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# THE CANADIAN JOURNAL.

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## ON THE PETROLEUM SPRINGS OF WESTERN CANADA.


BY CHARLES ROBB,

MINING ENGINEER, MONTREAL.


*Read before the Canadian Institute, February 2nd,* 1861.

The existence of vast reservoirs of mineral oil hidden beneath the rocks in the western part of our Province, and now for the first time being disclosed to the light of day, forms a subject of the deepest scientific interest, and will amply justify an enquiry into its nature and probable origin, on scientific grounds only. But when we consider the additional importance attaching to the question from the commercial value of the material; and since, in the present crisis of the history of Canada, so much study is directed to the development of her natural resources, no further considerations need be urged to secure attention to the subject.

Petroleum, mineral oil, or fluid bitumen, is an inflammable substance, composed of carbon and hydrogen; of a black or deep brown colour, unctuous to the touch, and exhaling a strong and unpleasant odor. It exudes from the earth, or flows into wells in the manner of water springs, and is generally accompanied with an evolution of gas, the pressure of which seems to constitute the force which occasions the flow at the surface. Springs of petroleum and naphtha (an allied substance), occur in many parts of the world, and are not peculiar to any of the geological formations.

In the Island of Trinidad there is a great deposit of asphalt, forming a lake about three miles in circumference, and of unknown depth. The pitch at the sides is perfectly hard, but towards the middle it becomes softer, until at last it is seen boiling up in a liquid state, emitting a disagreeable odor, which is sensibly felt at ten miles distance. The appearance of ebullition however is probably due, not to heat but to the evolution of gas; and the tar probably floats on water. In the Island of Barbadoes considerable quantities of petroleum are derived from tertiary strata; and in California, this substance has recently been discovered in great abundance. Lake Asphaltites, or the Dead Sea, in Judea, derives its name from the fact of this material abounding around its shores; here the rocks are of secondary or limestone formation. The bitumen employed by the ancient Babylonians, instead of mortar, was chiefly derived from the fountains of Is —the modern Hit—on the river Euphrates. These fountains are considered to be an inexhaustible source of bitumen, which still flows copiously, mingled with intensely saline and sulphureous waters. The rocks of the district are argillaceous limestone, interspersed with beds of coarse gypsum; but the cause which has for several thousand years produced the perennial flow probably lies at a considerable depth below the surface.

Naphtha is found in Persia and Circassia, rising in the form of vapour through marly soils; and in the north of Italy and some parts of France, the substance is found in considerable abundance. But probably the most powerful and copious petroleum springs yet known are those situated on the banks of the Irawaddi, in the Birman Empire, where in one locality there are said to be no less than 520 wells, annually yielding 400,000 hogsheads of the fluid; and which are reported to have been worked for ages without any symptoms of failure. These springs issue from a pale blue clay, saturated with the oil, and resting upon a species of slate, under which is coal containing much iron pyrites. Mr. Oldham, Superintendent of the Geological Survey of India, pronounces the rocks which yield the petroleum of the Irawaddi to be tertiary, and of the eocene period.

The fact of the existence of the petroleum springs in our own neighbourhood is by no means a new discovery. The early French settlers, and the Indians of western Pennsylvania, were aware of their existence, and made use of their products. Old oil vats and oil wells have been discovered, affording undoubted evidence of human works of great antiquity; and in Enniskillen, the great centre of the oil spring region in Canada, deers' horns, and pieces of timber bearing the marks of the axe, have been dug up from considerable depths below the surface, in what appear to have been old wells.

The fact of such remarkable springs occurring in western Canada could not fail to attract the attention of our Provincial Geologists, and accordingly we find them noticed in the reports of 1850–51 and 1851–52, although in a somewhat cursory manner, leading to the inference that the material was only to be found in very limited amounts. In the first named report we find the following slight notice: "Springs of petroleum, called usually *oil springs*, rise in the river Thames near its right bank in Mosa; the bituminous oil collected on cloths from the surface of which is used in the neighbourhood as a remedy for cuts and cutaneous diseases in horses. Similar springs exist in the township of Enniskillen, where a deposit of mineral pitch or mineral caoutchouc is said to extend over several acres on the seventeenth lot of the second concession." In a subsequent report, Mr. Murray, having visited the spot, thus describes the Enniskillen deposits: "This bed of bitumen, which in some parts has the consistence of mineral caoutchouc, occurs on the sixteenth lot of the second concession of Enniskillen, in the county of Lambton; but its extent does not appear to exceed half an acre, with a thickness of two feet over about twenty feet square, from which it gradually thins towards the edge in all directions. Bituminous oil was observed to rise to the surface of the water in Black Creek, a branch of Bear Creek, in two places on the seventeenth lot of the third concession of Enniskillen; and I was informed that it had been observed at other places farther down the stream."

The foregoing accounts embody the sum of what was publicly known regarding the oil springs in Western Canada previous to the year 1853, at which date they began to attract the attention of adventurers. It was not, however, until the year 1857 that the material was turned to profitable account. In consequence of the very successful introduction of the new coal oils, both for illuminating and lubricating purposes, under the patent of Mr. James Young, of Glasgow, certain gentlemen, foremost among whom was Mr. W. M. Williams of Hamilton, formed themselves into a company and acquired the lands in Enniskillen, on which the superficial deposits of asphalt occur, for the purpose of using it as a substitute for coal in the manufacture of such oils, it being ascertained to contain 80 per cent. of volatile matters. It was soon discovered, however, on penetrating below the asphalt, that the material could be obtained in large quantities in the fluid state, and consequently much nearer the condition required in the manufacture. Ultimately the whole adventure devolved upon Mr. Williams, to whom alone is due the merit of developing this branch of industry in Canada, as well as of pointing out the road to success in the same direction in the United States. The capital which Mr. Williams and his associates have invested in the works is over $42,000.

At first the distillation was carried on at the wells, but latterly the per centage of loss in refining being so small (about 30 or 35 per cent.), it was deemed expedient to remove the works to Hamilton, and convey the crude oil thither in barrels. The total quantity which has been raised by Mr. Williams is about 200,000 gallons. Mr. Williams has now five wells in more or less successful operation, yielding on an average from 600 to 800 gallons per day; but the amount which the wells are capable of yielding has never been thoroughly tested, as the difficulty attending the transportation from the wells to the railway station—a distance of about sixteen miles—has hitherto restricted the yield. At first the oil flowed into the wells unmixed with water, but latterly, although the supply is undiminished, large quantities of water are associated with it, insomuch as to render it necessary to use steam pumps to drain the wells.

The success which attended Mr. Williams' operations speedily induced other adventurers to enter upon the same field; and similar oil springs having been found to exist in Pennsylvania, our excitable and speculative neighbours rushed with characteristic eagerness into the business; and detachments from the main body soon invaded the more peaceful and primitive regions of Enniskillen—probing and torturing the earth in all directions, and polluting the air and the waters with the stench and scum of the oil. The success which has attended their operations has been in many instances very fair, and in one or two highly favourable; but in the great majority of cases the lottery has turned up blanks, though there is certainly no lack of gas to buoy up the spirits of the adventurers. Mr. Williams seems to have struck the main artery, and indeed the fact of the superficial deposits on his lands are a sure indication that here the petroleum existed in the greatest abundance, and nearest to the surface.

The material penetrated is a very stiff light-colored clay—in some cases almost pure white—no doubt chiefly derived from the ruins of decomposed rocks similar to those underlying the clay; unequivocal evidence of which is found in the fact that the clay contains numerous fossils identical with those embedded in the rocks, which are found at various depths, alternating with beds of clay, and consist of thin strata, more or less of a shaley nature, plentifully charged with the fossils peculiar to what is called the Hamilton group of the Devonian system of rocks. No rock of a bituminous nature seems as yet to have been struck; although detached masses of bituminous shale, identical with that which crops out at Kettle Point, on Lake Huron, and containing about fourteen per cent. of volatile matter, are frequently met with in forming the wells.

The depths hitherto penetrated vary from 40 to 120 feet; and in this respect little advantage seems to be obtained by commencing operations on the low grounds, as along the flats of the creeks; for at Mr. Williams' wells the depth is only about 40 feet, while at others in the immediate vicinity, on the flats of Black Creek, where the ground is at least 40 feet lower, although the depth penetrated is three times as great, the supply obtained is as yet inconsiderable. The strength of the oil, also, as indicated by the hydrometer, varies to a considerable extent in different wells, even although they may be very near together; and the supply to each well, at least in the southern part of the township, seems to be independent; these facts indicating the deep-seated origin of the oils. Here also the oil seems to be diffused throughout the clay, penetrating through numerous vertical cracks or fissures both in the rocks and clay, evidently in obedience to some force from beneath; no doubt due to the pressure of gas, which invariably issues in great quantities with the oil, giving to the wells the appearance of boiling caldrons of pitch. These gases produce a remarkable effect on the men who work in the wells, greatly resembling that caused by the inhalation of nitrous oxide or laughing gas; and, in order to the continuance of their operations, it is necessary to clear away the gas from time to time by exploding it. It has recently been ascertained that the vapours of naphtha, anilene, and other hydrocarbons produce physiological effects, resembling those of chloroform and other anæsthetic agents.

In other parts of the township, as at Kelly's wells, ten miles north of Mr. Williams', the conditions and mode of occurrence of the oil are quite different. Here it occurs in a bed of gravel and boulders, at a depth of about 47 feet from the surface, associated with such an amount of water as to render the wells exceedingly difficult in working, although the quantity of oil here is evidently very great. Whether these variations in the physical structure of the region have any connection with the origin of the deposits, it is in the present state of our knowledge of the subject, impossible with any degree of confidence to determine. Recently oil has been obtained by drilling into the rock, and in such cases it is said to be of a superior quality to that derived from the clay or superficial deposits.

The advantage which we possess in Canada over our neighbours in Pennsylvania and Ohio is, that the oil-bearing rocks lie much nearer the surface. On the other hand, the most of the oils obtained south of Lake Erie are lighter, and bear a less per centage of loss in manufacture; they are also much more easily deodorized, or rather have comparatively little unpleasant odor even in the crude state. But the chief drawback to the commercial value of the Canadian oil is its thick and tarry consistence; causing it to foam in an uncontrolable manner, in the ordinary retorts used for rectifying earth and coal oils, and to yield too large a proportion of heavy products. In view of these circumstances, it will obviously be expedient to prepare the material for the market in Canada, and with apparatus expressly adapted for the purpose.

I have hitherto purposely confined myself to what may be called a popular account of the oil springs, detailing only such facts as might attract the attention of a cursory observer. I shall now direct attention to what I proposed as the primary object of this inquiry, namely, an attempt to discover the source, and account for the origin of these extraordinary deposits. And here I must premise that whatever theory I might have to advance is only to be received as a guess at the truth. When so much uncertainty and difference of opinion still exist among scientific men with regard to the origin of coal, notwithstanding the amount of ability and learning that have been brought to bear upon the subject, it would be unreasonable to expect that this comparatively unexplored region of research should be opened up all at once.

The first step in our inquiry will naturally be to investigate and explain the geological structure of the region where the oil springs are found, regarding which no uncertainty exists, and which, apart from the subject of the oils, is peculiarly interesting.

Sir William Logan has pointed out that, if we conceive a line passing from the head of Burlington Bay through London, Zone, Chatham and Amherstburgh—being in fact the centre line or back-bone of the Western Peninsula—such line would form what is called, in geological parlance, the summit of a flat anticlinal arch; that is, the strata bend or dip slightly in an opposite direction on either side of it. In the present case the dip is so small as to be almost inappreciable by instruments; but it is nevertheless certain that the strata which occupy that part of our peninsula now under review pass under the coal measures of Pennsylvania on the one hand, and of Michigan on the other, at a depth varying from 1000 to 2000 feet; which thickness of course represents, or is the measure of the time, geologically speaking, which elapsed between the deposition of the newest of our rocks and the carboniferous era. Consequently it is quite evident that we must not seek for the origin of the petroleum deposits in the coal formation, properly so called.

The outcrops of the various members of the series of rocks immediately overlying the Appalachian and Michigan coal-fields form strips or belts which are rudely concentric with the coal basins themselves. The region now under notice is precisely the tangent point (as it were) where the corresponding strata under each coal-field meet and blend together, giving to the region occupied by the strata in question a form approaching that of the letter X. These rocks are called the Hamilton Shales, and constitute the lowest member of the Devonian or Old Red Sandstone system. Although in this locality of no great thickness—probably not exceeding 60 or 70 feet—the formation is most interesting in a geological point of view, as containing a well-marked and highly characteristic group of fossils, including the earliest known traces of terrestrial vegetation and of fishes. The formation consists of calcareous shales, with thin bands of denser limestone, and occasionally beds of sandy limestone, which are valuable for building purposes. The shaley portions crumble rapidly on exposure, and form a gray or ash-coloured clay; the fossil contents however remaining entire.

At Kettle Point, on Lake Huron, a locality comprised within the geographical boundaries of the Hamilton Group, there is exposed an interesting section of highly bituminous and argillaceous slates, which also occur in outlying patches throughout the oil-producing region, and have been ascertained to belong to the lowest measures of the Chemung Group, the next higher in the series.* It would appear at first sight most obvious and natural to attribute the origin and source of the petroleum to the subterranean distillation of these shales, which contain an amount of carbonaceous matter, abundantly adequate for its production; but there is most unequivocal evidence to prove that the oil and gas come from a lower source, and are in all probability the cause rather than the result of the bituminous nature of the shales.†

It is a peculiar and unique feature in the Canadian rocks of Silurian and Devonian age, that beds impregnated with bitumen, and evolutions of gaseous and fluid hydrocarbons occur at various points from the base to the summit of the series, although nowhere to such an extent as in the region now under review; and the fact that these oils have been obtained from the Hudson River group of rocks, in which few or no vegetable remains occur, would lead to the inference that the oils and gases may be entirely of animal origin. The upper beds of the Corniferous limestone in Canada, and the entire mass of the Hamilton shales, are characterized by the extraordinary profusion of organic remains, for the most part animal, with which they are charged; and the evidences which they furnish of the mode of their deposition indicate conditions highly favorable to the conversion of the organic matter into substances of a bituminous nature.

The process of bituminization consists of a species of fermentation or combustion, usually thought to be peculiar to vegetable matter, placed in such situations as not only to exclude the external air and secure the presence of moisture, but to prevent the escape of the volatile principles. The ultimate elements, and even to a great extent, the proximate structure of animal and vegetable tissues, are identical; and it is susceptible of demonstration that animal muscle, placed in similar circumstances, may be converted into substances closely resembling the products of vegetable bituminization.

* A full account of this highly interesting section of rocks will be found in the Geological Survey Reports of Progress for 1847–48, and 1853.

† This circumstance affords a strong corroboration of the theory which has been recently propounded before the French Academy by M. Riviere, attributing the origin of bituminous schists and shales in general to impregnation of their argillaceous material with carburetted hydrogen. See Wells' Annual of Scientific Discovery for 1860.

The epoch of the deposition of the rocks in question seems to have been a time when land and water were struggling for the predominance. The vast masses of the Silurian system of rocks had all been deposited in deep water; and the Devonian rocks are just beginning to emerge, forming vast lagoons, floored and surrounded by coral reefs, and densely inhabited by crinoids, brachiopods, and trilobites; though the latter remarkable creatures, so largely developed a little lower down in the scale, are now becoming rare and approaching extinction. Calamites, the earliest known of terrestrial vegetables, appear struggling for existence among the waves and shifting sands; and the first created fishes sport in the shallow waters. The floor of the ocean, together with these low spits and reefs, is sinking by slow and intermittent stages, and the remains of the scanty vegetation are entombed with those of the marine animals. Layer after layer are thus formed, the crust of the earth still subsiding as each is deposited.

Let us now inquire what would be the probable result of this condition of things, in so far as it affects the present question. The organic matter thus profusely scattered along the shores, and subjected to the influences of air and moisture, would decompose in the ordinary manner; but when, after partial putrefaction, it was covered up by a layer of sand or calcareous mud, and thus removed from the atmospheric influences, the resulting gases would be confined as in a closed retort; and the carbon and hydrogen, being greatly in excess of the oxygen, would enter into such combinations as we find subsisting in the petroleum and the various hydrocarbon gases; and these would remain pent up in crevices or caverns in the rocks until liberated either by natural or artificial means. In some cases, circumstances might be favorable for the production of the gaseous products unaccompanied by the fluid; and it by no means follows, as many imagine, that the development of gas, even in great abundance, would be an indication of the existence of oil in the same reservoir. The remarkable circumstance of the almost invariable association of salt water with petroleum would appear to afford a corroboration of this theory; for whether it be true, as some suppose, that the chloride of sodium exerts some chemical action on the bituminous matter favoring its production, it is at all events certain that the relative dispositions of land and water, which I have attempted to describe, would be highly favorable to the production of sea salt.

Whether this theory be correct in all its details or not, it seems certain, judging from the similarity of the products in both cases, that the petroleum has been generated by a process analogous to that which takes place in the destructive distillation of wood-coal or peat in close vessels, where, owing to the limited or total absence of oxygen, the combination of hydrogen and carbon in the form of hydrocarbons is effected. Nature appears to have the power of performing, by means of long time and very moderate temperature, processes which the chemist and manufacturer perform rapidly and by the application of great heat.

As bearing directly upon the chemical composition and nature of petroleum and its products, and illustrating the difference between the Canadian and Pennsylvania crude oils, and those derived from the Collingwood shales, I shall conclude by inserting (by the kind permission of the writer), the following letter with which I have been favored by Professor Croft:

UNIVERSITY COLLEGE, Toronto, Nov. 22nd, 1860.

DEAR SIR,

In reply to your letter of the 20th inst., requesting information as to the chemical nature of the Enniskillen, Pennsylvania and Collingwood oils, I am sorry that I cannot supply you with any very accurate details, not having examined these oils with a view to ascertaining their chemical composition, to any very great extent.

The first two being natural products, are of course quite different from the Collingwood shale oil, which does not apparently exist in a free state in the shale, but is obtained by and formed during the destructive distillation of the animal and vegetable substances contained therein. From the rock consisting almost entirely of fossil trilobites, the oil might perhaps be said to be of an animal origin, unless the rocks were subsequently impregnated with vegetable products.

Hence the Collingwood oil will be found to assimilate in its characters to the oil obtained by the slow distillation of coal, and more especially to that from the Boghead Coal; and will undoubtedly be found to contain a number of those curious chemical compounds which have been so ably investigated by Greville Williams, in his researches on the "Products of the Distillation of Boghead Coal." These substances are of a basic character and rank with the volatile vegetable alkaloids, having the general formula, $C^n H^m N$.

The petroleums or rock oils are essentially different, having been produced by a slow process continued through countless ages, and thus substances of a different chemical nature have been produced, although, perhaps, the material acted on has been nearly, if not quite, the same.

I am not aware of any means by which we can distinguish the products generated in the great laboratory of nature from animal substances, from those produced from bodies of a vegetable origin. Reasoning from analogy I should imagine it to be impossible, for recent researches have shown great similarity, in many cases identity, between the artificial products from animal and vegetable substances. See Anderson " On the bases from Dippel's Oil "—Williams, quoted above, &c. &c.

Besides the basic bodies above alluded to, these coal oils generally contain a number of hydrocarbons belonging to various series—*e.g.* Benzole, $C^{12}$ $H^{6}$ and its homologues.—Toluole $C^{14}$ $H^{8}$.—Xylole, Cumole, &c., and solid hydrocarbons, such as Naphthaline $C^{20}$ $H^{8}$, Paraffine, &c. &c.

The petroleums seem to be composed of hydrocarbons of a different class, having the formula $C^{n}$ $H^{n}$,— such as $C^{12}$ $H^{12}$—$C^{14}$ $H^{14}$—$C^{16}$ $H^{16}$ &c. &c., which are quite indifferent bodies, unacted on by nitric acid. Another substance exists in them which has been called Petrole $C^{16}$ $H^{10}$, and is acted on by nitric acid, and causes the brown or black colour when the petroleums is treated with nitric acid (and probably sulphuric ?). It has been said that Benzole exists in the light oils, but I know not on what authority.

When the Enniskillen oil is distilled it requires a high temperature to drive over much oil, and this oil, when re-distilled, does not pass over readily till between 200° and 210° Centigrade—the product, again distilled, goes over at 190°—200°, and by repeated fractional distillations, I have no doubt from the above experiments, we might obtain an oil boiling at a somewhat lower temperature.

When the Pennsylvania oil is distilled, it begins to pass over at about 130°, and a large proportion is distilled below 190°. When this product is re-distilled, a large proportion passes over below 150°.

Hence the Pennsylvania oil contains a much larger proportion of light volatile oils than the Enniskillen oil. None of them, however, are probably of the formula $C^{12}$ $H^{12}$ which boils at 70°; probably they belong to the higher part of the $C^{n}$ $H^{n}$ series; but in both cases (E. and P. oil) they are pure hydrocarbons, containing no oxygen, at least not in such a form as to act on potassium and sodium. The metals remain quite unaltered and with metallic lustre. Possibly there may be hydrocarbons of the formula $C^{n\,5}$ $H^{n\,4}$ present.

I am not aware that I have any further information to give you at present. The peculiar greenish colour is owing to fluorescence; if the Enniskillen oil be distilled very far, and the thick residue dissolved in hot alcohol, the solution is most powerfully fluorescent, but the dissolved substance is deposited as the solution cools. I am not aware that this fact has been observed. The Collingwood oil contains a very large percentage of heavy oil, paraffine, &c.; the light oil boils at 150°–190°.

Yours truly,

CHARLES ROBB, Esq., C.E. HENRY CROFT.

# ON THE MOVEMENTS OF THE DIATOMACEÆ.

BY PATRICK FREELAND, ESQ.

*Read before the Canadian Institute, January 19th,* 1861.

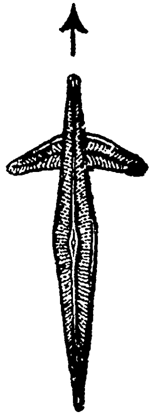
The producing cause of the movements of most of the free species of the Diatomaceæ has never yet been satisfactorily ascertained, notwithstanding the amount of attention bestowed upon the subject. Many eminent observers, with Ehrenberg at their head, maintain that the motion is owing to the action of cilia. "In some species of the Naviculeæ," he says, "it is produced by a flat snail-like foot protruded from each end of the valve." Others, again, maintain that it is owing to forces operating within the frustule, and connected with the endosmotic and exosmotic action of the cell—the fluids which are concerned in these actions entering and being emitted through minute foramina at the extremities of the valves. Dr. Smith, who maintains the movement to be of merely a mechanical nature, produced by a force not depending upon any act of volition in the living organisms, in his Synopsis of the British Diatomaceæ, says, "it appears certain that these motions do *not* arise from any external organs of motion. The more accurate instruments now in the hands of the observer have enabled him confidently to affirm that all statements resting upon the revelations of imperfect object-glasses, which have assigned motile cilia or feet to the Diatomaceous frustule, have been founded upon illusion or mistake. Among the hundreds of species (Dr. S. continues) which I have examined, in every stage of growth and phase of movement, aided by glasses which have never been surpassed for clearness and definition, I have never been able to detect any semblance of a motile organ; nor have I, by colouring the fluid with carmine or indigo been able to detect by the particles surrounding the diatom, those rotatory movements which indicate in the various species of true infusorial animalcules the presence of cilia."

