9 on the 26th, giving a range of temperature of 46.1 degrees. Warmest day was the 6th. Coldest day was the 25th.

Highest barometer reading was 30.57 on the 25th; lowest barometer was 29.49 on the 12th, giving a range of 1.08 inches.

Minimum relative humidity observed was 31 on the 30th.

Rain fell on 13 days.

Thunderstorms on the 7th and 16th.

Fog on the 3rd. Lunar halo on the 28th.

ABSTRACT FOR THE MONTH OF OCTOBER, 1901.

Meteorological Observations, McGill College Observatory, Montreal, Canada. Height above sea level, 187 feet. C. H. McLEOD, *Superintendent.*

DAY	THERMOMETER. † Mean.	Max.	Min.	Range.	* BAROMETER. † Mean.	Max.	Min.	Range.	‡ Mean relative humidity.	WIND. General direction.	Mean velocity in miles per hour	Per cent. possible Sunshine.	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAY.
1	54.74	63.0	44.2	18.8	29.98	30.13	29.74	.39	79	S.W	10.0	65	....	....	....	1
2	53.86	62.7	44.5	18.2	29.61	29.74	29.49	.25	88	S.E.	16.6	00	0.59	....	0.59	2
3	46.57	54.1	41.2	12.9	29.69	29.75	29.66	.09	77	W.	6.6	51	....	....	....	3
4	44.63	54.1	39.0	15.1	29.92	30.11	29.75	.36	82	W.	12.0	58	....	....	....	4
5	33.72	47.7	39.1	8.6	30.08	30.17	29.89	.28	79	W.	12.8	50	0.04	....	0.04	5
SUNDAY...... 6	42.62	49.0	35.5	13.5	30.13	30.36	29.85	.51	77	N.W.	13.5	13	....	....	....	6..........SUNDAY
7	44.77	51.0	36.7	14.3	30.41	30.47	30.35	.12	72	W.	14.6	90	....	....	....	7
8	50.80	58.7	43.3	15.4	30.24	30.35	30.11	.24	75	S.W.	13.3	07	....	....	...	8
9	54.35	62.0	47.1	14.9	30.09	30.11	30.06	.05	82	S.W.	13.3	00	....	....	....	9
10	56.83	61.0	53.0	8.0	30.14	30.17	30.09	.08	94	S	11.1	00	0.30	....	0.30	10
11	58.94	66.0	53.0	13.0	30.15	30.21	30.08	.13	90	S.W.	11.8	42	....	....	....	11
12	61.17	70.0	54.6	15.4	29.94	30.08	29.86	.22	83	S. E.	15.8	51	....	....	....	12
SUNDAY........13	59.17	63.0	54.9	8.1	29.77	29.86	29.67	.19	89	S.E.	19.3	00	0.60	....	0.60	13..........SUNDAY
14	53.84	57.0	50.7	6.3	29.94	29.99	29.81	.18	76	S.W.	10.8	07	....	....	....	14
15	52.37	59.0	47.0	12.0	30.00	30.02	29.94	.08	70	S.W.	14.7	93	....	....	....	15
16	50.35	52.2	46.2	6.0	29.99	30.03	29.94	.09	87	S.W.	13.7	00	0.13	0.0	0.13	16
17	40.87	47.5	35.5	12.0	29.82	29.94	29.78	.16	82	N.E.	8.3	00	0.62	....	0.62	17
18	37.21	41.0	34.1	6.9	29.9[illegible]	29.99	29.82	.17	60	W.	14.9	79	....	....	0.00	18
19	39.12	47.0	32.9	14.1	29.86	30.19	29.94	.25	78	N.	18.0	14	0.85	1.0	0.95	19
SUNDAY........20	35.34	38.8	30.5	8.3	30.34	30.40	30.19	.21	72	W.	14.0	39	0.02	....	0.02	20..........SUNDAY
21	39.15	42.0	35.5	6.5	30.27	30.34	30.16	.18	76	W.	11.8	80	0.06	....	0.06	21
22	49.32	55.3	35.0	20.3	29.87	30.16	29.83	.33	73	W.	20.4	70	....	....	....	22
23	52.89	62.6	42.1	20.5	29.53	29.83	29.36	.47	71	W.	27.5	32	0.02	....	0.02	23
24	40.02	43.8	36.0	7.8	29.88	30.11	29.63	.48	62	N.W.	20.6	01	....	....	0.00	24
25	37.72	42.1	31.0	11.1	30.18	30.24	30.11	.13	61	N.W.	13.7	78	....	....	....	25
26	46.44	57.0	35.0	22.0	29.96	30.14	29.82	.32	69	W.	18.6	63	0.00	0.0	0.00	26
SUNDAY........27	43.57	53.0	37.0	16.0	30.11	30.35	29.82	.53	58	N.W.	15.1	83	0.27	....	0.27	27..........SUNDAY
28	36.07	40.8	31.6	9.2	30.55	30.63	30.35	.28	68	N.W.	6.7	99	....	....	....	28
29	38.52	49.4	30.0	19.4	30.56	30.65	30.45	.20	73	E.	7.9	58	....	....	....	29
30	53.84	58.1	41.2	16.9	30.27	30.45	30.17	.28	74	S.W.	15.4	37	....	....	....	30
31	53.53	63.0	46.1	16.9	30.08	30.17	29.91	.26	74	S.	14.7	41	....	....	....	31
Means...... ..	47.17	53.93	40.76	13.17	30.041	30.166	29.924	.242	75.8	W.16 15′S.	14.11	41.8	3.50	1.0	3.60	..............Sums.
27 Yearsmeans for and including this month	45.95	52.93	39.05	13.88	30.014	....	......	.217	76.9	....	§ 13.44	¶4[illegible].60	3.03	....	3.13	27 Years means for and including this month.

ANALYSIS OF WIND RECORD.

Direction........	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	CALM.
Miles	676	205	197	987	864	2711	3274	1587	
Duration in hrs..	54	22	29	64	66	193	207	105	4
Mean velocity....	12.5	9.3	6.8	15.4	13.1	14.0	15.8	15.1	

Greatest mileage in one hour was 34 on the 23rd.

Greatest velocity in gusts was 40 miles per hour on the 23rd.

Resultant mileage, 5480.

Resultant direction, W. 16° 15′ S.

Total mileage, 10,501.

* Barometer readings reduced to sea-level and temperature 32° Fahrenheit.

† Mean of bi-hourly readings taken from self-recording instruments.

‡ Humidity relative, saturation being 100. Mean of observations at 8, 15 and 20 hours.

¶ 20 years only. § 15 years only.

The greatest heat was 70.0 on the 12th; the greatest cold was 30.0 on the 29th, giving a range of temperature of 40.0 degrees. Warmest day was the 12th. Coldest day was the 20th.

Highest barometer reading was 30.65 on the 29th; lowest barometer was 29.36 on the 23rd giving a range of 1.29 inches.

Minimum relative humidity observed was 47 on the 18th.

Rain fell on 12 days.

Snow fell on 3 days.

Rain or Snow fell on 14 days.

Lunar Corona on 31st.

Fog on the 29th.

ABSTRACT FOR THE MONTH OF NOVEMBER, 1901.

Meteorological Observations, McGill College Observatory, Montreal, Canada. Height above sea level, 187 feet. C. H. McLEOD, *Superintendent.*