In a paper on this subject, read before the London Microscopical Society, in 1855, by Mr. Hogg, he says, "I have repeatedly satisfied myself that their motive power is derived from cilia arranged around openings at either end—some around central openings, which, with those cilia at the ends, act as paddles or propellers."

Several facts which came under my own observation last summer while observing the motions of the *Pinnularia nobilis*, one of the largest of our fresh-water diatoms, have convinced me that Professor Smith is mistaken in the cause he assigns for these movements. If he is correct in his supposition that they are owing to the imbibing and ejection of fluid alternately at either end of the valve, then their motion must invariably be the same, never varying, advancing and retreating motion; but this is not so, I have repeatedly seen a diatom, when met by an obstacle in its path, suddenly change its course by a quick lateral motion, and go off in a direction quite different to that it was formerly pursuing, and frequently have I seen this done when there was nothing apparently to cause it, but as if from mere caprice the course had been changed.

On one occasion, I was fortunate enough to get a large, beautiful Pinularia in the centre of the field of view, and just beside it was a small piece of decayed vegetable matter. As the diatom moved along, this substance, instead of remaining stationary, or being carried along with the frustule in its forward motion, as would be the case were Professor Smith's theory correct, was propelled in the opposite direction, in a manner precisely similar to what it would have been, had it stood beside a ciliated infusorial Animalcule instead of a diatom. Its motion, however, was not regular, at least not as regular as that of the diatom, but somewhat intermittent, as if the repelling force to which it was subject was stronger in some places than at others, which fact seems to confirm the idea entertained by Mr. Hogg, that the cilia are not placed all along the valve, but at intervals. When this substance reached the end of the diatom, the rapidity of its motion increased, as if the force applied to it had suddenly become greater, or was more directly applied, and at a short distance from the valve, all its motion ceased. On the return journey of the diatom, the same process was repeated, the small body beginning to move before it came into contact with the diatom, and continuing its course as before, only in the contrary direction.

On another occasion, while a frustule of the *Pinnularia acuta* was traversing the field of view, it came in contact with a valve of Cocconema, lying directly across its path. Striking it fair in the centre, it passed partly over the obstruction for about one-third of its own length, as represented in the diagram, and then stopped as if it had got stuck between the diatom it was thus attempting to pass over,



and the thin glass cover of the live box. After a very short period of rest, the Pinnularia gave one or two short jerking motions, and then the Cocconema began to move rapidly, broadside on, in a direction opposite to that pursued by the former (which remained stationary) until it passed partly beyond it, when the Pinnularia resumed its journey; this was done twice in precisely the same manner; on the third journey, it had changed its course, and passed beyond the obstructing valve. The arrow indicates the direction in which the Pinnularia was moving. The Cocconema was of course forced in the opposite direction. Now, a result very similar to these might be produced by the expulsion of a fluid from the Diatom valve, according to Professor Smith's theory, but the orifices through which it would require to be forced would have to be placed along the side of the valve as well as at either end. And not only would this be necessary, but two sets of orifices, pointed in opposite directions, would be essential, in order to produce the double motion, backwards and forwards. While two sets more would be required to produce the motion I have before described, when the diatom saw fit to change its course. And besides all this elaborate mechanism, another must still be added, by means of which every opening would be completely closed but those for the moment employed in producing the motion in one given direction.

If this really is the correct solution of the question, the motion then of the Diatomaceæ is unique, for I doubt if any thing analagous to it can be found in nature. But if the presence of cilia be granted them, then there is no difficulty in at once understanding how every movement of the diatom valve can be readily produced merely by changing the direction of the ciliary motion. The objection urged by Professor Smith, that by colouring the water, no motion in the particles of the colouring matter could by him be detected, if it is a valid one against ciliary action, it is equally fatal to his own theory, for in his way of accounting for the motion, a current *must* be produced, but he has never seen any, or been able to detect it, and from this, he concludes there are no cilia. Let us reverse Professor Smith's argument, and the case will stand thus:—

If the motion is caused by the expulsion of a fluid from the frustule at each end alternately, then that must cause a current in the water, at the point where the fluid is forced out, and if there is a current, it will become visible if the water be coloured with carmine or indigo. But even with the best glasses, unsurpassed for clearness and definition, and with the water containing the diatoms, coloured in the usual way, no current is visible; therefore no current exists, and therefore the motion is not produced by the endosmotic and exosmotic action of the cell, and the consequent emission of a fluid through minute foramina at the extremities of the valve.

I must, however, admit that with objectives constructed by our best London makers, and after careful observation, I have hitherto failed to detect either cilia on the diatom, or a current in the water; but the facts I have now submitted, seem to me to be wholly irreconcileable with Professor Smith's theory, and to lead to the conclusion that these movements are owing to the presence of cilia arranged along the exterior of the diatom valve. It must be borne in mind that the very small specif' gravity of the diatom valve would require an extremely slight pow o produce all the motion we see, and that consequently the cilia, . he motion is so produced, may be so extremely delicate as hit o to have evaded actual detection, but that fact is not sufficient to warrant the conclusion that because cilia have not been actually seen, therefore, they do not exist."

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# NOTE ON LAND AND FRESH WATER SHELLS COLLECTED IN THE ENVIRONS OF TORONTO, C. W.

BY A. E. WILLIAMSON.

*(Read before the Canadian Institute, Saturday, Jan. 19th, 1861.)*

I propose, in the following short paper, to give the result of the researches of an amateur in one branch of a favourite pursuit, made in a somewhat desultory manner and in the intervals of business, during which I have managed to collect a tolerably well filled cabinet.

' nong the specimens thus collected, those of the fresh water and terrestrial shells comprise a small but very interesting portion;

restricted, however, to the species existing in my own immediate neighbourhood, and a few collected at Paris, C. W.

I intend here to confine myself to the shells found in the vicinity of Toronto, viz. at Weston, Toronto Island, and Todmorden on the River Don.

I must not omit the expression of grateful acknowledgment to the Rev. Professor Hincks, for his valuable aid in their determination.

The shells consists of representatives of the two classes, GASTEROPODA and CONCHIFERA.

In the class GASTEROPODA, we find examples of the genera *Helix*, *Planorbis*, *Succinea*, *Limnæa*, *Paludina*, *Valvata*, *Melania* and *Physa*, as shown in the following list of species.

Genus HELIX,—1. *H. albolabris* (or white-lipped Helix). 2. *H. alternata*, these two varieties are very common. 3. *H. monodon*; 4. *H. tridentata*; 5. *H. ligera*. I found this latter variety at Todmorden. Prof. Hincks was unaware of its being Canadian: his specimens are from Ohio.

Genus PLANORBIS,—1. *P. trivolvis;* 2. *P. bicarinatus;* 3. *P. campanulatus;* all very common.

Genus SUCCINEA,—*S. vermeta?* (Say.)—I have found this shell only at Weston.

Genus LIMNÆA,—1. *L. stagnalis;* is very common on the Island, the only locality at which I have observed it*. 2. *L. palustris*=*L. elodes* (Say), common on the Island.

Genus PALUDINA,—1. *P. impura;* 2. *P. porata* (Say); this variety is known now by the name of *Amnicola porata*. All the small shells heretofore known as Paludinas are now referred to the genus Amnicola: both these shells are found on the Island.

Genus VALVATA.—1. *V. tricarinata;* 2. *V. piscinalis.*

Genus MELANIA. *Melania*.—Very common, *Amnicola (paludina) porata*, classed with this genus under the sub-genus *Amnicola:* not very common.

Genus PHYSA,—1. *P. heterostropha* (Say); this variety closely resembles *P. fontinalis* of Europe: very common on the Island. 2. *P. ancillaria* (Say) also very common.

A few more species, one of which resembles *vertigo pygmæa* of Europe, can be obtained at the above mentioned localities.

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* Since writing this, Dr. Bovell informs me that he has found *L. stagnalis* in the River Humber.

In the class CONCHIFERA, we have representatives of the genera *Unio*, *Anodon*, and *Cyclas*.

Genus UNIO,—1. *U. nasutus;* very common on the Island. 2. *U. ochraceus:* 3. *U. complanatus*, also from the Island. A few more species or varieties can be obtained at the Island and Weston. Considerable difficulty is encountered in the naming of Unios, from the immense number of species, and the want of proper works of reference.

Genus ANODON:—Several varieties of this genus are to be found —principally at the Island.

Genus CYCLAS:—This genus is very common. The specimens obtained probably comprise several species, but their characters are too minute and inconspicuous to admit of any definite determination.

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# ON THE DEVONIAN FOSSILS OF CANADA WEST.

BY E. BILLINGS, F.G.S.

(*Continued from* Vol. VI. *page* 282.—No. XXVIII. *May*, 1860.)

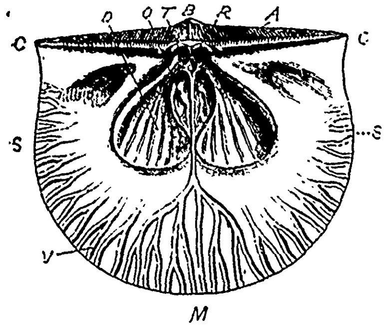
## Genus STROPHOMENA.—(Rafinesque.)

STROPHOMENA.—(Rafinesque.) De Blainville. *Manuel de Malacologie*, p. 513, Pl. 53, fig. 2, 2a, 1825. Davidson. *Introduction to the Classification of the Brachiopoda.* p. 106.

LEPTÆNA.—Dalman, *and many other authors.*

LEPTÆNA. + STROPHOMENA + STROPHODONTA, *either wholly or in part, of Hall and American authors.*

*Generic characters.*—Shell, semicircular, semioval, sub-quadrate or sub-triangular, with the hinge line straight; one valve convex and the other concave; in a few species both valves nearly flat. Both valves provided with an area, that of the ventral valve usually the larger. Area of ventral valve with a triangular or linear foramen or fissure in the middle beneath the beak, either wholly or partially closed by a deltidium; in some species no foramen. Area of dorsal valve often with a triangular projection in the middle, caused by the protrusion of the bases of the divaricator processes; in some species



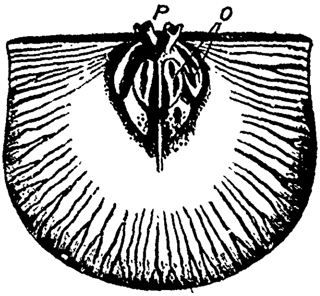




Fig. 103. Fig. 104.

Fig. 103.—*Strophomena inæquistriata.*—Conrad. Interior of ventral valve; S.S.,—the sides; M.—the front margin; C.C.—the cardinal angles; the edge of the area from C to C is the hinge line; A.—the flat space terminating the shell on the straight side is the area; B.—the beak; the small linear ridge beneath the beak is the deltidium; T.—teeth; R,—the rostral septum; D.—the divaricator muscular scar or impression; O.—the occlusor; V.—the vascular impressions. This figure is drawn as if the shell were flat in order to show all the parts more clearly.

Fig. 104.—*Strophomena demissa.*—Conrad. Interior of dorsal valve. P.—the two divaricator processes or levers for opening the valves; O.—the occlusor muscular impressions or scars.

this is absent. Valves articulated together at the hinge line or inner edge of the area, by teeth in the ventral valve, and sockets in the dorsal, the structure of which varies in different species. Surface ornamented with fine or coarse radiating striæ or small ribs; in a few species smooth.

On the inner surface of the ventral valve there are two large pyriform or subtriangular muscular scars or impressions, situated one on each side of the median line and in the upper half of the valve. These are the impressions of the DIVARICATOR MUSCLES or those whose function it was to open the valves. Between them there are two much smaller scars situated also, one on each side of the median line. These are the impressions of the OCCLUSOR MUSCLES, or those whose function it was to close the valves. On comparison it will be seen that the arrangement of the scars in the ventral valve is in a general way the same as in *Athyris* and *Spirigera.* It is nearly the same in *Orthis, Chonetes, Producta, Atrypa, Spirifera,* and in most other genera of Brachiopoda.

In some species, but not in all, the cavity within the beak and umbo of the ventral valve is divided into two compartments, by a vertical ridge or septum. This I propose to call the ROSTRAL SEPTUM. It varies greatly in size, and is often absent altogether. It cannot therefore be regarded as an organ of generic importance.

In the interior of the dorsal valve there are four small scars arranged in two pairs, one pair on each side of the median line. These are the OCCLUSORS corresponding to those of the ventral valve. In this valve the divaricators were attached to two small processes situated close to the hinge-line. (See fig. 104, P.) These are notched at their extremities, and grooved on the outside, or side next the area. These I propose to call the DIVARICATOR PROCESSES; their function was to open or divaricate the valves; the mechanical principal upon which they operated was simply that of the lever. This will be more clearly understood by consulting Fig. 105.

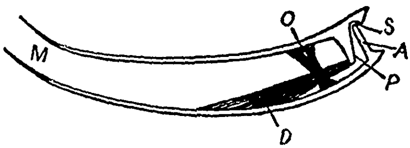



Fig. 105.

Fig. 105.—A longitudinal section through both valves of a *Strophomena* from the beak to the front margin; the dorsal valve uppermost. M.—the front margin; A.—the area of the ventral valve; S.—the socket in the dorsal valve for the reception of the teeth of the ventral valve; P.—the Divaricator Process (or lever); D.—the Divaricator Muscle; O.—the Occlusor. It is evident that by the contraction of the Divaricator muscle the extremity of the process P must be drawn towards the point D, and thus the dorsal valve must turn on the hinge at S, (as a door turns on its hinges.) By this movement of course the valves were separated at the front margin M. By the contraction of the Occlusor O, the valves were drawn together. It appears that in most of the *Palæozoic* genera of Brachiopoda the muscular apparatus consisted of these two sets of muscles, but a little modified in different groups.

In *Strophomena* the form of the scars and their distinctness varies to some extent in different species, but their arrangement is in a general way the same in all.

In addition to the muscular scars, the inner surface of many species exhibits numerous radiating branching channels, usually most distinct near the margin. These are the impressions of the vessels of the vascular system.

We shall now notice more particularly some of the variations exhibited by the parts above mentioned in connection with the following proposed genus.

Genus STROPHODONTA.—(Hall.)

In 1847, Mr. Sharpe pointed out that in *Strophomena demissa* there was no foramen, and says: "It will probably be found to indicate a distinct genus, as it must be accompanied with a peculiar internal arrangement. Until this can be ascertained this species may remain in *Leptæna*, the genus to which it is most closely related."*

In 1849, Professor Hall proposed his genus *Strophodonta* (giving *S. demissa* as the type) founding it on the characters pointed out by Sharpe, and adding thereto the following remarks on the interior: "In the interior there are no dental lamellæ margining or surrounding the muscular impressions, which are spread out over a considerable surface in the dorsal valve, shewing partially a double or bilateral arrangement. In the ventral valve there is some indication of a limitation, or marginal elevation, to the muscular impression, but the character is quite distinct from the same in *Leptæna*."†

In 1852, Prof. Hall redescribed the genus, founding it upon the striated area and closed foramen, but gave no internal characters, except, "Muscular impression somewhat bilateral."‡

In 1858, Professor Hall, in the Geology of Iowa published the following more detailed description of the internal characters:

"In the ventral valve the teeth are much reduced or nearly obsolete, a central more or less prominent bilobed process usually occupying the centre of the area in place of the triangular fissure of STROPHOMENA. Muscular impressions strongly marked, semielliptical or subreniform, separated in the middle by a depressed line, and sometimes margined by a semicircular ridge, which is an extension of the lamellæ from either side. Vascular impressions foliate or flabellate, extending beyond the areas towards the base of the shell.

"Dorsal valve with the muscular and vascular impressions strongly marked: cardinal process bifurcate from the base, with each branch bilobed at the extremity, *by which it is articulated to processes beneath the area of the opposite valve*, receiving between its forks the cardinal process of the opposite or ventral valve, which is bilobed or grooved for the passage of the peduncle. Entire interior surface papillose."§

I hold that the above is simply a description of the internal characters of the genus *Strophomena* with the exception of the passage that I have put in italics, which contains a statement decidedly incorrect. We have a number of specimens of *S. demissa*, *S. inæquistri-*

* SHARPE, in *Quar. Jour. Geol. Society*. Vol. 6, p. 172.
† HALL. In Proc. Am. Ass. 1850, p. 348.
‡ Pal. N. Y. Vol. 2, p. 63.
§ HALL. Geology of Iowa. Vol, I., Part 2, p. 491.

*ata* and *S. ampla*, showing clearly the inside of the area of the ventral valve, and there are no such processes as those mentioned by Prof. Hall. It is also evident that if the Divaricator processes were as he says—articulated to processes beneath the area of the ventral valve—the shell could not be opened at all. The notch and groove in the Divaricator levers are simply the scars or marks of the attachment of the muscle.

The divaricator processes *i. e.* the ("*cardinal process bifurcate from the base*") occur in all species. of *Strophomena*, and are not peculiar to those which he has placed in his genus *Strophodonta*. They vary a good deal in their form in different species. The most ancient species in which I have seen them is *S. filitexta*. The following Fig. 106 represents their form in this species, and it will be seen that they differ only specifically from those of *S. demissa*.

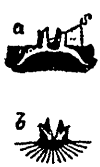


Fig. 106.

Fig. 107.

Fig. 106. *S. filitexta.* *a* Divaricator processes, front view. *b* Viewed from the outside, shewing the groove. The specimen is from the Black River Limestone. *s.* The dental sockets.

Fig. 107. *S. demissa.* Copied from Geology of Iowa, Pl. 3, fig. 5. *c*—Divaricator processes, front view. *d*—The same viewed from the outside.

The specimen of *S. filitexta*, from which the above fig. 106 was drawn, does not show the occlusor muscular scars, and in fact the interior of the dorsal valve is rarely so preserved as to shew them. In *S. rhomboidalis* and *S. Philomela*, the divaricator processes consist of two short ridges, abruptly terminated on the side of the area, their extremities not elevated above the surface of the shell, and if the length of the processes were of generic importance, then these two species would belong to a genus distinct from *S. filitexta* and *S. demissa*.

As to the muscular impressions, the following figures will show that, although they are subject to considerable modifications of form, their arrangement does not vary.

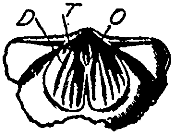



Fig. 108.

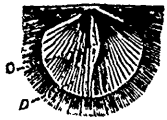



Fig. 109.

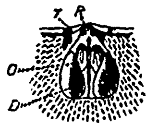



Fig. 110.

Fig. 108.—Represents the muscular scars in a specimen of a species closely allied to, if not identical with *S. alternata*. It is from the Black River Limestone, Pallideau Islands Lake Huron. The scars are deep, and well defined. O.—the occlusors. D.—the divaricators. T.—the teeth.

Fig. 109.—*S. alternata*. Hudson River group. The scars not well defined.

Fig. 110.—*S. Philomela*. Middle Silurian. The scars well defined. R.—the rostral septum, rudimentary. O.—occlusors. D.—Divaricators.

When these are compared with Fig. 103, it will be seen that, although there is some difference in form, the arrangement of the muscular apparatus is the same, *i. e.*, the divaricators outside, and the occlusors between them.

The same rule holds good with respect to the occlusors. In all the species (in which they have been observed) they are arranged in two pairs, one pair on each side the median line, and yet they differ in form according to the species. Even in different individuals in the same species they differ. Thus Fig. 107 differs from 104. Both of the figures differ from that given by Davidson in the *Geologist*, Vol. 2., pl. 4, fig. 15, which was drawn from a specimen procured from Prof. Hall, and all of them differ from a specimen in my possession—from the Hamilton Shales of New York.

With respect to the foramen, the specimens in our collection, and the figures given by various authors, show that there has been a gradual change in the size of the orifice.

1.—Silurian. Most of the species with the foramen large, its width greater than the height. Ex.—*S. alternata*, *S. filitexta*, *S. planoconvexa*, &c.

2—Devonian. Most of the species with the foramen very narrow, sometimes reduced to a mere line across the area of the ventral valve, and in some entirely absent. Ex.—*S. inæquistriata*, *S. ampla*, *S. demissa*.

In comparing the fine series in our collection (embracing species from every formation, from rocks holding Primordial Trilobites up to the Corniferous), and also the figures given by Barrande, De Verneuil, Davidson, Hall, and others, it is clear that in the size of the foramen there is every shade of gradation from an aperture two lines wide down to nothing. I hold, therefore, that the size of the foramen is too variable to be of value as a generic character.

The same gradation occurs also in the extent to which the hinge line is crenulated.

1.—LOWER SILURIAN.—Most of the species with the hinge-line and teeth smooth.

2.—MIDDLE AND UPPER SILURIAN.—Most of the species with the teeth or a small portion of the hinge-line next the foramen striated. Ex. *S. Leda. S. Philomela. S. euglypha, &c.*

3.—DEVONIAN.—Most of the species with a large portion or nearly the whole of the hinge-line striated.

The striation of the area appears to have kept pace with the diminution of the foramen; the one gradually increasing from the Silurian upwards to the Devonian and the other as gradually diminishing.

The striated hinge-line and area is not peculiar to *Strophomena. Leptæna transversalis* and *Chonetes hemispherica* exhibit the same character, although most other species of these two genera do not.

For the above reasons and also because there is no difference in the form of the shell, I hold that the genus *Strophodonta* is quite superfluous.

*Number of species of Strophomena.*

On examining the various Reports of the Geological Surveys of the neighbouring States, I find that SEVENTY-THREE species have been named as occurring in the Upper Silurian and Devonian Formations of these countries. According to my view, this number must be greatly reduced. I do not think there can be more than twelve or fifteen. In Canada West I can only recognize nine species in the Oriskany Sandstone, Corniferous Limestone and Hamilton group, and three of these, *S. magnifica, S. magniventra* and *S. Pattersoni,* may be only varieties, the first two of *S. perplana* and the last of *S. inæquistriata.*

STROPHOMENA RHOMBOIDALIS.—(Wahlenburg).

LEPTÆNA DEPRESSA + STROPHOMENA DEPRESSA + LEPTÆNA RUGOSA + STROPHOMENA RUGOSA + LEPTÆNA TENUISTRIATA? + PRODUCTA DEPRESSA + P. ANALOGA, &c. Either wholly or in part, of the generality of authors.*

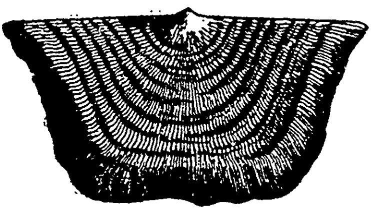


Fig. 111.

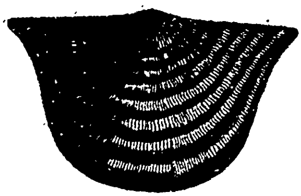


Fig. 112.

Fig. 111.—*Strophomena rhomboidalis*, with the front straight.
Fig. 112.—The same with rounded front.

*Description.*—Rhomboidal or irregularly semi-oval, widest on the hinge-line, occasionally somewhat square: visceral disc strongly corrugated by from nine to fifteen deep undulating concentric wrinkles; both valves abruptly bent at one-half or two-thirds the length to form a broad margin deflected towards the dorsal side. In the ventral or convex valve the disc is nearly flat, but with a small portion in front of the beak gently tumid. The curvature of the dorsal valve conforms very nearly to that of the ventral. Area of ventral valve narrow, seldom exceeding half a line in width; the dorsal area still narrower; the two areas inclined towards each other at an angle which varies from 30° to 60°. Foramen of ventral valve large, triangular, wider than high, partly filled by the two projecting extremities of the divaricator processes of the dorsal valve. Surface covered with fine crowded striæ of a nearly equal size throughout, five or six in the width of one line.

In the interior of the ventral valve the muscular impressions occupy a subcircular cavity which is about one-third the length of the valve and is bordered by an angular slightly elevated margin. The divari-

* Prof. Hall is desirous of having this species called *S. rugosa*, and says that he has seen specimens of it labelled under that name in Rafinesque's hand-writing. But according to the laws of scientific nomenclature, manuscript names cannot be recognized at all. The first published specific name is (*rhomboidalis*), and this must be retained. The figure of *S. rugosa*, published by De Blainville as the type of the genus, in 1825, in the *Manuel de Malacologie*, certainly does not represent this species.

cators are situated one on each side, and the occlusors (seldom well defined) between them. The form of these scars appears to be at first sight somewhat different from that of *S. inæquistriata* but on a little examination it will be seen that the general arrangement is the same and the form only specifically different. On each side of the foramen is a single short tooth.

In the interior of the dorsal valve the divaricator processes consist of two short elevated ridges terminating abruptly just over the area, their extremities not elevated, and free as they are in *S. demissa.* They are separated in some specimens (but not in all) by a deep oval pit. On each side is seen a small oblique socket or pit for the reception of the tooth of the opposite valve. Just in front of the divaricator ridges are the two small scars of the occlusor muscles, each scar divided into two by an oblique ridge not often well developed, but distinctly seen in a beautiful specimen now before me. These scars are small, each pair occupying a space only one line in length and breadth in a specimen one inch wide. The two pairs of scars are separated by a low mesial ridge, which in some specimens becomes a thin elevated septum towards the front of the shell. The vascular impressions are only well marked round the margin.

Width from one-inch to one-inch and a-half; length about one-third less than the width.

Specimens two inches wide sometimes occur.

*Affinities.*—This wonderful species has no near relatives in the Devonian rocks. By the form and structure of its foramen, divaricator processes and muscular impressions, it is clearly a Lower Silurian type belonging to the group, which includes *S. alternata,* and its varieties *S. deltoidea* and *S. tenuistriata* (Pal., N. Y., Vol. 1). It commenced its existence just at the close of the Lower Silurian period, or perhaps a little earlier, and lived on, with scarcely any change through the immeasurable ages of the Middle and Upper Silurian and Devonian, and even until the Carboniferous was well advanced.

*Locality and formation.*—Occurs at nearly all the localities of the Oriskany Sandstone, Corniferous Limestone and Hamilton group in Canada West. Also in all the older formations down to the top of the Hudson River group.

*Collectors.*—A. Murray, E. Billings, J. De Cew, E. De Cew, Judge Wells, Chatham, Wm. Saunders, London.

STROPHOMENA INŒQUISTRIATA.—(Conrad.)

STROPHOMENA INŒQUISTRIATA —Conrad. *Journal of the Academy of Natural Sciences of Philadelphia* Vol. 8, p 254. Pl. 14, fig. 2, 1839. Also compare the descriptions and figures in the same work of S. CREBRISTRIATA; S VARISTRIATA; S. RECTILATERIS and S. IMPRESSA.—Conrad. Also, S. VARISTRIATA; and S. VARISTRIATA, *var.* ARATA.—Hall. *Pal. N. Y.* Vol. 3, p. 180, 184. Also the following in the 10th Ann. Rep. Regents N. Y. Univ., S. INŒQUIRADIATA; S. TEXETILIS and S. CONCAVA. —Hall.

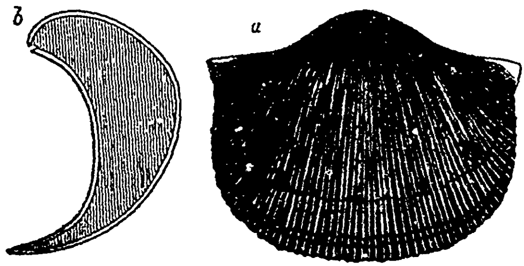



Fig. 113.

Fig. 113.—*Strophomena inæquistriata.*—Ventral view of one of the forms of this species b., longitudinal section.

*Description.*—Semi-circular, semi-oval, or sub-triangular, width on hinge-line varying from one to three inches; length from two-thirds to seven-eighths of the width; cardinal angles compressed, forming rounded or acute ears which are more or less extended. Ventral valve varying greatly in the amount and in the form of its convexity; usually with the visceral disc depressed convex and the margin all round abruptly curved down for one-third or one-half the whole length of the shell; sometimes the shell uniformly arched from beak to front; the umbo often so greatly developed as to overhang the hinge-line and bring the area under the body of the shell; in other specimens the convexity of the umbo is continued along the middle to the front, producing a broad mesial carination; in many the front is greatly produced in a gradual slope from the anterior margin of the disc, and occasionally we find specimens with the front margin so much curved as to be to some extent inrolled under the shell; in all the umbo is more or less prominent, there being a somewhat flat or depressed sub-concave space of greater or less extent on each side extending to the cardinal angles. The dorsal valve is usually not so much curved as the ventral, thus leaving a comparatively large space for the animal.

Area of ventral valve from one-fourth of a line to one line in width, flat or concave, obliquely striated all except about one-tenth the length at each extremity, a wide shallow notch on the edge, in the middle of which is the foramen. Dorsal area about half-a-line wide and not so variable in its dimensions as is the ventral.

Fig. 114.

Fig. 114.—A fragment of the ventral area natural size, showing the foramen and the wide notch in the edge of the area.

Foramen small, linear, closed, usually about one-fourth of a line wide, sometimes less. Teeth rudimentary, and situated one on each side of the foramen on the edge of the area. Cavity of the beak divided into two compartments by a rather strong rostral septum.

In the interior of the ventral valve the divaricator scars are large, sub-pyriform, and one-third the length of the whole shell. The occlusors are ovate, half the length of divacirators, often with the surface covered with minute corrugated wrinkles like the scars of some species of *Producta*. The vascular impressions are well marked on some of the casts of the interior, but vary in the number of the branches, usually from three to five in the width of one line at the margin. In thin shelled individuals they are not seen at all. Interior of dorsal valve not observed.

Surface very variously striated. In some the striæ alternate in size, there being one set of fine sharply elevated lines distant from half a line to one line from each other, the intervening spaces flat and with from three to seven finer striæ just visible to the naked eye; in others the intervening spaces are concave. In many the principal striæ become coarser and closer together until the whole surface is covered with strong angular bifurcating ridges from one-fourth of a line to half a line in width. In very well preserved specimens of these latter, the coarse ridges are seen to be themselves ornamented with the fine longitudinal striæ. In all cases the whole surface when perfectly preserved, is beautifully cancellated by minute crowded concentric striæ.

*Affinities of this species.*—This species belongs to a type which appeared in the lower Silurian seas, and is found more or less abundantly in every formation from the Chazy up to the Chemung group. Many of the Devonian specimens so exactly resemble some of the varieties of *S. alternata*, the dominant species of the Trenton and Hudson River group, that were it not for the striated area and nearly obsolete foramen, they could not be separated therefrom. The general form, striation of the surface, and some of the internal markings are so nearly the same, that one can scarcely help thinking that those we find in the Devonian rocks are the lineal descendants of those with which the lower Silurian strata are crowded. Professor Hall's description of *S. varistriata* of the Lower Helderberg rocks, of New York, applies exactly to this species (See Pal. N. Y., Vol. 3, p. 180–184) the only difference being that the specimens are in general smaller. I think that on comparison of good series of specimens that species may yet be united to this, or perhaps all those above cited may be united under one name *S. varistriata*. Should only the Devonian varieties be united I think they should all be referred to *S. inæquistriata*, as that form has been more extensively described and illustrated by Conrad and Hall than any of the others.

*Locality and formation.*—Oriskany Sandstone; Corniferous Limestone; and Hamilton Group at nearly all the localities of these rocks in Canada West.

*Collectors.*—A. Murray; J. Richardson; J. De Cew; E. De Cew; Wm. Saunders, London, and Judge Wells, Chatham.

### Strophomena Patersoni?—(Hall.)

Strophomena Patersonia.—Hall. Tenth Annual Report of the Regents of the University of New York.

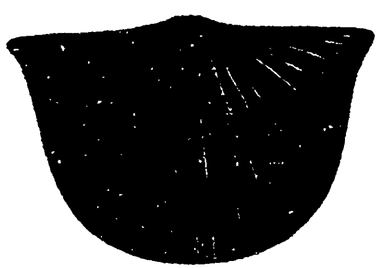


Fig. 115.

Fig. 115. *Strophomena Patersoni* Ventral view.

This species has all the characters of *S. inæquistriata*, the only difference being that the surface is marked by numerous concentric wrinkles. I retain the name for the present provisionally, but have strong doubts as to its claims to rank as a distinct species. The shells are always thin, with two sets of radiating striæ, the stronger ones distant from one-fourth of a line to one line, and with from three to twelve very fine ones between.

*Locality and formation.*—Oriskany Sandstone, and Corniferous limestone. County of Haldimand.

*Collectors.*—J. De Cew; E. De Cew.

STROPHOMENA DEMISSA.—(Conrad.)

STROPHOMENA DEMISSA.—Conrad. *Journal of the Academy of Natural Sciences of Philadelphia.* Vol. 8, p. 258, pl. 14, fig. 14, 1839. STROPHOMENA or STROPHODONTA DEMISSA.—Hall, in various works. Compare also S. SUBDEMISSA.—Hall. Tenth Ann. Rep. Regents, N. Y. Univ. p. 145, and S. ARCUATA.—Hall. Geology of Iowa. Vol. 1. Part 2, p. 492, Plate 3, fig. 1, *a, b, c, d,* 2. *a, b, c.*

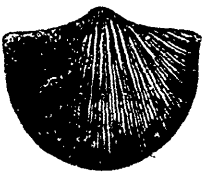


Fig. 116.

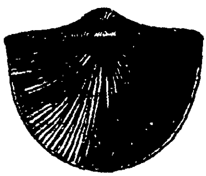


Fig. 117.

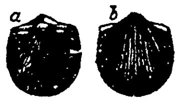



Fig. 118.

Fig. 116.—One of the forms of *S. demissa*, ventral view.
Fig. 117.—The same specimen, dorsal view.
Fig. 118.—Two views of a very small specimen.

*Description.*—Semioval, subquadrate or subtriangular; hinge line equal to, greater or less than the width of the shell; cardinal angles often forming extended or short acute ears; in some specimens the sides and front margin are uniformly curved, giving the semioval form represented above, (fig. 116); in others the sides are somewhat straight and parallel for two-thirds of the length, and the front margin broadly rounded, approaching the subquadrate aspect; others are rounded subtriangular, the hinge line being extended and the front narrowed, while some have the greatest width in the front half. The width varies from a little less to one-third greater than the length.

The most common size is from one inch to one inch and a half in width, but very small specimens of from four to twelve lines are often found.

The ventral valve is in general rather strongly convex, uniformly arched from beak to front, sometimes a little flattened in the central region; the umbo small, rounded but prominent, overhanging the area, the shell on each side depressed or subconcave towards the cardinal angles; in some a broad obscure carination extends from the umbo along the middle to the front, with an obscure longitudinal depression on each side.

Dorsal valve moderately concave, usually with a shallow mesial sinus commencing in a point at the beak and growing wider towards the front.

Area of ventral valve in some specimens broad and somewhat flat: usually narrow; often concave beneath and on each side of the beak, either striated the whole length, or with a very small portion at the cardinal angles smooth. Dorsal area not so variable as the ventral; the two areas inclined to each other at an angle which varies from less to greater than a right angle, according to the degree of curvature of the beak of the ventral valve.

No foramen; a smooth triangular space beneath the beak on the area of the ventral valve.

Surface with from ten to fifteen coarse angular ridges on the umbo of the ventral valve which bifurcate several times, and become smaller towards the front margin. In some small specimens the ribs do not bifurcate.

In the interior of the ventral valve the muscular scars are of the same type as those of *S. inæquistriata*, but the occlusors are proportionally nearer the beak. In the dorsal valve the occlusors are situated in the upper one fourth of the length of the shell; they are divided by a median ridge which sometimes is much elevated about the middle of the shell. There are usually two or three large tubercles or short curved ridges just in front of the impressions. In thick shelled specimens, the scars, median ridge and tubercles form a group occupying an oval space which extends nearly half the length, and is narrowed to a point below. In some there is a large space around the muscular area covered with small tubercles; in others this space is smooth. The vascular inpressions are only well marked near the margin.

*Affinities and varieties.*—This species stands nearer to *S. inæquistirata* than to any other. It differs from that species in the absence of a foramen, in the area being striated the whole length, in being more uniformly convex, and in the characters of the surface. There is little variation in the aspect, although the general contour differs somewhat. The ventral area varies from half a line to two lines wide, being almost linear in some specimens, and in others so wide as to give a low triangular form. In general the specimens from the corniferous limestone are smaller than those of the Hamilton group. I have seen none from the former rock more than one inch and a quarter wide; but many from the last mentioned formation with a breadth of one inch and a half.

*Locality and Formation.*—In most of the localities of the corniferous Limestone in Canada West. As yet, we have found none in the Hamilton group in Canada. My comparisons have been made altogether with specimens from the Hamilton shales of New York.

*Collectors.*—E. De Cew, J. De Cew, E. Billings.

STROPHOMENA PERPLANA.—(Conrad).

STROPHOMENA PERPLANA and S. PLURISTRIATA.—(Conrad). *Journal of the Academy of Natural Sciences of Philadelphia.* Vol. 8., p. 257–259. Pl. 14, fig. 11.

S. CRENRISTRIA and S. FRAGILIS.—(Hall). *Tenth Annual Report of the Regents of the University of the State of New York.* P. 111–143.

*Description.*—Nearly flat; covered with fine, equal radiating striæ. Width on hinge line from one to two inches; length varying from a little more to one-fourth less than the width. In form, the shell is usually semioval—the front regularly rounded; sometimes the sides are suddenly constricted just beneath the cardinal angles; often the sides are nearly straight and parallel for half the length, then uniformly rounded to the fronts; some have the front rather straight, giving a subquadrate aspect. The ventral valve is slightly convex, most elevated at about one-fourth or one-third from the beak, flattened towards the hinge line, often with a few obscure irregular concentric wrinkles. Dorsal valve gently concave. Area of ventral valve about one line wide at the beak, slightly concave. Area of dorsal valve about half the width of the ventral—the two areas inclined towards each other at an angle of about 90°. Both areas striated. No foramen.

Surface covered with fine equal striæ; from six to nine in the width of one line; these are crossed by fine concentric striæ eight to twelve in one line. The radiating striæ increase both by subdivision and intercalation of new ones between the old; they are often irregularly undulated, and the surface of the shell has thus a somewhat minutely uneven surface. In some specimens, however, this character is not apparent.

In the interior of the ventral valve the muscular impressions occupy a large sub-triangular depression in the substance of the shell. This is about a line wide at the hinge line, from which point the sides of the depressed space are nearly straight, and diverge outwards at an angle of about 45° to the median line of the shell. The depression gradually disappears, so that it is difficult to define its front margin. Still, in very well preserved specimens, it can be seen that the divaricators are of an elongate oval shape, and that they extend more than half the length of the shell; the occlusors are elongate oval, and situated close to the hinge line, their length one-third of that of the divaricators. These latter are sometimes divided into several lobes by thin, slightly elevated, longitudinal ridges. On each side of the muscular cavity, near the hinge, the shell is covered with small tubercles.

This species is so easily recognized by its flat form and evenly striated surface that a figure of it is unnecessary.

Although it has received a separate name for every formation in which it occurs, yet I cannot make out the slightest difference between the specimens of the Oriskany Corniferous and Hamilton rocks. I think, also, that *S. magnifica* of Hall is only a large variety of this species.

*Locality and Formation.*—Oriskany Sandstone, Corniferous Limestone, in County of Haldimand. Hamilton Shales, Township of Bosanquet.

*Collectors.*—E. De Cew, J. De Cew, E. Billings.

STROPHOMENA LEPIDA.—(Hall).

STROPHODONTA LEPIDA.—(Hall). *Geology of Iowa.* Vol. I., part 2, p. 493. Pl. 3, figs. 3*a*, 3*b*, 3*c*. 1858.

Compare S. NACREA.—(Hall). *Tenth Annual Report of the Regents of the New York University*, p. 144. Also, S. LEPIS.—(Bronn). *Lethæa geognostica*, 3rd edition. Vol. I., p. 367. Atlas. Pl. 2, figs. 7, a, b, c.

*Description.*—Shell small, smooth or scaly, no radiating striæ, about three-fourths of an inch wide, half an inch long, sub-semicircular, or sub-quadrate, usually rounded in front, cardinal angles either rounded or auriculate. Ventral valve rather uniformly convex, cardinal angles compressed, rarely preserved, but when they are, a little reflected. Dorsal valve concave. Area of ventral valve half a line wide, lying in the plane of the lateral margin; when perfect, longitudinally striated, or nearly smooth; when a little worn, shewing obscure vertical striæ; edge of the area serrated. Area of dorsal valve half the width of the ventral, with a row of small tubercles on the outer edge, and a corresponding row of small pits on the inside. No foramen.

Internal surface of dorsal valve covered with small tubercles, usually about half a line apart; occlusor scars (in a specimen nine lines wide) situated one line from the hinge, each scar longitudinally divided by three elongated tubercles; one line below each scar there is a prominent oval tubercle; half way between these are two others on the median line. The divaricator processes are two short stout projections. with their extremities notched, and the upper side grooved. I have not seen the interior of the ventral valve.

This species is probably only a variety of *S. lepis*, Bronn, of the Devonian rocks of Europe. It is easily recognized by its surface, which is destitute of radiating striæ.

*Locality and Formation.*—Corniferous Limestone, County of Haldimand. Township of Bosanquet, in the Hamilton Shales.

*Collectors.*—E. De Cew, J. De Cew, J. Richardson.

### STROPHOMENA AMPLA.—(Hall.)

STROPHOMENA AMPLA.—Hall. *Tenth Annual Report of the Regents of the University of the State of New York*, p. 112, 1857.

Compare S. PUNCTULIFERA.—Conrad, S. HEADLEYANA.—Hall, S. CAVUMBONA.—Hall, S. LEAVENWORTHANA.—Hall, and S. GENICULATA.—Hall, all in the 3rd Vol. of the Palæontology of New York.

*Description.*—Shell, large; from two to three inches wide on the hinge line; length from two-thirds to four-fifths the width; ventral valve concave, with a gentle convexity in the region of the umbo; often with a wide rounded mesial ridge, extending from the beak to the front margin. Dorsal valve convex, with a large, flat or gently concave space just in front of the beak; sometimes with a shallow rounded mesial sinus extending from beak to front. Area of ventral valve varying from one to three lines in width at the beak; varying

Fig. 119.

Fig. 119 —STROPHOMENA AMPLA.—Hall. Dorsal Valve.

also in the amount of its inclination to the plane of the lateral margin from 90° to 120°; obliquely striated for one-third or one-half the distance between the foramen and the cardinal angles. Area of dorsal valve smaller than the ventral, of nearly a uniform width throughout, usually about half a line wide. Foramen small, linear closed, one-third of a line in width. From the point where the striation is discontinued the edge of the area of the ventral valve has a distinct narrow groove extending to the cardinal angle.

Surface with moderately fine, somewhat equal, sharp, irregular striæ, which bifurcate several times before reaching the margin; the number also increasing by interstitial addition; crossed by small concentric striæ, which are usually more distinct in the spaces between the radiating striæ. The radiating ridges are sometimes of a uniform size all over the shell, six to eight in the width of two lines; in others larger near the beak than towards the margin, diminishing in size from three or four in two lines at the beak, to six or eight in the same width at the margin. The surface characters are very variable within a small limit, but the general aspect is that of a sharp or angular somewhat rugose striation. When the shell is partially exfoliated, it is seen to be perforated along the bottom of the grooves between the radiating ridges by small circular or oval pores, of which there are from two to seven in the length of one line. These are indicated on the inner surface of the shell by irregular rows of small tubercles. It is probable that when perfect the surface is always covered with small spines, as seen in the following figure.

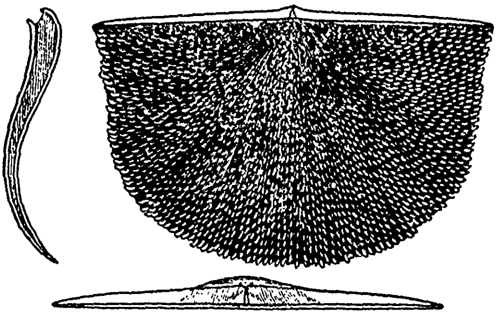


Fig. 120.

Fig. 120. *S. Ampla.*—Dorsal view of a specimen covered with spines, from the Corniferous Limestone. The lower figure shows the area and foramen; the left hand figure, the longitudinal section.

In the specimen above figured the spines are seated upon the crests of the radiating ridges. They are about two-thirds of a line in length, slightly curved, and appear to be tubular. They do not seem to have any connection with the pores of the shell, as these are situated, not on the radiating ridges, but in the grooves between them. In the interior of the ventral valve the muscular scars have very nearly the shape of those of *S. inæquistriata*, except that they are proportionally broader. The divaricators are divided into four or five longitudinal concave lobes by as many obscure ridges. At their anterior margins the shell is thickened so as to make a sort of elevated border. The rostral septum is, in some specimens, rudimentary, in others, well developed. The whole of the internal surface appears to be covered with small tubercles. These leave punctures in the cast of the interior.