DAY	THERMOMETER. † Mean.	Max.	Min.	Range.	* BAROMETER. † Mean.	Max.	Min.	Range.	‡ Mean relative humidity.	WIND. General direction.	Mean velocity in miles per hour	Per cent. possible Sunshine.	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAY.
1	52.58	57.7	48.5	9.2	29.94	30.01	29.86	.15	70	S.W	20.7	71	0.02	....	0.02	1
2	44.02	49.0	37.0	12.0	30.25	30.37	30.01	.36	64	N.W.	12.0	47	....	....	....	2
SUNDAY........ 3	38.67	47.0	33.2	13.8	30.24	30.36	30.06	.30	72	N.E.	9.5	89	....	....	....	3..........SUNDAY
4	43.75	53.9	34.0	19.9	30.01	30.09	30.04	.05	66	S.	15.9	76	....	....	....	4
5	27.07	40.1	34.1	6.0	30.17	30.21	30.04	.17	75	W.	14.5	01	....	....	...	5
6	36.86	42.1	33.2	8.9	30.16	30.21	30.14	.07	68	W.	10.9	69	....	....	....	6
7	35.57	40.1	28.6	11.5	30.06	30.20	29.91	.29	77	E.	7.6	00	....	....	....	7
8	38.65	43.0	35.0	8.0	29.97	30.08	29.88	.20	79	W.	13.0	06	0.01	....	0.01	8
9	37.82	41.6	30.5	11.1	29.97	30.06	29.88	.18	78	W.	15.6	01	0.04	....	0.04	9
SUNDAY........10	25.67	30.5	21.2	9.3	30.32	30.45	30.04	.41	74	N.W.	19.9	91	....	....	....	10..........SUNDAY
11	25.72	29.7	20.2	9.5	30.17	30.44	29.86	.58	87	E.	10.0	00	....	0 0	0.00	11
12	31.38	33.7	27.0	6.7	29.45	29.86	29.26	.60	96	E.	14.7	00	0.88	0.6	1.02	12
13	27.40	32.0	24.0	8.0	29.39	29.44	29.29	.15	94	N.W.	24.4	00	....	4.4	0.44	13
14	25.97	28.9	23.0	5.9	29.18	29.29	29.11	.18	92	W.	17.8	00	....	9 7	0.99	14
15	27.03	29.0	25.0	4.0	29.43	29.49	29.27	.22	94	S.E.	5.3	02	....	3.2	0.32	15
16	30.07	30.9	27.0	3.9	29.63	29.77	29.46	.31	88	W.	17.8	00	....	1.0	0.10	16
SUNDAY........17	30.07	33.6	27.0	6.6	29.86	29.94	29.77	.17	86	W.	16.8	63	....	1 4	0.14	17..........SUNDAY
18	31.90	34.3	30.0	4.3	30.01	30.03	29.94	.09	88	N.W.	8.8	33	....	0.3	0.03	18
19	27.92	29.5	24.2	5.3	30.09	30.17	30.01	.16	89	W.	8.5	00	....	0.5	0.05	19
20	20.69	26.0	19.5	6.5	30.23	30.26	30.17	.09	90	W.	10.9	00	....	....	....	20
21	26.14	30.5	20.5	10.0	30.26	30.27	30.25	.02	80	W.	13.0	71	....	0.0	0.00	21
22	32.77	38.1	22.3	15.8	30.14	30.25	30.05	.20	87	W.	18.1	00	....	1.2	0.12	22
23	16.40	22.3	11.1	11.2	30.34	30.43	30.23	.20	89	N. E.	13.5	60	....	....	....	23
SUNDAY........24	22.15	28.2	14.5	13.7	29.98	30.23	29.79	.44	89	N.E.	18.0	00	0.10	0.0	0.10	24..........SUNDAY
25	28.23	32.5	26.0	6.5	29.63	29.79	29.54	.25	95	N.E.	21.1	00	....	4.1	0.41	25
26	21.59	27.0	16.0	11.0	29.75	29.90	29.56	.34	87	N.W.	21.5	00	....	2.0	0.20	26
27	12.32	16.0	6.1	9.9	30.05	30.18	29.90	.28	82	W.	23.0	27	....	0.5	0.05	27
28	12.22	15.3	6.2	9.1	30.20	30.24	30.16	.08	83	W.	20.2	00	....	0.2	0.02	28
29	12.16	17.0	4.3	12.7	29.95	30.17	29.85	.32	89	W.	8.2	00	....	0 0	0.00	29
30	19.22	22.2	13.8	8.4	30.00	30.04	29.87	.17	77	W.	13.3	00	....	0.1	0.01	30
Means......	28.73	33.39	24.10	9.29	29.963	30.074	29.840	.234	82.8	W.19°47′N.	14.81	23.8	1.05	29.2	4.07	............Sums.
27 Yearsmeans for and including this month	31.73	38.69	26.62	12.08	30.013	....	......	.269	80.48	....	§ 15.95	¶28.69	2.32	13.90	3.74	27 Years means for and including this month.

ANALYSIS OF WIND RECORD.

Direction........	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	CALM.
Miles	214	1302	781	209	239	714	4488	2715	
Duration in hrs..	18	89	72	23	20	48	301	150	2
Mean velocity....	11.9	14.6	10.8	9.1	11.9	14.9	14.9	18.1	

Greatest mileage in one hour was 30 on the 5th, 9th, 13th and 27th.

Greatest velocity in gusts was 32 miles per hour on the 5th and 27th.

Resultant mileage, 6307.
Resultant direction, W. 19° 47′ N.
Total mileage, 10,662.

* Barometer readings reduced to sea-level and temperature 32° Fahrenheit.

† Mean of bi-hourly readings taken from self-recording instruments.

‡ Humidity relative, saturation being 100. Mean of observations at 8, 15 and 20 hours.

¶ 20 years only. § 15 years only.

The greatest heat was 57.7 on the 1st; the greatest cold was 4.3 on the 29th, giving a range of temperature of 53.4 degrees. Warmest day was the 1st. Coldest day was the 29th.