I have only partly seen the interior of the dorsal valve. The divaricator processes resemble those of *S. demissa.*

*Affinities and variations.*—This species has in general a semicircular or broad semioval contour, but it sometimes approaches the triangular form from being narrowed towards the front. The form of the curvature of the valves is subject to innumerable modifications; the only constant curves being the general ones above stated. I think all the specimens in our collection from the Oriskany Sandstone, Corniferous

Limestone, and Hamilton Group, constitute but one species. The only variation that could be regarded as of specific importance are those of the area of the ventral valve above mentioned. In four of our specimens it forms a right angle to the plane of the lateral margin. In several others it forms an angle of about 120°, and taking these extremes it might well be thought that there are two species. But we have one fine specimen in which the angle is about 100°. I therefore think that this is not a variation of specific value.

In all the more general characters this species is precisely identical with *S. punctulifera,* (Conrad) and those allied therewith, which I have cited above from the 3rd vol. of the Pal. N. Y. The corniferous specimens are, upon an average, larger than those figured by Prof. Hall from the Lower Helderberg. This, however, of itself would not be of specific value. The only doubt I have as to the identity of this species with *S. punctulifera* rests upon the characters of the foramen of this latter. It is (at the time of writing this) not figured, but Prof. Hall thus describes it:[1] "*Foramen nearly closed, with a narrow prominent callosity along the centre.*" In *S. cavumbona,* he says, "*Foramen small, narrow, closed by a callosity.*" In *S Headleyana,* "*Foramen narrow, closed.*" In *S. Leavenworthana,* "*Foramen small, triangular, closed in full grown individuals.*" As there thus appears to be some difference, I strongly suspect that a series might be made out showing a gradation in the size of the aperture in all the above named species. In such poor specimens of the Lower Helderberg species as I have before me, the foramen cannot be observed at all. The surface characters and the form seems to me to be the same, and for the present it should be left an open question whether or not *S. ampla* is distinct from *S. punctulifera.*

*Locality and Formation.*—County of Haldimand, in the Oriskany Sandstone and Corniferous Limestone, Township of Bosanquet, in Hamilton Group.

*Collectors.*—A Murray, J. De Cew, E. De Cew, E. Billings.

### STROPHOMENA MAGNIFICA.—(Hall).

This is a large, nearly flat species, three or four inches wide. It resembles *S. perplana.* Our specimens are all very imperfect. It occurs in the Oriskany Sandstone, County of Haldimand.

### STROPHOMENA MAGNIVENTRA.—(Hall).

Of this species, I have only seen some fragments, shewing casts of the area of the ventral valve and muscular impressions. It appears to be closely allied to *S. magnifica,* and occurs in the rock in the same localities.

The specimens of these two species in our possession agree exactly with Professor Hall's figures. I am endeavouring to procure materials to illustrate them properly.

### *Genus* CHONETES.—(Fischer).

This genus differs from *Strophomena* in some internal characters, which cannot be very well described without the aid of good illustrations. The shells are in general much smaller than those of *Strophomena:* they are more evenly striated, and the cardinal edge of the ventral valve usually displays a row of small slender spines, which become gradually longer towards the angles. The area and foramen are similar to those of *Strophomena,* as are also (very nearly) the muscular impressions and divaricator process of the dorsal valve. The valves articulate by teeth and sockets, and in one species (*C. hemispherica*) the area of the ventral valve is striated.

Between twenty-five and thirty species have been described as occurring in the Devonian rocks in the neighbouring States, and it is thus almost certain that the four or five which occur in Canada include no form that has not been named. At present, I can identify only one.

### CHONETES HEMISPHERICA.—(Hall).

CHONETES HEMISPHERICA × C. ARCUATA.—Hall. *Tenth Annual Report of the Regents of the University of New York,* p. 116-117.

Fig. 121. Fig. 122. Fig 123.

Fig. 121.—*Chonetes hemispherica,* drawn from the largest specimen seen. Fig. 122.—View of the ventral valve. A portion of the ventral area, shewing the striation and the bases of five species. Since this figure was engraved, other specimens have been procured, shewing seven and eight spines. Fig. 123.—Longitudinal section, shewing the curvature of the ventral valve. [The dotted line representing the dorsal valve; conjectural, the valve not having been seen.]

*Description.*—This species resembles in shape some of the forms of *S. inæquistriata*, but it can always be distinguished therefrom by the surface, which is covered with fine crowded, rounded or sub-angular striæ of an uniform size, from eight to ten in the width of one-fifth of an inch, presenting that even aspect peculiar to the genus *chonetes*, and rarely exhibited by species of *Strophomena*.

The ventral valve is usually extremely convex, most prominent in the upper half; the umbo large—obtusely rounded, overhanging the hinge line; the cardinal angles compressed, reflected, forming short projecting scars; on the cardinal edge from five to eight small spines, rarely preserved, their bases only being visible. Area of ventral valve, in old specimens, owing to the extreme incurvation of the cardinal portion of the shell, inverted or brought under the body of the shell at right angles to the plane of the margin; in young specimens not so much inverted; its width about half a line, or a little more; obliquely striated, the striæ most distinct at the hinge line. Area of dorsal valve, very narrow—almost linear, the inner edge with a row of small pits for the reception of the serrated teeth of the opposite valve.

The width of this species is usually about one-inch on the hinge-line but it sometimes attains the size of one-inch and a half. Length equal to, .. one-third less than the length.

The dorsal valve is seldom found, although the ventral valve is somewhat common. Of the former I have seen only two fragments, consisting of the hinge-line and a portion of the shell. One of these was in its natural connection with the ventral valve, and being silicified came away on immersion in acid; the divaricator processes are united at the base and separated above by a narrow fissure; they are grooved on the outside, the grooves converging towards the hinge-line so that when viewed from the side of the area they have the appearance of four small radiating ridges.

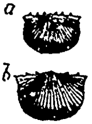
The muscular impressions and foramen have not been observed by me. The triangular opening in the area represented by Fig. 121, may be the foramen, but it seems to me to be a fracture.

Prof. Hall describes two species differing from each other in the size of the striæ; in *C. arcuata*, "sixteen occupying the space of one-fifth of an inch, while only one-half that number can be counted in the same space on *C. hemispherica*." (10th Regents, Rep., p. 117). Our specimens agree with the latter.

*Locality and formation.*—Oriskany Sandstone and Corniferous Limestone, County of Haldimand.

*Collectors.*—A. Murray; E. Billings; E. De Cew and J. De Cew.

Other Species of CHONETES and PRODUCTA.



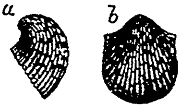




Fig. 124. Fig. 125.

Fig. 124.—Two species of *Chonetes* undetermined.
125.—*Producta.* A small undetermined species. *a.*—Side view. *b.*—View of ventral valve.

Besides CHONETES HEMISPHERICA there are three or four other small species of the genus in the Corniferous Limestone and Hamilton Group in Canada West, but in the present condition of the literature of American Palæontology I cannot determine them. The student is referred to N. Y. Regents' Reports. Fig. 124 represents two species, one with the spines directed obliquely outwards and in the other erect. They are both from the Hamilton Group.

In the Corniferons Limestone we have also two small species of *Producta.* One of these (Fig. 125) is covered with nodular radiating ribs. The other is about the same size as the above but with a smooth tubercular surface.

### Genus LEPTOCŒLIA? Hall.

This genus as described by Professor Hall in the 12th Annual Report of the Regents, published in October or November 1859, seems to differ from *Centronella* only in consisting of species which have the surface ribbed instead of smooth. Professor Hall dates his genus back to 1856, but no description was published until the issue of the 12th Regents' Report and therefore should it be the same as *Centronella* it cannot be retained, as the latter has the priority. For the present I shall use it provisionally, not having seen the internal structure myself.

### LEPTOCŒLIA? FLABELLITES. (Conrad.)

ATYRPA FLABELLITES. (Conrad.) Annual Report on th Palæontology of New York for 1841, p. 55.

LEPTOCŒLIA PROPRIA + L. FIMBRIATA + L. DICHOTOMA.—Hall, in various works.

Fig. 126.

Fig. 126.—*Leptocœlia flabellites.*—Dorsal and side views.

*Description.* Shell semi-elliptical, or sub-circular, or transversely oval. Dorsal valve nearly flat, with from ten to fourteen rounded or sub-angular ribs, one or two of which, in the middle, are usually separated from those on each side by grooves deeper and wider than the others and sometimes depressed so as to give the appearance of a mesial sinus ; hinge-line either nearly straight or with the portions on each side of the beak forming an obtuse angle seldom so acute as 150°. Ventral valve moderately convex, often carinate along the middle, beak small, pointed, incurved down to the dorsal area ; ribbed like the opposite valve.

Width from six to ten lines. Length a little less than the width.

*Locality and Formation.*—Oriskany Sandstone and Corniferous Limestone, County of Haldmand, Canada West, also in prodigious numbers in the Oriskany Sandstone at Gaspé, Canada East.

*Collectors.*—A. Murray ; E. Billings ; E. De Cew ; J. De Cew, in Canada West. Sir W. E. Logan ; J. Richardson ; R. Bell, Gaspé.

## LEPTOCŒLIA CONCAVA. Hall.

Fig. 127.

Fig. 127.—*Leptocœlia concava.* Ventral, dorsal and side views.

*Description.*—Ovate or nearly circular ; length three or four lines ; width equal to, or a little less than the length. Ventral valve convex sub-carinate along the middle. Dorsal valve flat or often concave. Surface with from ten to fourteen rounded radiating ribs.

This species closely resembles the *L. flabellites* but is never more than half the length or width. On comparison with specimens of *L. concava* from the Lower Helderberg of New York, I find so little difference that I do not see how those of the Corniferous Limestone are to be separated. In several the dorsal valve is not so deeply concave as it is in those from the lower rock, but in others it is. The ribs are also in general coarser, but occasionally specimens with fine bifurcating ridges are found exactly like those from the shaly limestone of the Helderberg mountains.

*Locality and Formation.*—Oriskany Sandstone and Corniferous Limestone, County of Haldimand.

*Collectors.*—E. Billings; E. De Cew; J. De Cew.

LAMELLIBRANCHIATA.—(Blainville.)

In the Oriskany Sandstone, Corniferous Limestone, and Hamilton Group of Canada West, we find about twenty species of lamellibranchiate mollusca, mostly in a bad state of preservation. These with several exceptions must remain for future examination. I shall only notice the following at present:

Genus CYRTODONTA.—(Billings,) 1858.

CYPRICARDITES.—Conrad. *Annual Report on the Palæontology of New York*, 1841, p. 51.

MEGALOMUS.—Hall. *Pal. N. Y. Vol.* 2, p. 243. 1852. *Not characterized.*

CYRTODONTA.—Billings. Report of the Geological Survey of Canada, 1858, p. 179. Sub-genus VANUXEMIA, p. 189.

PALÆARCA + MEGAMBONIA—Hall. *Twelfth Annual Report of the Regents of the University of New York*, 1859, p. 10–13. Also CYPRICARDINIA ?—Hall. Pal. N. Y. Vol. 3, p. 266. Not characterized. In part. Also PALÆARCA and MEGAMBONIA in same work. 1861.

*Generic characters.*—Equivalve, inequilateral; umbones near the anterior end; general form obliquely tumid, transversely sub-rhomboidal, ovate or sub-cordiform; posterior extremity larger than the anterior, which latter is often reduced to a small auriculate projection in front of the umbones; two muscular impressions, of which the posterior is superficial, and the anterior sometimes deeply excavated; several linear anterior teeth crossing the hinge plate, backwards and obliquely downwards, usually curved and in some species striated, situated either beneath or a little in front of the umbones; posterior teeth situated at or near the extremity of the hinge line, usually from two to five, elongate; pallial line simple; some of the species with a narrow area between or behind the beaks.

*History of the Genus.*

The somewhat numerous species which belong to this genus, have been variously distributed and shifted about among the genera *Ambonychia, Cardiomorpha, Edmondia, Modiola, Modiolopsis, Megambonia, Palæarca, Cypricardinia, Megalomus,* and *Cypricardites* in a very remarkable manner. Conrad, the first Palæontologist of the New York Survey, placed all the species, (twenty-three in number) described by him in a single genus, and I think that the many changes made by his successor in office, have not been productive of any improvement on that simple arrangement. The following are a few of the facts:

In the fifth Annual Report on the Palæontology of New York, Conrad, in 1841, characterized his genus *Cypricardites* and described sixteen species from the Silurian and Devonian rocks of the State. He did not give any illustrations, but it now appears that he prepared a figure, (shewing the characters of the hinge,) which, however, remained in Professor Hall's hands eighteen years without publication. In the 8th volume of the Journal of the Academy of Natural Sciences, Conrad described seven other species from the Devonian rocks of New York. These are all figured.

In 1847, Professor Hall suppressed the genus *Cypricardites* and substituted his own genus *Modiolopsis,* in which he placed all Conrad's Lower Silurian species. The following are his remarks in a note at the foot of p. 157, Vol. 1. Pal. N. Y.

"I find myself compelled to abandon the use of the name *Cypricardites,* as applied to shells differing so widely as these do from Cypricardia, and belonging apparently to the Monomyaria and Dimyaria. So far as it is possible to ascertain, none of the species of the older strata possess two muscular impressions, and therefore do not strictly fall under the genus *Cypricardites* of Conrad, (Ann. Geol. Report, 1841, p. 51.)"

The principle upon which the above decision was given, is perfectly correct. It is one of the established laws of nomenclature that a name which involves a zoological error (such as referring a genus to the wrong place in the system of classification) should be excluded. The reasons given by Professor Hall for bringing *Cypricardites* within the operation of this law are not so well founded, because both *Modiolopsis* and *Cypricardites* have two muscular impressions. The correct reason is that the name implies a close relationship to the recent genus *Cypricardia,* which belong to the family Cyprinidæ while the species in question constitute a group in the family *Arcadæ.* No Conchologist would think of admitting such a name as *Cypricardites* among the ARCADÆ.*

In 1858, I published the genus *Cyrtodonta* and its sub-genus *Vanuxemia*, and illustrated them fully by figures shewing the internal characters of several species. (See my Report for 1858.) About the same time Professor Hall described the same genus under the names of *Palæarca* and *Megambonia* the latter being identical with my sub-genus *Vanuxemia.* His descriptions were (as he says) printed in 1858, in the 3rd volume of the Palæontology of New York. At the foot of page 270 of that work the reader will find a note on the genus *Cypricardites* which shews very clearly that at the time the author had his new genera under consideration, Conrad's genus was also receiving some attention as it had on several previous occasions. When my Report was published, Professor Hall seeing that his genus *Palæarca* was too late, resolved if possible to revive *Cypricardites* for the purpose of suppressing *Cyrtodonta.* He therefore issued a small pamphlet of 18 pages, (being part of the 12th Ann. Rep. of the N. Y. Regents, in which he gives his descriptions, and in addition thereto a note pointing out the identity of *Cypricardites* and containing Conrad's figure. This probably appeared in May or June 1859, as it is noticed in the July No. of Silliman's Journal of that year. In 1860, the 3rd Vol. of the Pal. N. Y., was published, but without the plates. On page 523 of that work, I find the following statement:

"At the time that my examinations and descriptions of PALÆARCA were made (in 1857,) I had overlooked the genus CYPRICARDITES of Conrad, which was published in the Annual Geological Report for 1841. The description and figure correspond so nearly with the fossils which I have described that I feel compelled to adopt the prior name, which will include those described in this volume under the genus PALÆARCA, as well as those described by MR. BILLINGS under the genera CYRTODON and VANUXEMIA." (Compare the above with the note at the foot of page 270, Pal. N. Y., vol. 3).

As for myself, I must say that when I described the genus *Cyrtodonta*, I was aware of Conrad's description, but considered, as I do now, that the genus (having been suppressed by Professor Hall, and never acknowledged by palæontologists, or quoted by them except as

* See DANA in Silliman's Journal, 2nd Series, Vol. 28, p. 149. 1859.

a synonim) was perfectly obsolete. And as the name is decidedly inappropriate, I hold that it cannot be restored now.

I shall, in conclusion, direct attention to the uncharacterized genus, *Megalomus*. This name was proposed by Professor Hall in the 3rd volume of the *Pal.*, N. Y., as a generic appellation for a species which is a true *Cyrtodonta*. I have ascertained that it has the same curved anterior teeth, and although I have not seen the posterior teeth, there is not the least doubt but that they do exist. Now, it might be thought that *Megalomus*, having priority over *Cyrtodonta*, should take its place. I contend that this would not be the correct or the just course. In Professor Hall's description he has "overlooked" the generic characters, and only given those which are specific. All that he has described is not sufficient to constitute a genus. The best proof of this is, that the author cannot recognize it himself, as he has since described two other genera, *Palæarca* and *Megambonia*, which, if retained, would include *Megalomus*. I have been the first to describe correctly and illustrate this genus under a name that is in no respect inappropriate, and I have a right to retain that name against those which are objectionable or not founded on an intelligible generic description. I further consider *Megalomus* an inconvenient name, because it so closely resembles *Megaloma*, a genus of Gasteropods.

*Sub-genus* VANUXEMIA.

Fig 128.

Fig. 128.—*Vanuxemia Bayfieldii*—Billings, shewing the interior of left valve.

This sub-genus was proposed by me, to include those species of *Cyrtodonta* which have the beaks terminal, or nearly so, and the anterior extremity reduced to a small auriculate expansion or obsolete. The above figure shews the teeth and muscular impressions of *V. Bayfieldii,* Hudson River Group.

VANUXEMIA TOMKINSI.—(N. Sp).

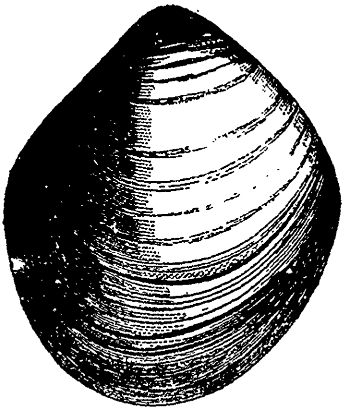


Fig. 129.

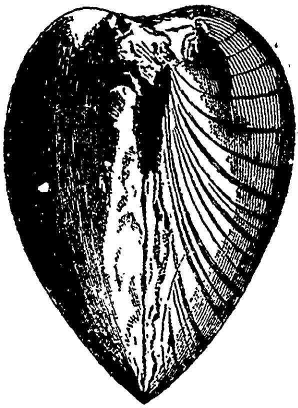


Fig. 130.

Fig. 129.—*Vanuxemia Tomkinsi.*—View of right side.
Fig. 130.—View of anterior side.

*Description.*—Ovate, exceedingly gibbous, cordiform; umbones very prominent; beaks closely incurved.

Placing the shell with the hinge-line in a horizontal position, we find that the line passing through the greatest length of the shell forms an angle with it (*i.e.* with the hinge-line) of about 45°; the apical angle, or the angle formed by the slope in both directions from the umbones is about 80°; both of these slopes extend about half the length of the whole shell; from their extremities the remainder of the margin on the posterior, ventral and anterior sides is rounded, somewhat pointed in the middle. At the anterior extremity of the hinge-line there appears to be a small auriculate projection, but this point is not very well preserved in the specimen.

Surface somewhat smooth, with obscure, concentric striæ, three or four in the width of one line. Besides these there are some obscure, shallow, concentric, undulations of growth.

The best preserved specimen is two inches and one-eighth in length —measuring from the umbones to the most projecting or pointed part of the margin below. The greatest width (which is at mid-length, and nearly at right angles to the greatest length) is one inch and three quarters. Depth of both valves, at a little above the middle, one inch and a half. The umbones are elevated nearly half an inch above the hinge-line. The whole shell is pretty evenly convex, with a slight approach to a concave slope in front of the umbones. There appears to be an area, but our specimens do not shew it with sufficient clearness to warrant a positive opinion.

This species is dedicated to the discoverer, W. G. Tomkins, Esq., C. E. St. Mary's, Canada West.

*Locality and Formation.*—Corniferous Limestone, St. Mary's.

*Collector.*—W. G. Tomkins.

GASTEROPODA.—(Cuvier.)

We have in the Devonian Rocks of Canada West about 25 species of Gasteropoda of the genera *Euomphalus, Straparollus. Murchisonia, Pleurotomaria, Loxonema, Macrocheilus, Platyostoma and Platyceras.* Of these I shall only notice the following at present.

EUOMPHALUS DE CEWI.—N. Sp.

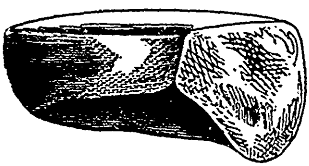


Fig. 131.

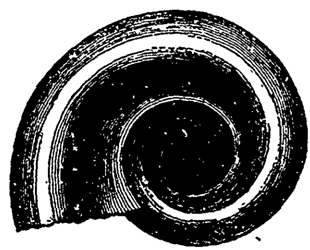


Fig. 132.

Fig. 131.—*Euomphalus De Cewi.*—A small specimen.
Fig. 132.—View of the umbilicus.

*Description.*—Shell from two to four inches in diameter; whorls about three. Spire nearly flat or gently concave; umbilicus deeply concave. The upper side of the whorls is nearly flat, with an angular edge all round the margin, (in casts narrowly rounded). The outside of the whorls nearly at right angles to the upper, but inclining a little inwards and gently convex. On the lower side there is a narrow rounded edge all round, from which there is a nearly uniform concave slope into the deep sub-hemispherical umbilicus.

The surface is marked with large slightly elevated lines of growth four or five in one line which on the upper side of the whorl curve backwards to the outer margin, and, then crossing the marginal edge curve forward for half the depth of the whorl on the outside, then backwards to the edge of the umbilicus within which they are not preserved in any specimen that I have seen. The aperture has the upper outer and inner sides nearly straight and at right angles to each other. The lower side is narrowly convex at the outer angle and then concave conforming to the curve of the umbilicus. In a nearly perfect specimen three inches across, the upper-side of the last whorl is full an inch wide at the aperture and the outer-side an inch and a half·

In general the spire is flat or gently concave but in some of the casts the two inner whorls are a little elevated above the plane of the outer one.

This fine species is closely allied to *Euomphalus trigonalis.*—(Goldfuss) of the Devonian rocks of Germany, but it is flatter above, and, according to Goldfuss' figures, the surface of that species is finely cancellated.

Dedicated to the discoverer Mr. J. De Cew, of Cayuga, C. W.

*Locality and Formation.*—County of Haldinand, Corniferous Limestone.

*Collector.*—J. De Cew.

STRAPAROLLUS? CANADENSIS.—(N. Sp.)

*Description.*—This species consists of a simple, cylindrical, slender, gradually tapering tube, coiled up so as to make a nearly flat disc about two inches and a half across. A transverse section of the tube is very nearly circular, which must also be the form of the aperture. The spire is nearly flat or gently concave. The umbilicus is widely but not very deeply concave. There are about four whorls. In specimens two inches and a half wide the diameter of the aperture is from seven to nine lines. The surface markings are not preserved in the specimens that I have seen. In one there are several concave transverse septa and it may be that this is a Cephalopod of the genus *Trochoceras* and not a Gasteropod. As however species of *Straparollus* are occasionally septate I shall place it in thatgenus provisionally.

This species is closely allied to *Euomphalus planorbis,* (Archiac and Verneuil) of the Devonian Rocks of Germany but has fewer whorls.

*Locality and Formation.*—County of Haldimand. Corniferous Limestone.

*Collectors.*—J. De Cew ; E. De Cew.

LOXONEMA COTTERANA.—(N. Sp.)

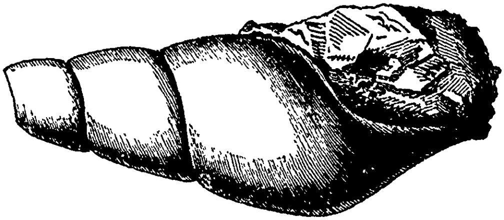


Fig. 133.

Fig. 133.—*Loxonema Cotterana.*

*Description.*—Elongate, fusiform, acute, apical angle, between 25° and 30° ; whorls four to six ; very depressed convex ; body whorl large, occupying full one-half the whole length of the shell, descending with a uniform convexity into the aperture ; aperture elongate ovate, effuse below, columellar lip extending about three-fourths of an inch below the body of the whorl. The suture in the cast deeply excavated, but narrow, the fissure descending into the fossil obliquely downward, the whorl below presenting a sharp edge over it, and the one above, an obtusely convex slope into it ; this is the appearance presented when the suture is completely cleared of the shell. Surface unknown.

Length, three inches. Length of last whorl measured on a line passing longitudinally along the inner lip, one inch and a half ; diameter of last whorl, one inch.

Dedicated to the discoverer, Miss Catherine Cotter, daughter of Col. G. S. Cotter, of the Township of Dunn.

*Locality and Formation.*—Lake Shore, Township of Dunn. Corniferous Limestone.

*Collector.*—Miss Catherine Cotter.

CEPHALOPODA.—(Cuvier).

In this class I estimate that there are twenty-five species of the genera *Orthoceras, Cyrtoceras, Phragmoceras, Nautilus,* and *Goniatites.*

### Cyrtoceras Ammon.—(N. Sp.)

*Description.*—Six to eight inches in length; section nearly circular; rather abruptly curved; a specimen, six inches in length, forming a half whorl, which would lie in a circle of four inches in diameter; the apical three inches, curved with a radius of about one inch and a half, more gently curved towards the aperture. Tube tapering from a diameter of fifteen lines at the larger extremity, to six lines at the smaller, in a length of six inches.

The shell of this specimen is beautifully ornamented by strongly elevated, encircling, waved ridges, of which there are forty-seven in the length of five inches and a half; these are distant from each other about three lines at the larger extremity, becoming gradually more and more approximated towards the smaller end—where the last two are scarcely a line distant. In their course round the shell, the ridges are undulated by short, zig-zag curves, from half a line to two lines wide, and one line, or a little less, in depth. In crossing the median line of the ventral aspect, they make a deep curve towards the apex, two lines deep near the aperture, and one line and a half wide, becoming gradually less as the diameter of the shell decreases. The ridges project abruptly from the surface of the shell to the height of half a line, the intervening spaces are flat, and nearly smooth, or with apparently obscure, concentric striæ.

The deep flexures of the encircling ridges along the ventral aspect seem to shew that the siphuncle is situated close to the margin on that side. The septa have not been observed. The aperture is not preserved in the specimen, but it is most probably circular.

The above description is founded upon a single specimen, which is nearly perfect, and has the shell preserved—but silicified.

*Locality and Formation.*—Township of Rainham, Corniferous Limestone.

*Collector.*—E. De Cew.

### Cyrtoceras Belus.—(*N. Sp.*)

*Description.*—Six to eight inches long; curved so as to make about half of a whorl, of which the diameter would be about six inches. In a specimen seven inches long, measuring along the ventral aspect, the curve corresponds very nearly to that of a circle with a radius of three inches, and the remainder to one with a radius of about two inches. The cross section of the tube is transversely oval; the greatest thickness, from side to side; the least, from the ventral to the dorsal aspect; the diameters having a proportion to each other of about ten or eleven to fifteen. The sides are narrowly rounded; the dorsal aspect uniformly depressed convex; the ventral aspect more strongly convex than the dorsal, and most prominent along the median line. In the cast of the interior there is close to the aperture a broad, shallow constriction, showing either that the shell is thickened on the inside at this point, or that the aperture is smaller than the greatest size of the tube. There is also an appearance which leads me to suspect that the aperture is obscurely trilobed. In the specimen above mentioned, the chamber of habitation is one inch and a half in depth. The first four septa occupy one inch in length of the tube, and the others become nearer to each other as they approach the apex. The siphuncle is about two lines in thickness and close to the margin, but not in contact therewith, there being in one specimen half a line and in another about a line between it and the shell. The latter appears to thin with obscure encircling striæ.

A specimen seven inches in length has a dorso ventral diameter of sixteen lines, at about one inch from the aperture; and it tapers to six lines at seven inches. The remainder to the apex is broken off and not preserved. The lateral diameter of this specimen cannot be ascertained, as it is partly imbedded in the stone. But in another, (a fragment) the diameters are, at the large end, 12 lines to 16 lines, and at two inches nearer the apex 7 to 11 lines.

There appears to be some variation in this species with regard to the distance of the septa. In one specimen the first two next the outer chamber are only two lines distant, and in another which appears to belong to this species there are six septa in one inch at three inches from the aperture.

*Locality and Formation.*—Corniferous Limestone, County of Haldimand.

*Collectors.*—E. DeCew, J. DeCew.

### CRUSTACEA.

The Trilobites that have been determined are *Calymene Blumenbachii*, *Phacops bufo*, *Dalmanites calliteles*, and *Phillipsia? crassimarginata*. Besides these, there are five other species belonging to the genera *Lichas*, *Dalmanites*, and *Phillipsia*,—in all nine species. There are also two species of *Leperditia*.

### Pisces.

There appear to be three or four species of fish in the Oriskany Sandstone and Corniferous Limestone, one or two of them covered with plates resembling those of an *Asterolepis*. Dr. Newbury informs me that one of them is his *Agassizicthys Sullivanti*.

### Summary.

The following is a statement of the number of species in the Devonian Rocks of Canada West according to my estimation of the specimens in the Museum of the Survey :

| | *Determined.* | *Undetermined.* |
|---|---|---|
| Zoophyta | 54 | 10 |
| Crinoidea | 0 | 10 |
| Bryozoa | 0 | 13 |
| Brachiopoda | 47 | 10 |
| Lamellibranchiata | 2 | 18 |
| Gasteropoda | 4 | 21 |
| Cephalopoda | 2 | 23 |
| Crustacea | 4 | 5 |
| Pices | 1 | 3 |
| | 114 | 113 |

Nearly all of the species above given as determined will be found noticed in the several papers published in this Journal. Among those undetermined there must be a great many identical with those described in the publications of American Geologists. I shall endeavour to give some account of them in a few months.

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# ON THE KLAPROTHINE OR LAZULITE OF NORTH CAROLINA.

BY E. J. CHAPMAN.

PROFESSOR OF MINERALOGY AND GEOLOGY IN UNIVERSITY COLLEGE, TORONTO.

The Klaprothine or Lazulite is comparatively a rare mineral. It appears to have been first recognized by Widenmann in 1791, in the valley of the Muhr, near Krieglach in Upper Styria. By Werner, it was mistaken for Feldspar ; and, although examined by Klaproth, its true nature was not detected until the analysis by Fuchs of specimens afterwards discovered near Werzen, in Salzburg. Brandes then re-examined the Krieglach specimens, and shewed their identity in composition with the examples analysed by Fuchs.* The other known localities of this mineral, comprise Vorau near Gratz in Styria, (examples from which spot have been analysed by Rammelsberg); the foot of the Wechsels near Therenberg in Lower Austria; Minas Geraes in Brazil; and Sinclair County in North Carolina. Specimens from this latter locality have been very carefully analysed by Professor J. Lawrence Smith, and George J. Brush (now Professor of Metallurgy in Yale College), but I have failed to discover in any publication, a crystallographic or mineralogical description of this North American lazulite. A specimen, however, consisting of numerous small crystals imbedded in fine-granular quartz or sandstone, having been kindly presented to me within the few last months, by Prof. T. Sterry Hunt, of the Geological Survey of Canada, I propose, in the present place, to offer a brief notice of its leading mineralogical characters.

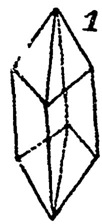
All the earlier determinations of Lazulite crystals referred the mineral to the Trimetric or Rhombic System. Prüfer of Vienna was the first to maintain its Monoclinic character, and the angles given in the more recent works on Mineralogy are adopted from his measurements. The European crystals present in general a somewhat complicated aspect, although certain combinations closely resemble those of the Trimetric System. Two "augite pairs," are always present. These, according to Prüfer, measure respectively over a front edge 100° 20′ and 99° 40′, the difference being but little more than half-a-degree. According to the same observer, moreover, the inclination of the base on the prism-plane (0 P : ∞ P, in the notation of Naumann†) only differs from a right angle by 23 minutes. Were these values, consequently, all that we had to depend upon, it would be manifestly unsafe to rely upon them as proofs of the monoclinic crystallization of Lazulite. But in some combinations, the forms below the middle zone of the crystal are less numerous than those above this zone, or otherwise differ from the latter in their measurements. Nevertheless, in certain Trimetric minerals, and notably in Datolite and Wolfram, we have the same peculiarity, and we might therefore look

* Brandes appears, however to have missed the water, present in this substance: unless there be a typographical error in his recorded numbers. If we transpose these numbers, as regards the silica (an impurity) and the half-per-cent of water said to have been obtained, his analysis will agree closely with those of other chemists.

† = O: İ in Dana's notation; and B: V in that of the writer.

upon these Lazulite crystals as Trimetric combinations, hemihedrally modified. From my examination of the North Carolina specimens, I cannot but think that this view will in the end prevail. It is supported by the fact that in many combinations the upper and lower forms do actually correspond in number and character; and that practised crystallographers like Phillips and Lévy, skilled in the use of the goniometer, were unable to detect in their measurements the differences announced by Prüfer.*

The North Carolina crystals—presuming those in my possession to represent the generality of crystals obtained at this locality—although usually distorted, are of an extreme simplicity: contrasting remarkably in this respect with the majority of European examples. At first sight, they resemble a monoclinic prism terminated by a single "augite-pair" or hemi-pyramid; but they really consist (if monoclinic) of two hemi-pyramids, the four planes of one of which are greatly elongated; or, if trimetric (as I conceive them to be), they form a rhombic octahedron in which four planes, in opposite sets of two, are thus lengthened beyond the others. Fig. 1 represents this distorted aspect; Fig. 2, the same form (or combination, if monoclinic) in symmetrical proportions. These symmetrical crystals are of smaller size, and less numerous, than the distorted forms.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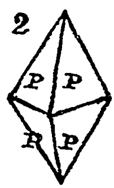
Although the edges of these crystals are sharply defined, the planes are unfortunately without lustre. The most careful measurements of five crystals, by means of a fixed or Adelmann's goniometer gave me the same angles for both the upper and lower faces. The difference found by Prüfer is too slight, however, to be satisfactorily detected by any kind of application goniometer. I attached, therefore, thin films of mica as carefully as possible to the planes of one of the crystals, and measured the angles by reflected light with a Wollaston goniometer of the best construction. The following table shews the measurements thus obtained, supporting the apparently Trimetric character of these crystals:

2



* These observers appear to be the only crystallographers who have practically examined crystals of Lazulite. Thus, the measurements of Phillips are followed by Hausmann, Breithaupt, and others; those of Lévy, by Dufrénoy; and those of Prüfer, by Naumann Dana, Quenstedt, and Miller.

| | Upper Planes over front edge: | Lower Planes over front edge: |
|---|---|---|
| 1st measurement...... | 100° 4′ | ...... 100° |
| 2nd " ...... | 99° 99′ | ...... 99° 99′ |
| 3rd " ...... | 99° 99′ | ...... 100° 2′ |

| | Upper Planes over side edge: | Lower Planes over side edge: |
|---|---|---|
| 1st measurement...... | 97° 27′ ...... | 97° 28′ |
| 2nd " ...... | 97° 30′ ...... | 97° 26′ |
| 3rd " ...... | 97° 26′ ...... | 97° 27′ |

| | Front Planes over middle edge: | Back Planes over middle edge: |
|---|---|---|
| 1st measurement...... | 134° 10′ ...... | 134° 7′ |
| 2nd " ...... | 134° 10′ ...... | 134° 12′ |
| 3rd " ...... | 134° 8′ ...... | 134° 10′ |

Whether monoclinic or trimetric, these measurements should of course correspond. The two sets were taken, however, for greater satisfaction.

Adelmann's goniometer gave me 100°—100° 30′ over a front edge; 97°—97° 30′ over a side edge; and 134°—134° 30′ over a middle edge. If we look upon the mineral as Trimetric, and adopt the angle of 100° as the mean inclination over a front edge, with 91° 30′ for the value of the prism-angle (according to general adoption), the following angles and axial relations are obtained by calculation:

$$P : P \text{ (over a front edge)} = 100^\circ$$
$$P : P \text{ (over a side edge)} = 97^\circ\ 24\tfrac{1}{2}'$$
$$P : P \text{ (over a middle edge)} = 134^\circ\ 12'$$

$$x \text{ (vertical axis)} = 1{\cdot}652.$$
$$\bar{x} \text{ (macrodiagonal)} = 1.$$
$$\breve{x} \text{ (brachydiagonal)} = 0.9741.$$

The measurements of Phillips give for the octahedral angles, as deduced by Hausmann, 99° 16′ (over front edge), 96° 39′ (over side edge) and 136° 20′ (over middle edge). The position of the crystals, as adopted by Phillips, is here changed however—his middle edge being made a front polar edge, and the reverse.

Many of these North Carolina crystals appear to possess another form, in addition to those enumerated above. This is the front polar or macrodome, occurring generally on two opposite edges only, and thus presenting a monoclinic character, but lying sometimes on only one edge, and being consequently (if the mineral be Trimetric) a tetartohedral modification. It is a mere line, dull like the other planes, and too narrow to admit of satisfactory measurement. The crystals are sometimes implanted in one another, but I have not detected any definite twin-combinations. The crystals extracted from my specimen, together with those exposed on the surface of this, do not amount however to more than ten or twelve in number. The hardness of these crystals is equal to 5.75, or very nearly to 6·0. The sp. gr. (one determination only) I found to equal 3·108, a value corresponding sufficiently with that obtained by Smith and Brush (3·122). The cleavage I have not been able to determine in a satisfactory manner. The blow-pipe reactions are as follows :

In the closed tube, the assay gives off water and loses its colour, becoming yellowish or greyish-white.

*Per se*, it exfoliates and expands greatly in bulk, changes colour, tinges the flame green, and crumbles away without fusing.

In borax, it dissolves very easily, imparting to the glass a pale ferruginous tinge.

In salt-of-phosphorus, it dissolves also very readily, and with slight effervescence.

In carbonate of soda it dissolves partially, but the dissolved portion is in great part precipitated as the glass cools, forming a white enamel. If the bead be dissolved in a little boiling water, a drop of nitric acid added to decompose the excess of carbonate of soda, and the clear supernatant liquid be then poured upon a small crystal of nitrate of silver, a yellow precipitate of phosphate is at once obtained. In employing this test for phosphates, the beginner should be cautioned, however, that silicates (if decomposable by carb. soda,) will produce the same reaction, but the silica may be eliminated by adding several drops of acid, and evaporating to dryness. By treatment with salt-of-phosphorus, moreover, silicates are at once recognized. If the solution of our mineral, as obtained above, be treated with acetate of lead, the precipitate presents the well-known blowpipe reaction of phosphate of lead, *i.e.*, the formation of a faceted globule without reduction.

Two analyses of the North Carolina lazulite are given by Professors Smith and Brush in the *American Journal of Science and Arts* for September, 1853. These exhibit the following results :

| | 1. | 2. |
|---|---|---|
| Phosphoric acid............ | 43·38 | 44·15 |
| Alumina ..................... | 31·22 | 32·17 |
| Protoxide of Iron.......... | 8·29 | 8·05 |
| Magnesia .................. | 10·06 | 10·02 |
| Water ........................ | 5·68 | 5·50 |
| Silica (an impurity) ...... | 1·07 | 1·07 |
| | 99·70 | 100·96 |

From the above values, Messrs. Smith and Brush have deduced the annexed formula:—2 [3 (MgO, FeO), $PO^5$] + 5 $Al^2O^3$, 3 $PO^5$+5 HO.

The true position of Lazulite, in a natural classification, appears to be amongst a group of phosphates containing both anhydrous and hydrous species (the distinction between these being entirely artificial), and in some of which fluorine is also present. In this group I would place the following minerals:—Childrenite, Wavellite, Fischerite, Turquoise, Lazulite, Wagnerite, Herderite, Amblygonite, Monazite, Xenotime, and Cryptolite.

## SELECTED ARTICLES AND TRANSLATIONS.

### ON THE CO-EXISTENCE OF MAN WITH CERTAIN EXTINCT QUADRUPEDS, PROVED BY FOSSIL BONES (FROM VARIOUS PLEISTOCENE DEPOSITS) BEARING INCISIONS MADE BY SHARP INSTRUMENTS.

BY M. E. LARTET,
FOREIGN MEMBER OF THE GEOLOGICAL SOCIETY OF LONDON.

[The general interest occasioned by the recently admitted occurrence of extinct remains in association with objects of human art, induces us to transfer to our pages the following interesting letter from the pen of M. Lartet, published, with some additional notices by Mr. Leonard Horner, in a late Number of the *Quarterly Journal* of the London Geological Society (No. 64, November 1860.) By some accident, this Number of the *Journal* did not reach us until greatly after date.]

*To the President of the Geological Society of London, L. Horner, Esq.:*

"You have been good enough to offer to communicate to the Geological Society the observations which I have for some time past made upon fossil bones exhibiting evident impressions of human agency. The specimens of them which I showed to you yesterday were those only whose origin is authentic, and which were obtained from deposits well defined in regard to geological relations. Thus the fragments of the Aurochs exhibiting very deep incisions, apparently made by an instrument having a waved edge, and the portion of the skull of the *Megaceros Hibernicus*, in which I thought I recognized significant marks of the mutilation and flaying of a recently slain animal, were obtained from the lowest layer in the cutting of the Canal de l'Ourcq, near Paris. These very specimens are figured or mentioned by Cuvier (Oss. Fossiles, 4to. 1823, tom. iv. pl. 6, fig. 9, *M. Hibernicus*); and Alex. Brongniart (Descr. des Environs de Paris, 4to. 1822, p. 562, pl. 1 A. fig. 10) has given a detailed description of the deposit, consisting of distinct layers, which he considers to be of higher antiquity than those of the valleys. The bones of the Aurochs and the *Megaceros* were found in the same layer as the remains of the Elephant (*Elephas primigenius*) of which Cuvier has given figures of two molars, which, according to that author, had not been rolled, and were found under circumstances which showed that they were in an original and not in a *remanié* deposit. I have said that the deep incisions on the bone of an Aurochs from the cutting of the Canal de l'Ourcq (which you may remember I showed you in the Gallery of the Jardin des Plantes) appear to have been made by an instrument with a waved edge. By this I meant an instrument having an edge with slight transverse inflections, so as to produce, by cutting obliquely through the bone, a plane of section somewhat undulated. The cut seems to have been made by a hatchet not entirely finished—a state in which the greatest part of the flint implements from St. Acheul, near Amiens, seem to be; but in the marked bones of Abbeville and other ancient localities the incisions must have been made by rectilinear edges. These considerations would lead us to think that, independently of the case of the hatchets simply chipped and roughed out, the place for the manufacture of which might be near that where they are now found, those primitive people must have been provided with more perfect instruments, such as would be more suited to their ordinary wants. I should therefore hesitate to adopt the system (too absolute, in my opinion) of Mr. Worsaae, who distinguishes the first subdivision of the "Stone Period" by hatchets that are merely chipped, to the exclusion of those that are polished, which he assigns to the second subdivision. It is to be presumed that the want of instruments with polished surfaces and having a fine cutting edge must have been felt from the earliest time, when the people had learned to fix, by a much more difficult process, to flints and other rocks intentional forms so well defined.

Among the bones with incisions obtained from the sands of Abbeville, there is a large antler of an extinct Stag, referred to the *Cervus Somonensis*, or the *grand Daim de la Somme* of Cuvier, together with several horns of our common Deer, which I was not able to show you. The bones of the *Rhinoceros* (*Rh. tichorhinus*) which I laid before you were found at Menchecourt, a suburb of Abbeville, where there are gravel-pits which formerly afforded many fossil bones of Elephants, &c., and where M. Boucher de Perthes, at a later period, obtained the flints worked by human hands. The incisions that may be observed on those bones are neither so deep, nor do they afford evidence so striking, as those in the bones of the Aurochs from the Canal de l'Ourcq; but the shallow cuts and the incisions of the bony surfaces which may be observed upon them, especially in the articulations, have in my eyes not less value; for I have satisfied myself, by comparative trials on homologous portions of existing animals, that incisions presenting such appearances could only be made in fresh bones still retaining their cartilage. As to the fragment of the horn of the *Megaceros Hibernicus*, which Cuvier had received from England without any indication as to where it came from, you may have observed that it bears the marks of several blows, which have made incisions of a depth that it would be impossible to produce in the present state of mineralization of that fragment; further, the blow which detached that piece from the rest of the horn must have been given before that immersion in the sea which caused its fossilized condition; for in the internal cavity of this fragment there was found the valve of an *Anomia* (preserved with the specimen), which could not have found its way there except at the place of fracture. I have observed very significant marks, evidently produced by a sharp tool, on the horn of a young *Megaceros* which the late M. Alcide d'Orbigny had received from Ireland some years ago.