Highest barometer reading was 30.45 on the 10th; lowest barometer was 29.11 on the 14th, giving a range of 1.34 inches.

Minimum relative humidity observed was 46 on the 4th.

Rain fell on 5 days.

Snow fell on 18 days.

Rain or Snow fell on 21 days.

Depth of snow on ground at end of month, 13 inches.

Fog on the 7th.

ABSTRACT FOR THE MONTH OF DECEMBER, 1901.

Meteorological Observations, McGill College Observatory, Montreal, Canada. Height above sea level, 187 feet. C. H. McLEOD, *Superintendent.*

DAY	THERMOMETER. † Mean.	Max.	Min.	Range.	* BAROMETER. † Mean.	Max.	Min.	Range.	‡ Mean relative humidity.	WIND. General direction.	Mean velocity in miles per hour	Per cent. possible Sunshine.	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAY.
SUNDAY........ 1	29.83	36.3	20.4	15.9	29.84	29.99	29.73	.26	79	S.	17.0	00	....	....	....	1..........SUNDAY
2	34.21	41.5	19.0	22.5	29.71	29.99	29.59	.40	76	S.W	25.0	05	0.06	....	0.06	2
3	14.33	19.0	10.9	8.1	30.13	30.21	29.99	.22	81	N.E.	15.9	11	....	....	....	3
4	12.94	15.6	10.2	5.4	30.04	30.17	29.97	.20	91	N.W.	17.5	00	....	1.1	0.11	4
5	9.87	12.9	6.8	6.1	30.32	30.44	30.17	.27	80	W.	15.4	00	....	....	....	5
6	7.03	11.0	3.2	7.8	30.53	30.58	30.44	.14	87	E.	5.3	00	....	....	....	6
7	9.02	17.0	1.7	15.3	30.45	30.58	30.29	.29	84	N.E.	10.7	00	....	....	....	7
SUNDAY........ 8	20.92	25.5	18.0	7.5	30.24	30.36	30.00	.36	87	N. E.	8.6	00	0.01	1.8	0.19	8..........SUNDAY
9	34.22	39.3	25.5	13.8	29.87	30.00	29.75	.25	91	W.	17.1	00	0.47	....	0.47	9
10	30.27	35.0	26.1	8.9	29.62	29.95	29.43	.52	82	S.W.	25.7	00	0.40	1.3	0.53	10
11	23.74	26.1	21.4	4.7	30.21	30.37	29.87	.50	81	S.W.	19.7	93	....	....	....	11
12	23.08	26.5	19.9	6.6	30.39	30.43	30.35	.08	85	E.	6.6	00	....	0.0	0.00	12
13	35.57	43.5	22.0	21.5	30.13	30.36	29.99	.37	72	S.E.	22.6	00	....	....	....	13
14	52.49	59.1	43.5	15.6	29.75	29.99	29.56	.43	83	S.E.	27.6	00	0.95	....	0.95	14
SUNDAY........ 15	21.02	50.0	6.6	43.4	29.82	30.10	29.56	.54	..	W.	28.2	00	1.00	0.8	1.08	15..........SUNDAY
16	—0.21	6.6	—4.7	11.3	30.18	30.23	30.09	.14	..	W.	15.6	69	....	....	....	16
17	1.55	5.0	—2.7	7.7	30.16	30.21	30.07	.14	..	N.E.	7.4	00	....	....	....	17
18	6.67	10.0	2.5	7.5	30.11	30.21	30.06	.15	..	N.E.	3.6	01	....	....	....	18
19	7.29	10.3	4.3	6.0	30.28	30.32	30.21	.11	..	E.	3.0	00	....	0.3	0.03	19
20	9.81	15.2	4.2	11.0	30.34	30.38	30.31	.07	..	E.	2.2	08	....	0.2	0.02	20
21	6.71	9.0	3.2	5.8	30.37	30.45	30.32	.13	..	W.	3.7	13	....	....	....	21
SUNDAY........ 22	15.71	23.3	5.3	18.0	29.99	30.32	29.71	.61	78	S.	14.7	00	....	0.0	0.00	22..........SUNDAY
23	28.64	31.9	23.3	8.6	29.71	29.72	29.68	.04	89	S.	16.3	00	....	0.5	0.05	23
24	32.52	34.0	28.3	5.7	29.85	29.74	29.65	.09	86	W.	11.6	00	....	1.4	0.14	24
25	27.22	32.0	23.2	8.8	29.86	30.06	29.74	.32	77	S.W.	18.0	44	....	....	....	25
26	30.46	35.0	28.0	7.0	30.13	30.22	30.02	.20	90	S.W.	14.7	16	....	....	....	26
27	30.57	33.0	27.3	5.7	30.01	30.22	29.89	.33	88	N.W.	9.8	08	....	1.7	0.17	27
28	30.43	33.2	26.5	6.7	30.19	30.29	29.98	.31	75	S.E.	10.9	00	....	....	....	28
SUNDAY........ 29	33.30	34.3	32.1	2.2	29.66	29.98	29.46	.52	97	N.	8.8	00	....	3.8	0.72	29..........SUNDAY
30	29.48	34.5	20.8	13.7	29.65	29.69	29.55	.14	81	W.	13.0	00	....	....	....	30
31	20.19	30.7	4.5	26.2	29.62	29.97	29.42	.55	87	W.	26.7	00	....	2.2	0.16	31
Means..........	21.58	26.98	15.53	11.45	30.038	30.178	29.898	.280	83.6	W.32°55′S.	14.23	‖c8.6	2.89	15.1	4.68	..............Sums.
27 Years means for and including this month	19.24	26.22	12.13	14.08	30.030	....	......	.295	83.4	....	§ 16.13	¶21.99	1.38	23.23	3.65	27 Years means for and including this month.