I would call to your recollection that the Rev. John Cumming, in his geological description of the Isle of Man, (*Quarterly Journal* of the Geological Society, vol. ii. p. 345), notices the occurrence of the remains of the *Megaceros* imbedded in blue marl "with implements of human art and industry, though of an uncouth and ancient character;" and in a note at the foot of page 344, alluding to a submarine forest, to which he is inclined to assign a more ancient date, he says, "It is singular that the trunk of an oak tree, which has been removed from the submerged forest at Strandhall, exhibits upon its surface the marks of a hatchet." With regard to the historical existence of the *Megaceros*, after referring to what is to be found in the works of Oppian, of Julius Capitolinus, and S. Münster,* I have found nothing which appears to me to justify in this respect the opinion put forth by Dr. Hibbert, and since then accepted by other palæontologists, except Professor Owen, who, speaking of the *Megaceros* of the British Isles, entirely dissents from the opinion of Dr. Hibbert. All the remains of that animal found on this side of the Channel, which I have examined, belong to deposits of greater antiquity than that of the peat-bogs.

M. Delesse has shown you fragments of bone that have been sawn, which he recently obtained from a deposit in the neighbourhood of Paris, where he had previously collected remains of the Beaver, the Ox, and the Horse. From an examination of these fragments, I have satisfied myself, by experiments on recent bones, that the action of a metallic saw would not produce the transversally striated plane of section which you must have observed on those ancient bones collected by M. Delesse; but I have obtained analogous results by employing as a saw those flint knives, or splinters with a sharp chisel-edge, found in the sands of Abbeville.

If, therefore, the presence of worked flints in the diluvial banks of the Somme, long since brought to light by M. Boucher de Perthes, and more recently confirmed by the rigorous verifications of several of your learned fellow-countrymen, have established the certainty of the existence of Man at the time when those ancient erratic deposits

* For the text of Oppian I have consulted the French translation of the poem "de la Chasse" by Belin de Balu (1787), chant second, p. 42. Julius Capitolinus is quoted by Aldrovandus, 'de Quadrupedibus bisulcis,' lib. i. c. xxviii. p. 857. Aldrovandus explains why he has changed his opinions after having received from an English physician the head of (*Megaceros*) *Euryceros*, which he has figured. There is another citation, and some conclusions interesting to read, at page 742 of the same work.

With regard to S. Münster, I have not taken notice of more than plate 9. fig. 2. of his "Cosmographia Universalis." But you will find his text reproduced and interpreted by Dr. Hibbert in the *Edinburgh Journal of Science*, 1830, vol. ii. p. 307. Dr. Hibbert has likewise given the figures of Münster, which are evidently fantastical, as admitted by the most eminent men of science in Germany.

were formed, the traces of an *intentional operation* on the bones of the *Rhinoceros*, the *Aurochs*, the *Megaceros*, the *Cervus Somonensis*, &c., supply equally the inductive demonstration of the contemporaneity of those species with the human race.

It is true that certain of those species, the *Cervus elaphus* of Linnæus (the same as your Red-deer or Stag) and the Aurochs, are still represented in existing nature: but although it is exactly the bones of the Aurochs which exhibit the most evident proof of human action, the fact is not of less value as regards the relative antiquity; for the remains of the Aurochs have been found associated in the same beds with those of *Elephas* and *Megaceros*, not, as I have already said, by the effect of a *remaniement*, but in an original inhumation. Moreover, fossil remains of the same Aurochs, have been found in England, in France, and in Italy, in præglacial deposits (that is, in deposits anterior to the most ancient pleistocene formations containing bones of *Elephas primigenius* and *Rhinoceros tichorhinus*). I would add, that the more rigorous observation of facts tends clearly to demonstrate that a great proportion of our living Mammifers have been contemporaneous with those two great extinct species, the first appearance of which in Western Europe must have been preceded by that of several of our still existing quadrupeds.

In endeavouring to connect those proofs of the antiquity of the human race with the geological and geographical changes which have since taken place, I have not met with any more precise induction than that offered by M. d'Archiac, viz. the relative epoch of the separation of England from the Continent. The former connexion of the two is a fact generally admitted: it is proved by the similarity in structure of the opposite sides of the Channel, by the identity of species of terestrial animals, the original intermigration of which could only have been effected by the existence of *terra firma*. M. d'Archiac (Bull. de la Soc. Géol. de France, 1ère série, t. x. p. 220, and Histoire des Progrès, &c., t. ii. pp. 127 and 170) has been led, by a series of well-weighed inductions from stratigraphical considerations, to consider the epoch of the separation of the British Islands as occurring after the deposition of the diluvial rolled pebbles, and before that of the ancient alluvium, the Loess of the North of France, of Belgium, the Valley of the Rhine, &c. The inference to be drawn from that hypothesis is self-evident: it is this, that the primitive people to whom we attribute the hatchets and other worked flints of Amiens and Abbeville might have communicated with the existing land of England by dry land, inasmuch as the separation did not take place until after the deposit of the rolled diluvial pebbles, from among which the hatchets and worked flints have been collected. On the other hand, M. Elie de Beaumont having assigned the production of the erratic phenomena existing in our valleys to the last dislocation of the Alps, we should be authorized to conclude from this second hypothesis, that the worked flints carried along with the pebbles in that erratic deposit in the bottom of the valleys afford a proof of the existence of Man at an epoch when Central Europe had not yet reached the completion of its present great orographic relief.

While it has been held that no change has taken place in the great lines of level since the formation of the erratic deposits in the lower parts of our valleys, and although such changes cannot be distinctly traced in the central parts of the continents, from the absence of standards of comparison, they are not the less easy to be recognised as having occurred, even since the existence of Man, throughout the whole extent of the European coasts, from the Gulf of Bothnia to the very eastern extremity of the Mediterranean. They have been observed by different authors on a considerable number of points of the coast, where they have verified the existence of objects of human industry in deposits of marine origin, raised up at different elevations above the sea-level. Such changes, be they the result of action more or less violent, of movements more or less sudden, have not amounted to catastrophes so general as to affect to a sensible degree the regular succession of organized beings.

We find incontestible proof of this in the British Islands, whither the most considerable number of terrestrial species must necessarily have immigrated prior to the separation of those islands from the Continent, and where they have established themselves and have continued by successive generations to the present day. The same thing has occurred on the Continent, where the same terrestrial fauna has continued without any other modification than the geographical displacement of certain species and the final disappearance of some others—disappearances that have resulted, not from a simultaneous destruction, but rather from a series of successive extinctions which appear to have been equally gradual as regards space and time.

I may add to what I have stated above, that the finding of worked flints in the diluvium of Amiens and Abbeville is by no means an isolated fact. M. Gosse of Geneva, a young medical student in Paris, has recently discovered in the sands of the Parisian suburb of Grenelle, of the same age as those of Abbeville and of other parts of Europe, a flint hatchet of a most distinct form, together with knives or thin plates split in a longitudinal direction. I myself have had an opportunity of verifying these facts in the collection formed by that skilful explorer. He has shown me an Elephant's tooth, a canine tooth of a large Feline animal, and bones of the Aurochs, Horse, &c., all obtained from the same sands and from the same bed in which the flint hatchet was found.

I may add that, among the bones obtained in Switzerland under the lacustrine habitations of the Stone Period (in the lakes of Moosdorf, Bienne, and others), there never have been found any remains of the *Megaceros*, although the remains of the Elk, the Aurochs, and the *Bos primigenius* are by no means rare. In Denmark, where still more ancient stations have been carefully examined with the same object, Prof. Steenstrup has assured me that he has never discovered the smallest fragment of the *Megaceros* in the midst of the most abundant remains of the Reindeer, Elk, Aurochs, and other species of animals which from time immemorial have not existed in that region. Nevertheless these primitive stations in Denmark are referred back to a period when no other domestic animal existed in that country except the Dog. No remains have been found either of the Horse, Sheep, or Goat,—not even any kind of dwarf Ox.

If, Sir, you are of the opinion that the above notes, drawn up in haste, are likely to prove interesting to the Geological Society of London, I should be happy if you would submit them to the enlightened judgment of your learned associates, and if they will receive them at the same time as a mark of my deference, and as a feeble expression of the profound gratitude I feel for the honour conferred upon me by my name having been inscribed among the Foreign Members of that Society.

## Addition by the President of the Geological Society,—L. Horner, Esq.

In the foregoing communication, M. Lartet has referred to my friend M. Delesse having shown me some fragment of bone bearing incisions made by a sharp instrument, which he had recently discovered in the neighbourhood of Paris. He presented me with one of those which he had submitted to the examination of M. Lartet, and which I now lay before the Society, together with the following copy of a note I received from M. Delesse describing this specimen:—

"I send you a fragment of a rib which I recently found at Ver, i the department of the Seine et Oise, about nine leagues from Paris, at the depth of three mètres (nearly ten feet), in a kind of cleft filled by the diluvial soil (*le terrain diluvien*), occuring with the sandstone and sands belonging to the *étage* denominated *les sables de Beauchamp*. It was associated with divers bones of the Stag and Horse, and also of an animal no longer existing in the country, namely, the Beaver. I have submitted this fragment to M. Lartet, with whose profound scientific attainments you are well acquainted but he has not been able to decide whether it belongs to a species of quadruped still living, or to one now extinct. But he considers this small fragment of a rib very interesting, from its having at one extremity traces of a rude operation of sawing, and presenting an appearance very different from that which would be produced by a metallic blade or by a saw. M. Lartet did not rest satisfied with a mere conjecture, but ascertained by experiments on a fresh rib of an Ox that a metallic blade produced an uniform and almost a smooth cut. Hence he concludes that the rib in question had been sawn by flint with a jagged edge. Taking a splinter of flint with a chisel-edge from the sands of Abbeville, he easily sawed a fresh rib, but always obtained an uneven, irregular cut (*des surfaces de resection avec reprises nombreuses*), such as may be observed on the specimen I send you. There is therefore every reason to believe that this rib had been sawn by a flint, and it affords proof of Man having lived in France at the same time as the Beaver, an animal no longer existing with us; and M. Lartet has thus supplied a new and elegant demonstration of the contemporaneity of Man and quadrupeds during the period of the *Terrains diluviens*."

### SUBSEQUENT ADDITION BY THE PRESIDENT OF THE GEOLOGICAL SOCIETY.

The day after the above communication was read, on showing the fragment of bone given to me by M. Delesse above referred to, it was observed that it had a remarkably fresh appearance, that it did not adhere (*happer*) to the tongue as fossil bones usually do, and that thus a doubt might exist as to its assumed antiquity. After hearing this remark, I exposed a minute fragment to the flame of a candle, when it gave out the odour of burnt animal matter; and on immersing another fragment in hydrochloric acid, after effervescence, a soft gelatinous substance, nearly the size of the original fragment, was left. Knowing full well that M. Delesse and M. Lartet would cordially agree on the importance of the most scrupulous investigation of every fact produced in evidence on this recently-agitated question of the antiquity of Man, I communicated to both of them what I have stated above respecting this bone. I received immediately answers from them; and these, with their leave, I now give, not only because of their confirmation of the opinions they formerly expressed, but as containing some additional remarks of much interest.

M. Delesse, in his letter dated the 19th instant, says:—

"The specimen of the rib which I gave you was incontestibly found in a sand-pit (*sablonière*), where it was associated with the bones of animals no longer existing in the country—as, for example, the Beaver. I would observe that the presence of gelatine can in no way be opposed to the antiquity of that rib. I have only just now brought to a conclusion a long series of researches by which I have shown that bones even of a high antiquity still retain a notable proportion of organic matter. If you take the bones of an *Ichthyosaurus* from the Lias, or of reptiles from the Muschelkalk, you will easily satisfy yourself that in spite of their great antiquity, they still contain a very notable proportion of organic matter. Coprolites from the oldest formation contain it. On the other hand bones comparatively recent, such, for instance, as those found in caverns or in travelled materials, have no great amount of organic matter. In brief, the preservation of organic matter in bones is very irregular; it depends on the nature of the rock in which they are found, at least quite as much as on their antiquity.

"I pronounce no opinion as to the nature of the instrument that had been employed in sawing that rib, for I made no experiments on the subject; but M. Lartet, whose caution and sagacity are known to you, made a special examination of the question along with eminent physiologists; and they had no doubt that the rib had been cut by a sharp flint."

M. Lartet, in his letter dated the 22nd instant, states as follows:—

"I am sorry to learn that a somewhat hasty objection has been made to the palæontological value of the fragment of bone which you exhibited. I have no right to give any opinion regarding the locality where it was found, because I have not visited it; but the opinion of M. Delesse, who had an opportunity of examining all its geological features, is deserving of all confidence. Among the other fossil remains which he found in that locality, there is a fragment of bone of a Horse, having also traces of human agency, and which is in a much more altered condition than that of the bone he gave you; but there is another fragment also bearing the mark of a saw, the appearance of which is quite as fresh as the specimen in your possession; nevertheless, when we endeavoured to authenticate this fragment specifically, we were unable to do so by comparing it with the homologous part in the skeleton of our living animals.

"It is moreover important to remark that, in any given locality, all the bones collected do not present the same degree of organic change. That depends, first, on their anatomical structure being more or less compact according to the species, and again, chiefly on the composition and physical condition of the mineral matter in which they have been in immediate and prolonged contact. Mr. Hart, in his description of the *Megaceros Hibernicus* (Dublin, 1830), states that a fragment of a rib analysed by Dr. Stokes yielded 42·87 per cent. of animal matter; and Dr. Apjohn, who analysed another portion of a rib, states as follows:—'The bone was subjected for two days to the action of dilute muriatic acid; and when examined at the end of this period, it had become as flexible as a recent bone submitted to the action of the same solvent. The cartilage and gelatine had not been perceptibly altered by time.' It is long since the observation was made by many other persons, and especially by Schmerling (Recherches sur les ossements des cavernes de la province de Liége, 4to. 1833, 1ère, par. pp. 18–52): and the remarkable researches on this subject recently made by M. Delesse, and which he is about to publish, have demonstrated that the organic change in bones by no means bears a relation to their palæontological antiquity. For example, he has found that the teeth of the bone-bed in the Upper Keuper at Otterbronn contain more azotized organic matter than most of the tusks of the Mastodon and Elephant found in tertiary or diluvial deposits. The amount of azote which they yield is even almost double that in the tusks of the Mastodon in the

Miocene limestone of Sansan or in the Miocene deposits of the Upper-Garonne. Thus it is evident that, if the amount of organic matter generally diminishes in proportion as the age increases, there are, nevertheless, exceptions to that general rule.

"As to external appearance, that depends also on the circumstances of the locality. It is not long since a large number of bones of the *Hyæna spelæa* were sent to me, which had been obtained from an ancient alluvial deposit in the centre of France. They were in no degree changed in weight or colour, and in external appearance they were quite as fresh, if not more so, than the fragment given to you by M. Delesse. I have some of them now in my possession; and they are still so much impregnated with animal matter, that I was able with the utmost ease to saw and cut them with a flint knife. On the other hand, I have now before me a statuette made of stag's horn, obtained from a grave at the external base of a barrow, certainly not older than the 12th century, the substance of which is so much altered that it might be said to be fossilized, in a certain sense of the term, as much as the greater part of those found in caverns or diluvium. Hence we perceive that the greater or less amount of alteration in bones is not a character from which we can absolutely determine their palæontological antiquity.

"With regard to the mode by which the fossil bones of M. Delesse have been sawn, I must confess that at first sight I thought, as M. Desnoyers did, that the operation must have been performed with a metallic plate; but upon a more attentive examination of recent bones, I became convinced that the peculiar appearance presented by the section of one of the bones in the possession of M. Delesse must have been produced by the employment of a sharp tool of *flint*, rather than by a metallic plate, which has always given me a section with a very different surface. I send you the extremity of a tooth of *Hyæna spelæa*, which has been sawn by a flint. If you examine with a magnifying glass the plane of the section, you will find the same system of *striæ* as are observed in the bones collected by M. Delesse, sawn with the same kind of tool. You may further satisfy yourself that in this fragment nearly all the organic matter remains, although the tooth comes from an ancient deposit."

In my letter to M. Lartet I had said that when his communication was read, Dr. Falconer observed that, a considerable time ago, M. Marcel de Serres had given an account of a fossil Stag's horn that had evidently been cut. On this M. Lartet observes—"It is very true, as Dr. Falconer remarked, that M. Marcel de Serres gave a figure in 1839 of a Stag's horn cut and fashioned by human hands. I had occasion to remark that, a long time before, M. Tournal in 1829 (Ann. des Sc. Nat. 1829, t. xviii. pp. 242 *et seq.*) and Schmerling in 1833 (*loq. cit.*) had made similar observations. I might myself have stated that among the bones of caverns I had seen those of the Rhinoceros and the Reindeer bearing marks that must have been made by man; but I was on my guard against bringing forward those facts, because they would only have afforded opponents an opportunity of bringing forward anew their favourite objection, viz. 'that nothing that had been observed in caverns was deserving any confidence, and that the traces left by man on fossil bones might have been made a long time after the introduction of the bones into the caverns.'

"What constitutes the whole value of my observations on the impressions or marks of human agency on the fossil bones found in the diluvial deposits of Abbeville, and in the cutting of the Canal de l'Ourcq, is this, that, once admitting the reality of those marks, their relative antiquity becomes rigorously demonstrated by the geological circumstances of their locality being clearly defined. At Abbeville the marked bones, as well as the flint hatchets, were found in the diluvial gravel, which is itself covered by the Loess deposit. In the cutting of the Canal de l'Ourcq, the bones of the *Aurochs* and those of the *Megaceros Hibernicus* were found at a depth of 7 mètres (23 feet,) in a bed of earth (*limon*) and under other beds in normal stratification. They were not rolled (as Cuvier has said,) and were mixed with the remains of an Elephant, and evidently under the conditions of an original deposit.

"At the meeting of the Geological Society of France yesterday evening, M. de Verneuil exhibited a worked flint hatchet, and an Elephant's tusk found in the gravel-pit of Précy, near Creil, in the valley of the Oise. Thus these worked flints have been found in the diluvium of three of our valleys—of the Somme, the Seine, and the Oise."

# ON COMBUSTION IN RAREFIED AIR.

BY DR. EDWARD FRANKLAND, F.R.S.

(*From the Proceedings of the Royal Society. Vol. XI., No. 43.**)

"In the autumn of 1859, whilst accompanying Dr. Tyndall to the summit of Mont Blanc, I undertook at his request some experiments on the effect of atmospheric pressure upon the amount of combustible matter consumed by a common candle. I found that, taking the average of five experiments, a stearin candle diminished in weight 9·4 grammes when burnt for an hour at Chamounix; whilst its ignition for the same length of time on the summit of Mont Blanc, perfectly protected from currents of air, reduced its weight to the extent of 9·2 grammes.

"This close approximation to the former number under such a widely different atmospheric pressure, goes far to prove that the rate of combustion is entirely independent of the density of the atmosphere.

"It is impossible to repeat these determinations in a satisfactory manner with artificially rarefied atmospheres, owing to the heating of the apparatus which surrounds the candle, and the consequent guttering and unequal combustion of the latter; but an experiment in which a sperm candle was burnt first in air under a pressure of 28·7 inches of mercury, and then in air at 9 inches pressure, other conditions being as similar as possible in the two experiments, the consumption of sperm was found to be,—

"At pressure of 28·7 inches' 7·85 grms. of sperm per hour,
" " 9·0 " 9·10 " "

thus confirming, for higher degrees of rarefaction, the result previously obtained.

"In burning the candles upon the summit of Mont Blanc, I was much struck by the comparatively small amount of light which they

* Paper received, February 28th; Read, March 7th, 1861.

emitted. The lower and blue portion of the flame, which, under ordinary circumstances, scarcely rises to within a quarter of an inch of the apex of the wick, now extended to the height of $\frac{1}{8}$th of an inch above the cotton, thus greatly reducing the size of the luminous portion of the flame.

"On returning to England, I repeated the experiments under circumstances which enabled me to ascertain, by photometrical measurements, the extent of this loss of illuminating effect in rarefied air. The results prove that a great reduction in the illuminating power of a candle ensues when the candle is transferred from air at the ordinary atmospheric pressure to rarefied air. It was, however, found that, owing to the circumstances mentioned above, no satisfactory quantitative experiments could be made with candles in artificially rarefied air, and recourse was therefore had to coal-gas, which, although also liable to certain disturbing influences, yet yielded results, during an extensive series of experiments, exhibiting sufficient uniformity to render them worthy of confidence. The gas was in all cases passed through a governor to secure uniformity of pressure in the delivery tubes. A single jet of gas was employed as the standard of comparison, and this was fixed at one end of a Bunsen's photometer, whilst the flame to be submitted to various pressures, and which I will call the experimental flame, was placed at the other. The experimental flame was made to burn a uniform amount of gas, viz. 0·65 cubic foot per hour in all the experiments.

"The products of combustion were completely removed, so that the experimental flame, which burnt with perfect steadiness, was always surrounded with pure air, the supply of which was, however, so regulated as to secure a maximum of illuminating effect in each observation.

"In all the following series of experiments, the illuminating power given under each pressure is the average of twenty observations, which accord with each other very closely. In each series, the maximum illuminating effect, that is the light given by the experimental flame when burning under the full atmospheric pressure, is assumed to be 100. The following is a summary of the results :—

1st Series.

| Pressure of air in inches of mercury. | Illuminating power of experimental flame. |
|---|---|
| 29·9 | 100· |
| 24·9 | 75·0 |
| 19·9 | 52·9 |
| 14·6 | 20·2 |
| 9.6 | 5.4 |
| 6.6 | ·9 |

2nd Series.

| Pressure of air in inches of mercury. | Illuminating power of experimental flame. |
|---|---|
| 30·2 | 100· |
| 28·2 | 91·4 |
| 26·2 | 80·6 |
| 24·2 | 73·0 |
| 22·2 | 61·4 |
| 20·2 | 47·8 |
| 18·2 | 37·4 |
| 16·2 | 29·4 |
| 14·2 | 19·8 |
| 12·2 | 12·5 |
| 10·2 | 3·6 |

"These numbers indicate that even the natural oscillations of atmospheric pressure must produce a considerable variation in the amount of light emitted by gas-flames, and it was therefore important to determine, by a special series of observations, this variation in luminosity within, or nearly within, the usual fluctuations of the barometrical column. In order to attain greater delicacy in the pressure readings in these experiments, a water-guage was used, but its indications are translated into inches of mercury in the following tabulated results, each of which represents, as before, the average of twenty observations.

3rd Series.

| Pressure of air in inches of mercury. | Illum. power of exp. flame. |
|---|---|
| 30·2 | 100· |
| 29·2 | 95·0 |
| 28·2 | 89·7 |
| 27·2 | 84·4 |

"It is thus evident that the combustion of an amount of gas which would give a light equal to 100 candles when the barometer stands at 31 inches, would give a light equal to only 84·4 candles if the barometer fell to 28 inches.

"An inspection of all the above results shows that the rarefaction of air, from atmospheric pressure downwards, produces a uniformly diminishing illuminating power until the pressure is reduced to about 14 inches of mercury, below which the diminution of light proceeds at a less rapid rate. The above determinations give approximately 5·1 per cent. as the mean reduction of light for each diminution of 1 inch of mercurial pressure down to 14 inches. I am now extending this inquiry to pressures exceeding that of the atmosphere, and hope soon to lay before the Society the detailed results of the whole series, together with some observations on the causes of this variation of luminosity."