ANALYSIS OF WIND RECORD.

Direction........	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	CALM.
Miles	448	1192	538	1267	1510	1620	3237	775	
Duration in hrs..	60	107	93	71	93	72	164	64	20
Mean velocity....	7.5	11.1	58	17.8	16.3	22.5	19.7	12.1	

Greatest mileage in one hour was 45 on the 10th.

Greatest velocity in gusts was 50 miles per hour on the 10th.

Resultant mileage, 3156.

Resultant direction, W. 32° 55′ S.

Total mileage, 10,587.

Wind from City Hall on 10th, 11th, 15th, 16th and 21st.

* Barometer readings reduced to sea-level and temperature 32° Fahrenheit.

† Mean of bi-hourly readings taken from self-recording instruments.

‡ Humidity relative, saturation being 100. Mean of observations at 8, 15 and 20 hours.

¶ 20 years only. § 15 years only.

The greatest heat was 59.1° on the 14th; the greatest cold was 4.7° below zero; giving a range of temperature of 63.8 degrees. Warmest day was the 14th. Coldest day was the 16th.

Highest barometer reading was 30.58 on the 6th and 7th; lowest barometer reading was 29.42 on the 31st, giving a range of 1.16 inches.

Minimum relative humidity observed was 62 on the 13th.

Rain or sleet fell on 6 days.

Snow fell on 13 days.

Rain, sleet or snow fell on 16 days.

Depth of snow on ground at end of month, 6.5 inches.

Ground clear of snow on the 15th.

Rainbow on the 16th.

Lunar corona on the 22nd.

Light fog on the 6th and 28th.

Meteorological Abstract for the Year 1901.

Observations made at McGill College Observatory, Montreal, Canada. — Height above sea level 187 ft. Latitude N. 45° 30′ 17″. Longitude $4^h\ 54^m\ 18{\cdot}67^s$ W.

C. H. McLEOD, *Superintendent.*

Month.	Thermometer. + Mean.	¶ Deviation from 27 years, means.	Max.	Min.	Mean daily range.	* Barometer. † Mean.	Max.	Min.	Mean daily range.	‡ Mean relative humidity.	Wind. Resultant direction.	Mean velocity in miles per hour.	Per cent. possible bright sunshine	Precipitation. Inches of rain.	Number of days on which rain (or sleet) fell.	Inches of snow.	Number of days on which snow fell.	Inches of rain and melted snow.	No. of days on which rain *and* snow fell.	No. of days on which rain *or* snow fell.	Month.
January	12.75	+ 0.43	39.6	— 16.7	15.27	29.978	30.78	29.03	.387	86.5	W. 6°38′N.	16.58	34.1	0.27	4	27.1	17	2.98	2	19	January
February	12.46	— 3.09	29.5	— 1.0	11.67	29.825	30.39	29.41	.190	81.1	W. 3°43′N.	19.58	43.5	....	..	22.4	13	2.01	..	13	February
March	24.87	+ 0.54	40.0	— 0.0	13.27	29.878	30.51	29.29	.303	79.6	W. 9°42′N.	17.91	30.4	2.90	7	26.0	20	7.32	4	23	March
April	43.61	+ 3.02	75.2	30.7	14.35	30.049	30.48	29.61	.167	73.9	N. 44°38′E.	17.47	39.3	4.01	16	1.3	2	4.19	2	16	April
May	56.17	+ 1.45	79.4	40.1	14.82	29.863	30.24	29.40	.187	68.0	S. 23°43′ W.	9.69	43.8	2 50	19	....	..	2.50	..	19	May
June	66.83	+ 1.86	92.0	43.7	17.20	29.890	30.23	29.55	.137	70.8	W.40°44′ S.	11.15	61.5	1.97	12	....	..	1.97	..	12	June
July	70.27	+ 1.38	93.7	53 7	16.16	29.907	30.24	29.59	.150	67.7	W.22°51′N.	11.56	57.9	5.27	12	....	..	5.27	..	12	July
August	67.31	+ 0.53	84.7	55.0	14.61	29.998	30.28	29.71	.116	76.0	W.27°29′N.	10.36	49.2	5.44	14	....	..	5.44	..	14	August
September	60.36	+ 1.83	83.0	36.9	15.02	30.011	30.57	29.49	.208	76.6	W.13°28′N.	11.87	60.3	3.95	13	....	..	3.95	..	13	September
October	47.17	+ 1.22	70.0	30.0	13.17	30.041	30.65	29.36	.242	75.8	W.16°15′ S.	14.11	41.8	3.50	12	1.0	3	3.60	3	12	October
November	28.73	— 3.00	57.7	4.3	9.29	29.963	30.45	29.11	.234	82.8	W.19°47′N.	14.81	23.8	1.05	5	29.2	18	4.07	2	21	November
December	21.58	+ 2.34	59.1	— 4.7	11.45	30.038	30.58	29.42	.280	83.6	W.32°55′ S.	14.23	08 6	2.89	6	15.1	13	4.68	3	16	December
Sums for 1901	....	....	....	....	....		....	....	....	....	....	....	....	33.75	120	121.1	86	47.98	16	190	Sums for 1901
Means for 1901	42.67	+ 0.71	....	....	13.94	29.953	....	....	.219	76.87	W. 8′ N.	14 07	41.18	....	....	....	..	4.00	..	..	Means for 1901
Means for 27 years ending Dec. 31, 1901	42.03	....	....	....	....	29.980	....	....	....	75.49	....	*a* 14.95	§45.75	28.84	134	120.93	80	40.94	16	201	Means for 27 years ending Dec. 31, 1901

* Barometer readings reduced to 32° Fah. and to sea level. † The monthly thermometer and barometer means are derived from bihourly readings taken from self-recording instruments, beginning 1 h. 0 m. Eastern Standard time. ¶ "+" indicates that the temperature has been *higher*: "—" that it has been *lower* than the average for 27 years inclusive of 1901. ‡ Humidity relative, saturation being 100; the humidity means are derived from observations made at 8 *h*, 15 *h* and 20 *h*. § For 20 years only. *a* For 15 years only. The anemometer and wind vane are on the summit of Mount Royal, 54 feet above the ground and 807 feet above sea level. The wind tower on the mountain was burned down on April 29th; it was replaced by a steel structure, and the instruments were set up on June 26th; the readings for the intervening period were obtained from the anemometer and wind vane on the City Hall.

The greatest heat was 93.7° above zero (Fah.) on July 16th; the greatest cold was 16.7 below zero on Jan. 19th. The extreme range of temperature was, therefore 110.4°. Greatest thermometer range in one day was 38.6° on Jan. 21; least range was 2.2° on Dec. 29th. The warmest day was July 16th, when the mean temperature was 82.84° above zero. The coldest day was Jan. 19th, when the mean temperature was 13.77° below zero. The minimum relative humidity observed was 24 on May 3rd. The greatest mileage of wind recorded in one hour was 55 on Feb. 15th, and the greatest velocity in gusts was at the rate of 60 miles per hour on Feb. 15th. The total mileage of wind was 123,240. The resultant direction of the wind for the year was W. 8′ N., and the resultant mileage 59200. Lunar halos were observed; on 4 nights; lunar coronas on 6 nights; fog on 13 days; thunderstorms on 15 days; total number of thunderstorms 17. First sleighing of winter in city was on Nov. 13th. The first appreciable snowfall of the antumn was on Oct. 19th. The first trace of snow was on Oct. 18th.

Note.—The yearly means of the above are the averages of the monthly means, except for the velocity of the wind.