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## ON THE CALORIFIC RELATIONS OF HYDROGEN AND OTHER GASES.

ABSTRACT OF A PAPER BY PROFESSOR MAGNUS.

*(Translated from Poggendorff's Annalen. No. 2, 1861.)*

"Professor Magnus communicated to the Academy of Sciences of Berlin, on the 30th of July, 1860, a series of investigations respecting the conductibility, &c., of heat in various gases; and on the 7th of February, of this year, he laid before the Academy a second series of these investigations,* the principal results of which are given below:

"1. The final temperature indicated by a thermometer placed in a vessel warmed from above, varies according to the nature of the gas with which the vessel is filled.

"2. In hydrogen this temperature becomes higher than in any other gas.

* *Ueber die Verbreitung der Wärme in den Gasen. Pogg, Ann., Febuar*, 1861. An abstract by the Editor of the *Annalen*, of an article published by Professor Magnus (in continuation of some previous investigations on this subject) in the *Monatsberichte der Akademie der Wissenchaften zu Berlin*. An abstract of this memoir, with some additional observations by M. Verdet, is also given in the *Annales de Chimie et de Physique* for March, 1861; but in this, many of the conclusions, as given by Prof. Magnus, are omitted.—E. J. C.

"3. The temperature is also higher in this gas than in a vacuum; and the denser the gas employed, the higher the temperature.

"4. Hydrogen, therefore, conducts heat like a metal.

"5. In all other gases the final temperature, as shown by an enclosed thermometer, is lower than in a vacuum; and the denser these gases become, the lower the temperature falls.

"6. It must not be concluded from this, however, that the gases in question do not conduct heat at all; but only that their powers of conduction are so feeble, as to be unable to overcome the opposition offered by their substance to the transmission of heat.

"7. The striking conductibility of hydrogen is not only manifested when the gas is entirely free, so to say, within itself, but also when the enclosing vessel is filled with eider-down or other flocculent matters by which the free motion of the hydrogen is more or less hindered.

"8. All gases, including hydrogen, offer a certain opposition to the passage of heat-rays; and the denser the gas, the greater this opposition.

"9. Of all gases, atmospheric air, (and its constituents) offers the least opposition to the passage of heat.

"10. The transmission of heat varies according to the source from which the heat comes. The rays which proceed from boiling water exhibit the greatest variation as regards their passage through different gases.

"11. Of all colourless gases, Ammonia transmits the least heat. Next to this stands Olefiant gas.

"12. The action of rays of heat, like those of light, may be increased by the employment of a tube.

"13. The nature or condition of the inner surface of the tube affects the transmission of these rays.

"14. The character of this surface changes also the conditions under which the rays are transmitted through different gases.

"15. It follows consequently, that rays reflected from different surfaces are transmitted through gases with different degrees of facility.

"16. The rays transmitted from different sources of heat always pass through hydrogen gas with greater difficulty than through atmospheric air.

"17. The high temperature indicated by a thermometer placed in hydrogen gas into which heat is transmitted from above, does not depend therefore on the possession, by this gas, of higher heat-transmitting powers, but solely on its greater power of conduction.

"18. This striking conductibility affords an additional proof of the analogy of hydrogen to the metals.

"19. Hydrogen also conducts electricity better than other gases.

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# ON THE ELECTRICITY OF THE FLAMES OF HYDROGEN AND ALCOHOL.

BY M. MATEUCCI.

*(Translated from the Annales de Chimie et de Physique. Mars, 1861.)*

It has been generally admitted, hitherto, that the electrical manifestations discovered by M. Pouillet in the flame of hydrogen, depend on the chemical phenomena of combustion. Subsequently to M. Pouillet's researches, I shewed the analogy which exists between these electrical phenomena and the fact that a voltaic couple may be obtained by the immersion in water of two strips of platinum, one of which has been (or is) in contact with hydrogen, and the other with oxygen.

More lately, M. Hankel has made some interesting experiments on the same subject, but these, I should observe, are only known to me by an extract give. in the *Annales de Chimie*, by M. Verdet. According to the latter, the experiments of M. Hankel show clearly that the chemical reactions which take place in the flame, go for nothing in the production of the electricty observed therein. This conclusion, however, does not appear to be sufficiently proved by the experiments cited in the extract, and it is contradicted, moreover, by an apparently decisive experiment of my own, to which I now beg to recal attention This experiment was made some time ago, but I have subsequently verified it by repetition under different conditions. It is made with a galvanometer of 24,000 coils, the ends of which consist of two platinum wires terminating in spirals. The homogeneity of the wires is secured by plunging them into distilled water. They are then suffered to dry in the air, and one is inserted into the central or obscure portion of a hydrogen (or alcohol) flame, whilst the other is placed at the point of the flame itself. A current is immediately set up, passing from the wire in the central part of the flame, to that placed in contact with the outer envelope of this or with the atmospheric air. It is well known that gas or vapours heated to a certain temperature become conductors, and hence, there is an analogy between the conditions of this experiment and those of the one mentioned above, in which two strips of platinum are plunged into water, after having been in contact, the one with hydrogen, and the other with oxygen. This analogy appears to me to be sustained by the following experiment. After the platinum wires are removed from the flame, as described above, they are allowed to cool in the air, and are then, after the lapse of several minutes, plunged into distilled water. A current is manifested of much greater intensity than that which originates in the flame; but the direction is similar—*id est*, from the wire that was placed in the centre of the flame to that which was in contact with the flame's outer surface. This fact may be verified by changing the positions of the wires. Finally, the wires which have been thus in contact with the flame, produce no current if plunged into mercury, whilst a current is obtained immediately on plunging them into water. This experiment, I must repeat therefore, appears to me to prove the existence of a certain analogy between the electrical phenomena of flame and those of the oxy-hydrogen battery. E. J. C.

## SCIENTIFIC AND LITERARY NOTES.

### CANADIAN CAVERNS.—BY GEORGE D. GIBB, M.D., ETC.

Dr. Gibb has dedicated to the *Canadian Institute* an interesting memoir on Canadian Caverns, read by him before the British Association for the Advancement of Science at Aberdeen, and subsequently published in the pages of the *Geologist*. In its present garb, this memoir forms an octavo pamphlet of some thirty pages, with eight lithographed plates. The caverns described—including a few beyond the confines of the Province—are arranged in two series, as in the following tabular view:—

*A.—Caverns, Arched Rocks, etc., washed by the waters of existing seas, lakes, or rivers.*

1. Caverns on the shores of the Magdalen Islands.
2. Caverns and arched rocks at Percé, Gaspé.
3. Gothic arched recesses, Gaspé Bay.
4. The "Old Woman" or flower-pot rock at Cape Gaspé.
5. Little River caverns, Bay of Chaleur.
6. Arched and flower-pot rocks of the Mingan Islands.

7. Pillar sandstones, north coast of Gaspé.
8. Niagara caverns.
9. Flower-pot Island, Lake Huron.
10. Perforations and caverns of Mackinac, Lake Huron.
11. Pictured Rocks, Lake Superior.
12. St. Ignatius caverns, Lake Superior.
13. Pilasters of Mammelles, Lake Superior.
14. Thunder Mountain and Paté Island Pilasters, Lake Superior.

B.—*Inland Caverns and Subterranean Passages.*

15. The Steinhauer Cavern, Labrador.
16. The basaltic caverns of Henley Island.
17. Empty basaltic dykes of Mecattina Islands, off south coast of Labrador.
18. Bigsby's cavern, Murray Bay.
19. Bouchette's cavern, Kildare (north of Montreal.)
20. Gibb's cavern, Montreal.
21. Protable caverns at Chatham on the Ottawa.
22. Colquhoun's cavern, Lanark.
23. Quartz cavern, Leeds.
24. Protable caverns at Kingston.
25. Mono cavern (County of Simcoe.)
26. Eramosa cavern (County of Waterloo.)
27. Cavern in the Bass Islands, Lake Erie.
28. Subterranean passages in the Great Manitoulin Island, Lake Huron.
29. Murray's cavern and subterranean river, Ottawa.

Up to this time, neither bones nor other animal remains appear to have been met with in any of the above excavations. A strict search, however, might lead to the discovery of these remains, beneath the stalagmitic deposit with which the floor of some of the caverns, described by Dr. Gibb, is more or less thickly covered.

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BAUXITE. HYDRATED SESQUIOXIDE OF IRON AND ALUMINA.

Large deposits of this peculiar compound have been announced by M. Deville as occurring in the Department of the Bouches-du-Rhône, (Commune of Beaux near Arles) and in those of the Gard and Var, in the south of France. Its occurrence in rock masses is also reported from Calabria. Analysis shews the presence (as essential components) of alumina, sesquioxide of iron, and water, although in variable proportions, the substance being rather a rock than a mineral, properly so-called. It is evidently, moreover, an altered product. Many samples are smelted as an ore of iron, yielding from 33 to 43 per cent. of cast metal. Others are employed in the *usines* of Salyndres in the preparation of alumina and aluminium. When strongly heated, it becomes converted into a crystalline corundum, resembling emery both in aspect and in physical and chemical characters. Additional observations of much interest on the geological conditions of this substance are promised by M.M. Le Chatelier and Meissonnier, to whom M. Deville was indebted for his specimens. *Annales de Chimie et de Physique, Mars,* 1861.

E. J. C.

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST—APRIL, 1861.

*Latitude—43 deg. 39.4 min. North. Longitude—5 h. 17 min. 33 sec. West. Elevation above Lake Ontario, 108 feet.*

| Day. | Barom. at temp. of 32°. 6 A.M. | 2 P.M. | 10 P.M. | MEAN. | Temp. of the Air. 6 A.M. | 2 P.M. | 10 P.M. | ME'N | Excess of mean above Average | Tens. of Vapour. 6 A.M. | 2 P.M. | 10 P.M. | M'N | Humidity of Air. 6 A.M. | 2 P.M. | 10 P.M. | M'N | Direction of Wind. 6 A.M. | 2 P.M. | 10 P.M. | Resultant Direction. | Velocity of Wind. 6 A.M. | 2 P.M. | 10 P.M. | Result. | ME'N | Rain in Inches. | Snow in Inches. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 29.777 | 29.573 | 29.516 | 29.6112 | 32.2 | 31.6 | 33.1 | 32.28 | — 3.95 | .118 | .170 | .184 | .162 | .64 | .96 | .98 | .89 | E | E b S | E | S 89 E | 19.2 | 21.3 | 10.3 | 12.22 | 16.38 | Inp. | 6.0 |
| 2 | .678 | .755 | .817 | .7568 | 28.7 | 36.0 | 32.4 | 32.85 | — 3.78 | .145 | .144 | .152 | .150 | .92 | .68 | .83 | .81 | W b S | W N W | N | N 63 W | 2.5 | 9.0 | 1.0 | 3.20 | 3.75 | ... | ... |
| 3 | .880 | .920 | 30.018 | .9483 | 26.2 | 37.4 | 29.1 | 32.05 | — 4.97 | .116 | .170 | .141 | .148 | .82 | .76 | .87 | .81 | N | S | S E b E | N 70 E | 4.4 | 1.0 | 0.5 | 0.67 | 1.28 | ... | ... |
| 4 | 30.081 | 30.050 | 29.993 | 30.0412 | 32.0 | 38.1 | 31.6 | 34.28 | — 3.05 | .166 | .169 | .132 | .156 | .91 | .74 | .74 | .79 | N E | E S E | Calm. | N 84 E | 4.7 | 1.2 | 0.0 | 1.83 | 2.24 | .. | ... |
| 5 | 29.980 | 29.961 | .924 | 29.9473 | 29.1 | 43.4 | 36.7 | 37.80 | + 0.08 | .126 | .125 | .128 | .126 | .78 | .44 | .59 | .56 | Calm. | S E b E | N | N 57 E | 0.0 | 3.8 | 4.2 | 2.27 | 3.23 | ... | ... |
| 6 | .910 | .884 | .857 | .8843 | 38.1 | 45.4 | 40.3 | 41.47 | + 3.43 | .109 | .134 | .201 | .151 | .47 | .44 | .80 | .58 | E N E | E b N | E | N 80 E | 5.8 | 15.5 | 15.2 | 12.95 | 12.98 | ... | ... |
| 7 | .786 | .769 | — | — | 37.1 | 43.2 | — | — | — | .182 | .217 | — | — | .83 | .77 | — | — | E b N | E b N | E b S | N 83 E | 10.6 | 19.8 | 4.0 | 13.02 | 13.20 | ... | ... |
| 8 | .714 | .675 | .630 | .6688 | 36.0 | 43.9 | 39.9 | 40.30 | + 1.58 | .172 | .235 | .155 | .191 | .81 | .82 | .62 | .75 | E b N | E | E b N | N 85 E | 12.0 | 19.5 | 16.5 | 16.04 | 16.06 | 0.015 | ... |
| 9 | .618 | .610 | .683 | .6403 | 37.1 | 46.6 | 46.4 | 43.67 | + 4.63 | .192 | .145 | .221 | .183 | .86 | .47 | .70 | .66 | E b N | E b N | E b N | N 79 E | 14.5 | 22.0 | 12.0 | 14.63 | 14.70 | 0.015 | ... |
| 10 | .725 | .758 | .726 | .7387 | 37.0 | 52.6 | 39.9 | 44.13 | + 4.72 | .124 | .130 | .190 | .147 | .56 | .33 | .77 | .53 | N E | S E b E | N b W | N 67 E | 4.8 | 7.4 | 1.5 | 2.31 | 4.47 | ... | ... |
| 11 | .734 | .663 | .541 | .6327 | 36.7 | 55.5 | 47.2 | 47.88 | + 8.15 | .171 | .241 | .138 | .201 | .78 | .54 | .42 | .59 | Calm. | E | E b N | N 87 E | 0.0 | 9.8 | 13.2 | 7.52 | 7.78 | 0.072 | ... |
| 12 | .506 | .447 | .393 | .4363 | 42.8 | 55.5 | 47.2 | 47.83 | + 7.70 | .258 | .315 | .310 | .287 | .94 | .71 | .95 | .87 | E | S E | Calm. | S 78 E | 6.2 | 5.6 | 0.0 | 4.30 | 4.60 | 0.515 | ... |
| 13 | .249 | .183 | .222 | .2155 | 42.8 | 55.6 | 46.8 | 48.62 | + 8.18 | .258 | .348 | .282 | .301 | .94 | .79 | .89 | .88 | E N E | S S E | W S W | S 77 W | 2.8 | 4.6 | 1.6 | 3.09 | 5.78 | Inp. | ... |
| 14 | .322 | .453 | — | — | 41.0 | 43.2 | — | — | — | .184 | .155 | — | — | .71 | .54 | — | — | W b N | W b N | W b N | N 76 W | 12.8 | 22.2 | 7.0 | 13.56 | 13.79 | ... | ... |
| 15 | .588 | .639 | .640 | .6308 | 34.2 | 37.8 | 35.3 | 35.95 | — 5.10 | .177 | .165 | .170 | .170 | .89 | .72 | .83 | .80 | Calm. | S S E | Calm. | N 42 E | 0.0 | 4.2 | 0.0 | 1.38 | 2.88 | ... | Inp. |
| 16 | .634 | .514 | .388 | .4918 | 33.1 | 42.8 | 37.8 | 38.50 | — 2.92 | .167 | .143 | .090 | .146 | .88 | .51 | .38 | .62 | N N E | N E | N E b N | N 32 E | 6.2 | 11.6 | 17.0 | 12.54 | 13.57 | ... | ... |
| 17 | .257 | .199 | .324 | .2602 | 32.4 | 43.2 | 33.1 | 36.03 | — 5.72 | .138 | .139 | .130 | .125 | .75 | .48 | .69 | .60 | N N W | N W b N | W b N | N 38 W | 16.4 | 25.5 | 13.0 | 15.99 | 16.76 | ... | ... |
| 18 | .247 | .133 | .273 | .2183 | 30.2 | 33.3 | 32.7 | 32.45 | — 9.62 | .149 | .165 | .172 | .158 | .89 | .86 | .92 | .86 | Calm | E N E | N E b N | N 21 E | 0.0 | 8.2 | 1.0 | 4.54 | 5.40 | ... | 0.7 |
| 19 | .414 | .486 | .576 | .5052 | 29.8 | 43.2 | 34.2 | 36.27 | — 6.08 | .147 | .217 | .130 | .160 | .88 | .77 | .66 | .74 | N N W | N W b N | W N W | N 34 W | 9.5 | 14.5 | 9.0 | 12.12 | 12.33 | .. | ... |
| 20 | .662 | .555 | .554 | .5865 | 33.8 | 38.2 | 40.3 | 41.30 | — 1.48 | .166 | .216 | .185 | .191 | .85 | .64 | .73 | .72 | Calm. | S W b S | S W | S 52 W | 0.0 | 18.0 | 2.3 | 6.63 | 7.40 | ... | ... |
| 21 | .612 | .622 | — | — | 37.8 | 52.9 | — | — | — | .157 | .224 | — | — | .69 | .56 | — | — | N b W | E S E | E N E | E | 3.4 | 6.5 | 9.0 | 5.96 | 7.68 | 0.025 | ... |
| 22 | .391 | .263 | .375 | .3392 | 42.5 | 59.4 | 60.1 | 54.77 | +11.40 | .207 | .276 | .402 | .307 | .76 | .54 | .77 | .70 | E N E | S S E | N W b W | S 79 W | 10.0 | 6.5 | 9.0 | 2.32 | 8.63 | 0.005 | ... |
| 23 | .529 | .510 | .443 | .4898 | 48.6 | 50.0 | 49.3 | 49.02 | + 5.32 | .279 | .324 | .313 | .304 | .81 | .89 | .88 | .87 | N N W | S W b S | E b N | N 68 E | 6.8 | 0.8 | 8.0 | 2.10 | 4.32 | 0.037 | ... |
| 24 | .325 | .297 | .354 | .3282 | 42.8 | 59.0 | 47.9 | 50.02 | + 6.02 | .268 | .357 | .193 | .245 | .98 | .71 | .57 | .71 | E S E | S W b S | S W b W | S 63 W | 3.2 | 21.6 | 9.4 | 11.09 | 13.10 | 0.005 | ... |
| 25 | .401 | .585 | .618 | .5792 | 40.7 | 50.0 | 42.5 | 43.98 | — 0.42 | .161 | .193 | .190 | .176 | .63 | .53 | .69 | .61 | W b N | W b N | N W | N 69 W | 17.0 | 17.0 | 5.5 | 10.19 | 10.83 | ... | ... |
| 26 | .723 | .663 | .570 | .6437 | 36.0 | 47.1 | 42.8 | 43.27 | — 1.43 | .175 | .194 | .213 | .194 | .83 | .59 | .77 | .69 | N | E S E | E | S 89 E | 2.0 | 9.8 | 11.0 | 9.19 | 9.50 | ... | ... |
| 27 | .391 | .229 | .085 | .2170 | 41.0 | 52.6 | 52.6 | 48.67 | + 3.65 | .210 | .290 | .375 | .286 | .81 | .73 | .94 | .82 | E b N | E | N E b E | N 82 E | 7.5 | 8.4 | 6.5 | 6.12 | 9.21 | 0.615 | ... |
| 28 | .087 | .316 | — | — | 46.1 | 52.6 | — | — | — | .292 | .321 | — | — | .94 | .80 | — | — | W | W N W | S E b E | N 52 W | 26.6 | 15.0 | 0.8 | 10.13 | 11.62 | ... | ... |
| 29 | .445 | .390 | .415 | .4182 | 40.5 | 60.5 | 50.4 | 51.03 | + 5.30 | .199 | .338 | .289 | .266 | .79 | .64 | .78 | .70 | E b N | S W | S W b W | S 40 W | 1.5 | 10.7 | 1.5 | 3.41 | 5.56 | ... | ... |
| 30 | .421 | .430 | .443 | .4338 | 47.5 | 51.1 | 43.9 | 48.12 | + 2.07 | .255 | .269 | .218 | .236 | .77 | .71 | .75 | .70 | W b S | W b N | W b N | N 39 W | 5.0 | 8.0 | 3.2 | 5.28 | 8.08 | 0.315 | 0.2 |
| M | 29.5900 | 29.5528 | 29.5544 | 29.5640 | 36.61 | 46.92 | 41.29 | 42.02 | + 1.03 | .179 | .216 | .204 | .199 | .81 | .65 | .75 | .73 | ...... | ...... | ...... | ...... | 7.18 | 11.63 | 6.44 | ...... | 8.90 | 1.619 | 6.9 |

## REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR APRIL, 1861.

Highest Barometer ........................ 30.120 at 8 a. m. on 4th } Monthly range=
Lowest Barometer ........................ 29.055 at midn't on 27th } 1.065 inches.

Self-registering Thermom.:
- Maximum Temperature ............... 67°0 on p.m. of 22nd } Monthly range=
- Minimum Temperature ............... 23°8 on a.m. of 3rd } 43°2
- Mean maximum Temperature ..................... 49°71 } Mean daily range=
- Mean minimum Temperature ..................... 35°35 } 14°36
- Greatest daily range ........... 28°8 from a. m. to p. m. of 29th.
- Least daily range................. 2°5 from a. m. to p. m. of 14th.

Warmest day......... 22nd... Mean temperature......... 54.77 } Difference = 22°72.
Coldest day........... 3rd... Mean temperature......... 32°05 }
Maximum Radiation. { Solar................................ 81°8 on p. m. of 13th } Monthly range =
{ Terrestrial.............................. 15°9 on a. m. of 3rd } 65°9
Aurora observed on 5 nights, viz.: 2nd, 4th, 8th, 9th, and 15th.
Possible to see Aurora on 17 nights; impossible on 13 nights.
Snowing on 4 days; depth 6.9 inches; duration of fall 22.0 hours.
Raining on 12 days,—depth 1.619 inches; duration of fall 29.3 hours.
Mean of cloudiness = 0.61. Above average 0.03.
Most cloudy hour observed, 6 a. m., mean = 0.67; least cloudy hour observed, 10 p.m., mean, = 0.54.

*Sums of the components of the Atmospheric Current, expressed in miles.*

| North. | South. | East. | West. |
|---|---|---|---|
| 2029.31 | 708.36 | 3088.56 | 2082.41 |

Resultant direction N. 37° E.; Resultant velocity 2.31 miles per hour.
Mean velocity.......................... 8.90 miles per hour.
Maximum velocity .................. 33.0 miles, from 5 to 6 a. m. on 28th.
Most windy day .........17th......... Mean velocity, 16.70 miles per hour. } Difference=
Least windy day......... 3rd......... Mean velocity 1.28 ditto. } 15.48 miles.
Most windy hour ...... 3 to 4 p.m............Mean velocity 12.31 ditto. } Difference =
Least windy hour...... 9 to 10 p.m...........Mean velocity 6.35 ditto. } 5.96 miles.

1st. Very stormy day; snowing and drifting from 8 a. m. to 10 p. m.
4th. Solar halo during the forenoon
5th. Solar halo at 2 p. m. 6th. Solar halo at 2 and 4 p. m.
12th. Frogs croaking at night, (first heard this season).
13th. Foggy at 6 and 8 a. m.; wild pigeons numerous.
18th. Slight snow from 10 a. m. to 8 p. m. Cold day.
19th. Solar halo from 9 a. m. to 2 p. m.
21st. Lunar halo at 8 p. m.
22nd. Thunderstorm, lightning, and rain, 7 to 9 p. m.
23rd. Thunderstorm, lightning, and rain, 9 p. m. to midnight.
24th. Dense fog, 6 and 8 a. m., and imperfect rainbow at 5.30 p.m.
25th. Solar halo at 6 a. m.; lunar corona at midnight.
26th. Solar halo at 1 and 2 p. m.
27th. Thunderstorm, lightning, and rain, 7 to 9 p. m.
30th. Thunderstorm, lightning, and rain, 1.20 to 3.20 p. m.

The Resultant Direction and Velocity of the Wind for the month of April, from 1848 to 1861 inclusive, were respectively N. 19 W. and 2.04 miles.

### COMPARATIVE TABLE FOR APRIL.

| YEAR. | TEMPERATURE. | | | | | RAIN. | | SNOW. | | WIND. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M'n. | Diff. from Aver. | Max. ob'd. | Min. ob'd. | Range. | No. of days. | Inch's. | No. of days. | Inch's. | Resultant Direction. | Resultant V'y. | Mean Force or Velocity. |
| 1840 | ° 42.4 | +1.4 | ° 65.9 | ° 25.3 | ° 40.6 | 14 | 3.420 | 2 | ... | ... | ... | ......... |
| 1841 | 39.2 | —1.8 | 62.9 | 22.1 | 40.8 | 3 | 1.370 | 3 | ... | ... | ... | 0.51 lbs. |
| 1842 | 43.1 | +2.1 | 89.5 | 21.6 | 67.9 | 8 | 3.740 | 2 | ... | ... | ... | 0.57 |
| 1843 | 40.9 | —0.1 | 70.0 | 15.1 | 54.9 | 7 | 3.185 | 3 | 0.1 | ... | ... | 0.46 |
| 1844 | 47.5 | +6.5 | 74.5 | 17.2 | 57.3 | 10 | 1.515 | 1 | Inap. | ... | ... | 0.24 |
| 1845 | 42.1 | +1.1 | 66.0 | 14.8 | 51.2 | 11 | 3.290 | 4 | 1.5 | ... | ... | 1.00 |
| 1846 | 44.0 | +3.0 | 79.4 | 24.4 | 55.0 | 10 | 1.300 | 2 | 1.3 | ... | ... | 0.55 |
| 1847 | 39 2 | —1.8 | 65.6 | 8.4 | 57.2 | 8 | 2.870 | 2 | 4.0 | ... | ... | 0.59 |
| 1848 | 41.3 | +0.3 | 65.4 | 26.5 | 38.9 | 5 | 1.455 | 1 | 0.5 | N 77° W | 1.46 | 4.89 mls. |
| 1849 | 39.0 | —2.0 | 70.9 | 23.2 | 47.7 | 10 | 2.655 | 2 | 1.7 | N 43° W | 3.14 | 7.50 |
| 1850 | 37.9 | —3.1 | 63.2 | 18.2 | 45.0 | 7 | 4.720 | 2 | 1.1 | N 39° W | 1.12 | 7.64 |
| 1851 | 41.3 | +0.3 | 59.2 | 25.8 | 33.4 | 11 | 2.295 | 3 | 1.2 | N 14° E | 2.52 | 8.07 |
| 1852 | 38.2 | —2.8 | 53.8 | 19.8 | 34.0 | 6 | 1.990 | 4 | 9.4 | N 23° E | 2.44 | 6.68 |
| 1853 | 41.9 | +0.9 | 65.7 | 27.0 | 38 7 | 10 | 2.625 | 1 | 1.0 | N 12° W | 1.95 | 5.20 |
| 1854 | 41.0 | 0.0 | 65.1 | 22.3 | 42.8 | 12 | 2.685 | 4 | 2.7 | N 50° E | 2.57 | 6.81 |
| 1855 | 42.4 | +1.4 | 63.8 | 12.2 | 51 6 | 8 | 2.030 | 3 | 1.6 | N 36° W | 3.99 | 7.57 |
| 1856 | 42.3 | +1.3 | 69.8 | 15.1 | 54.7 | 13 | 2.780 | 3 | 0.1 | N 29° E | 1.64 | 6.05 |
| 1857 | 35.4 | —5.6 | 51.9 | 10.0 | 41.9 | 10 | 1.755 | 11 | 12.9 | N 60° W | 4.15 | 10.24 |
| 1858 | 41.5 | +0.5 | 61.5 | 23.8 | 37.7 | 13 | 1.642 | 2 | 0.1 | N 14° W | 1.64 | 9.57 |
| 1859 | 39.5 | —1.5 | 62.1 | 23.9 | 38.2 | 9 | 2.527 | 8 | 1.2 | N 36° W | 2.33 | 10.79 |
| 1860 | 39.5 | —1.5 | 60.7 | 19.7 | 41.0 | 11 | 1.282 | 5 | 0.3 | N 37° W | 4.10 | 10.30 |
| 1861 | 42.0 | +1.0 | 62.3 | 26.2 | 36.1 | 12 | 1.619 | 4 | 6.9 | N 37° E | 2.31 | 8.90 |
| M | 40.98 | ... | 65.87 | 20.12 | 45.75 | 9.5 | 2.398 | 3.3 | 2.51 | ......... | ... | 7.87 Ml. |
| Diff. from av'g. | + 1.04 | ... | — 3.57 | + 6.08 | — 9.65 | + 2.5 | — 0.779 | + 0.7 | + 4.39 | ......... | ... | + 1.03 |

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—MAY, 1861.

*Latitude—43 deg. 39.4 min. North. Longitude—5 h. 17 m. 33 s. West. Elevation above Lake Ontario, 108 feet.*

| Day. | Barom. at temp. of 32°. | | | | Temp. of the Air. | | | | Excess of mean above Average | Tens. of Vapour. | | | | Humidity of Air. | | | | Direction of Wind. | | | Resul't. Direction. | Velocity of Wind. | | | | | Rain in inches. | Snow in inches. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6 A.M. | 2 P.M. | 10 P.M. | Mean. | 6 A.M. | 2 P.M. | 10 P.M. | ME'N | | 6 A.M. | 2 P.M. | 10 P.M. | M'N | 6 A.M. | 2 P.M. | 10 P.M. | M'N | 6 A. M. | 2 P. M. | 10 P. M. | | 6 A.M. | 2 P.M. | 10 P.M. | Result'. | ME'N | | |
| 1 | 29.466 | 29.690 | 29.813 | 29.6632 | 32.7° | 39.2° | 33.1° | 34.93° | −11.48° | .180 | .147 | .108 | .143 | .97 | .61 | .56 | .70 | N b W | N W | N W b N | N 37° W | 23.5 | 29.5 | 19.0 | 21.32 | 21.62 | ... | 0.5 |
| 2 | .870 | .821 | .766 | .8167 | 29.1 | 42.8 | 33.1 | 36.03 | −10.68 | .141 | .195 | .130 | .146 | .87 | .71 | .69 | .69 | N W b N | N W b W | Calm. | N 43 W | 13.5 | 11.6 | 0.0 | 5.20 | 7.23 | ... | ... |
| 3 | .721 | .631 | .625 | .6610 | 34.2 | 44.3 | 34.2 | 37.72 | − 9.33 | .131 | .106 | .131 | .125 | .66 | .36 | .66 | .56 | N b E | E b S | N E | N 70 E | 2.5 | 9.0 | 4.0 | 5.27 | 6.32 | ... | ... |
| 4 | .789 | .671 | .623 | .6523 | 37.4 | 48.6 | 38.8 | 42.57 | − 4.85 | .110 | .137 | .160 | .136 | .48 | .40 | .68 | .51 | N b E | S S W | N W | S 37 W | 3.2 | 8.2 | 1.6 | 1.44 | 4.44 | ... | ... |
| 5 | .616 | .440 | — | — | 40.3 | 51.8 | — | — | — | .158 | .181 | — | — | .63 | .45 | — | — | N b E | E b N | E | N 89 E | 2.0 | 13.2 | 10.0 | 11.33 | 11.46 | 0.260 | ... |
| 6 | .234 | .056 | 28.644 | 28.9728 | 45.0 | 51.1 | 47.9 | 47.75 | − 0.28 | .269 | .309 | .311 | .294 | .90 | .82 | .93 | .89 | E b S | N E b E | N W b N | N 22 E | 6.5 | 11.5 | 25.5 | 4.04 | 15.96 | 1.845 | ... |
| 7 | 28.766 | 28.819 | 28.994 | 28.8720 | 49.0 | 52.7 | 46.4 | 49.52 | + 1.10 | .257 | .278 | .270 | .265 | .74 | .70 | .85 | .75 | W b S | W S W | W S W | S 76 W | 18.0 | 23.0 | 10.6 | 14.99 | 15.53 | 0.100 | ... |
| 8 | 29.106 | 29.317 | 29.485 | 29.3225 | 40.7 | 49.0 | 42.5 | 44.17 | − 4.62 | .205 | .206 | .218 | .206 | .80 | .59 | .80 | .72 | N W b N | N W b N | N | N 40 W | 11.8 | 14.5 | 4.2 | 8.74 | 9.06 | Inp. | ... |
| 9 | .574 | .695 | .573 | .5850 | 38.5 | 52.6 | 43.2 | 44.93 | − 4.23 | .199 | .269 | .209 | .224 | .84 | .67 | .74 | .74 | Calm. | S | Calm. | S 26 E | 0.0 | 4.0 | 0.0 | 2.08 | 2.59 | ... | ... |
| 10 | .510 | .302 | .301 | .3688 | 41.7 | 47.2 | 45.7 | 45.05 | − 4.38 | .200 | .203 | .288 | .231 | .76 | .61 | .94 | .76 | N E b E | E b N | N E b E | N 69 E | 5.4 | 15.2 | 5.6 | 6.71 | 7.17 | 0.165 | ... |
| 11 | .355 | .424 | .465 | .4158 | 46.4 | 54.4 | 46.1 | 48.58 | − 1.32 | .249 | .298 | .273 | .270 | .79 | .69 | .87 | .79 | N N E | S S E | Calm. | S 43 W | 3.0 | 4.8 | 0.0 | 0.69 | 2.92 | ... | ... |
| 12 | .522 | .552 | — | — | 47.9 | 60.1 | — | — | — | .268 | .299 | — | — | .81 | .57 | — | — | Calm. | S E b E | Calm. | S 61 E | 0.0 | 1.8 | 0.0 | 1.70 | 3.07 | ... | ... |
| 13 | .522 | .396 | .503 | .3910 | 48.6 | 46.4 | 46.8 | 47.82 | − 2.75 | .279 | .288 | .302 | .296 | .81 | .91 | .94 | .89 | E N E | E b N | Calm. | N 82 E | 3.6 | 14.4 | 0.0 | 7.07 | 7.51 | 0.020 | ... |
| 14 | .289 | .384 | .518 | .4073 | 45.3 | 54.7 | 50.8 | 50.45 | − 0.43 | .281 | .251 | .230 | .259 | .94 | .59 | .62 | .71 | S W | W b S | W | S 79 W | 5.2 | 22.5 | 9.5 | 11.09 | 11.27 | ... | ... |
| 15 | .572 | .425 | .406 | .4573 | 44.6 | 54.4 | 41.3 | 48.90 | − 2.38 | .235 | .252 | .258 | .246 | .80 | .59 | .89 | .73 | Calm. | S E b E | W | S 62 W | 0.0 | 9.0 | 11.0 | 3.72 | 7.16 | 0.170 | ... |
| 16 | .433 | .538 | .647 | .5480 | 42.5 | 49.3 | 40.7 | 44.33 | − 7.25 | .227 | .194 | .223 | .210 | .83 | .51 | .87 | .73 | W | W b N | W b N | N 75 W | 2.2 | 21.5 | 8.6 | 15.00 | 15.15 | ... | ... |
| 17 | .708 | .764 | .847 | .7747 | 40.7 | 48.2 | 38.9 | 42.23 | − 9.70 | .188 | .179 | .134 | .162 | .73 | .52 | .57 | .60 | N W b W | N W b N | N W b N | N 37 W | 14.0 | 19.5 | 8.5 | 14.25 | 14.65 | ... | ... |
| 18 | .877 | .872 | .862 | .8725 | 35.2 | 50.0 | 42.8 | 44.13 | − 8.15 | .164 | .261 | .168 | .208 | .80 | .72 | .61 | .71 | N W | S | S E b E | N 86 W | 10.6 | 9.3 | 2.0 | 1.22 | 6.41 | ... | ... |
| 19 | .825 | .714 | — | — | 41.0 | 47.5 | — | — | — | .175 | .170 | — | — | .67 | .50 | — | — | N N E | N E b E | N E b N | N 52 E | 5.9 | 10.0 | 5.0 | 7.24 | 7.54 | Inp. | ... |
| 20 | .576 | .559 | .607 | .5775 | 46.4 | 54.4 | 49.0 | 50.53 | − 2.48 | .221 | .256 | .274 | .252 | .70 | .60 | .79 | .69 | N E b N | S E b S | N | N 51 E | 10.0 | 6.6 | 4.5 | 3.64 | 7.91 | ... | ... |
| 21 | .661 | .681 | .725 | .6910 | 47.1 | 60.1 | 48.8 | 52.70 | − 0.62 | .241 | .152 | .116 | .188 | .74 | .29 | .33 | .48 | N | N N W | N N W | N 22 W | 13.0 | 16.6 | 15.0 | 11.65 | 11.83 | ... | ... |
| 22 | .804 | .806 | .802 | .8103 | 45.4 | 60.9 | 48.6 | 52.45 | − 1.25 | .225 | .276 | .193 | .236 | .74 | .51 | .55 | .59 | N N W | S b W | S b W | S 54 W | 5.4 | 9.0 | 1.5 | 1.14 | 2.47 | ... | ... |
| 23 | .849 | .802 | .712 | .7792 | 42.1 | 56.9 | 51.1 | 50.90 | − 3.07 | .213 | .253 | .309 | .249 | .79 | .54 | .82 | .67 | Calm. | S E b E | E b S | S 77 E | 0.0 | 6.5 | 4.0 | 4.10 | 4.44 | ... | ... |
| 24 | .624 | .455 | .422 | .4968 | 50.0 | 63.0 | 54.4 | 56.82 | + 2.53 | .274 | .322 | .308 | .318 | .75 | .55 | .72 | .68 | E | S S W | S S W | S 47 W | 3.0 | 15.0 | 1.6 | 6.40 | 8.98 | 0.625 | ... |
| 25 | .401 | .385 | .409 | .3893 | 56.9 | 72.0 | 58.0 | 62.25 | + 7.57 | .408 | .515 | .343 | .419 | .88 | .65 | .71 | .74 | W N W | N W b W | W N W | N 60 W | 7.2 | 17.0 | 5.5 | 10.78 | 11.08 | ... | ... |
| 26 | .372 | .245 | — | — | 52.9 | 61.9 | — | — | — | .296 | .354 | — | — | .74 | .61 | — | — | N W b W | S b W | E b N | N 87 E | 12.0 | 3.6 | 8.5 | 1.79 | 7.10 | 0.115 | ... |
| 27 | 28.746 | .080 | .347 | .0860 | 49.0 | 50.0 | 42.1 | 47.33 | − 7.95 | .326 | .214 | .213 | .251 | .94 | .59 | .79 | .76 | N N E | W N W | N W b W | N 61 W | 4.0 | 37.9 | 28.5 | 27.39 | 27.96 | Inp. | ... |
| 28 | 29.483 | .531 | .615 | .5527 | 42.5 | 60.1 | 44.6 | 48.00 | − 7.65 | .164 | .181 | .217 | .197 | .59 | .34 | .74 | .60 | N W b W | W b N | N W b N | N 45 W | 20.0 | 10.6 | 7.0 | 10.28 | 11.50 | 0.080 | ... |
| 29 | .717 | .754 | .844 | .7767 | 42.8 | 52.2 | 42.1 | 45.82 | −10.13 | .223 | .244 | .178 | .215 | .81 | .62 | .66 | .69 | N W | N W | N W b W | N 47 W | 8.8 | 9.0 | 1.0 | 4.81 | 6.07 | ... | ... |
| 30 | .930 | .909 | .888 | .9095 | 40.3 | 60.1 | 50.8 | 51.62 | − 4.63 | .158 | .287 | .230 | .233 | .63 | .54 | .62 | .60 | Calm. | S S W | W | S 33 W | 0.0 | 8.0 | 3.2 | 4.22 | 4.64 | ... | ... |
| 31 | .942 | .874 | .809 | .8683 | 49.0 | 63.7 | 48.6 | 54.80 | − 1.75 | .235 | .278 | .269 | .286 | .67 | .47 | .79 | .67 | N | E b S | N E b E | S 73 E | 1.4 | 5.0 | 1.7 | 2.52 | 3.12 | ... | ... |
| M | 29.5343 | 29.5389 | 29.5575 | 29.5454 | 43.08 | 53.27 | 44.94 | 47.50 | − 3.98 | .222 | .243 | .225 | .232 | .78 | .58 | .73 | .69 | ......... | ......... | ......... | ......... | 6.96 | 12.81 | 6.68 | ...... | 9.17 | 3.380 | 0.5 |

# REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR MAY, 1861.

| | | |
|---|---|---|
| Highest Barometer . . . . . . | 29.955 at 8 a. m. on 30th. | Monthly range= 1.311 inches. |
| Lowest Barometer . . . . . . | 28.644 at 10 p. m. on 6th. | |
| Self-registering Ther.: Maximum temperature . . . . | 73°0 on p.m. of 25th | Monthly range= 45°0 |
| Minimum temperature . . . . | 28°0 on a.m. of 2nd | |
| Mean maximum temperature . . | 55°69 | Mean daily range=15°65. |
| Mean minimum temperature . . | 40°04 | |
| Greatest daily range . . . . . . | 28°4 from a. m. to p. m. on 30th. | |
| Least daily range . . . . . . . | 5.0 from a. m. to p. m. on 13th. | |
| Warmest day . . 25th ... Mean Temperature . . | .=62°25 | Difference=27°32. |
| Coldest day . . . 1st ... Mean Temperature . . | .=34°93 | |
| Maximum Radiation: Solar . . . . . . . . . | 88°0 on p.m of 25th | Monthly range= 66°0. |
| Terrestrial . . . . . . | 22.0 on a. m. of 2nd | |

Aurora observed on 5 nights, viz: 4th, 8th, 15th, 16th, and 17th; possible to see Aurora on 18 nights; impossible on 13 nights.

Snowing on 1 day: depth, 0.5 inches; duration of fall, 1.0 hours.

Raining on 12 days; depth, 3.380 inches; duration of fall, 47.9 hours.

Mean of cloudiness=0.49, below average 0.04; most cloudy hour observed 8 a. m., mean =0.56; least cloudy hour observed 10 p. m., mean=0.36.

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*Sums of the components of the Atmospheric Current, expressed in Miles.*

| North. | South. | East. | West. |
|---|---|---|---|
| 2789.34 | 962.51 | 1507.67 | 3471.05 |

Resultant direction, N 47° W; Resultant Velocity, 3.60 miles per hour.

Mean velocity 9.17 miles per hour.

Maximum velocity . . . 43.6 miles, from noon to 1 p.m. on the 27th.

Most windy day . . 27th—Mean velocity 27.96 miles per hour. } Difference

Least windy day . . 22nd—Mean velocity, 2.47 do } 25.49 miles.

Most windy hour, 11 a.m. to noon.—Mean velocity, 13.36 miles per hour. } Difference

Least windy hour, 4 to 5 a. m.—Mean velocity, 5.07 do. } 8.29 miles.

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1st. Snowing and sleeting till 7 a m.; cold, stormy day.—2nd. Ice 0.5 inch thick at 6 a.m.; cold day.—3rd. Thin ice at 6 a.m.; cold day.—4th. Ice ¼ inch thick at 6 a.m.—10th. Solar halo during the forenoon.—Dense fog at 10 p.m. and midnight.—14th. Dense fog and heavy dew at 6 a.m.—15th. Distant thunder, p.m.: perfect rainbow at 7 p.m.—17th. Lunar halo at 10 p.m. and midnight.—18th. Lunar halo at 10 p.m.—23rd. Lunar halo at 10 p.m.—24th. Severe thunderstorm from 10 p.m. to 3 a.m. of 25th.—26th. Thunderstorm, vivid lightning, and moderate rain from 6 to 8 a.m.

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Hoar frost recorded on 5 mornings during the month.

Heavy dew observed on 6 mornings during the month.

The barometric reading at 10 p.m. on the 6th, was the lowest noted in any May during the last 22 years.

The 27th was the most windy day in May during the last 14 years.

The Resultant Direction and Velocity of the Wind for the month of May, from 1848 to 1861 inclusive, were respectively N. 2° W., and 1.49 miles.

May, 1861, was the coldest since the establishment of this Observatory.

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## COMPARATIVE TABLE FOR MAY.

| YEAR. | TEMPERATURE. Mean. | Difference from Average. | Maximum observed. | Minimum observed. | Range. | RAIN. No. of days. | Inches. | SNOW. No. of days. | Inches. | WIND. Resultant Direction. | Resultant Velocity. | Mean Velocity |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1840 | ° 53.8 | + 2.4 | ° 74.5 | ° 30.8 | ° 43.7 | 9 | 4.150 | 0 | ... | ° ... | ... | ... |
| 1841 | 50.5 | — 0.9 | 76.2 | 26.6 | 49.6 | 11 | 2.350 | 1 | ... | ... | ... | 0.35lbs |
| 1842 | 49.1 | — 2.3 | 74 3 | 30.0 | 44.3 | 7 | 1.275 | 0 | ... | ... | ... | 0.53 " |
| 1843 | 49.1 | — 2.3 | 79.6 | 28.9 | 50.7 | 5 | 1.570 | 0 | 0.0 | ... | ... | 0.52 " |
| 1844 | 53.6 | + 2.2 | 77.7 | 29.0 | 48.7 | 14 | 5.670 | 0 | 0.0 | ... | ... | 0.30 " |
| 1845 | 49.6 | — 1.8 | 76.6 | 29.4 | 47.2 | 8 | 2.300 | 0 | 0.0 | ... | ... | 0.55 " |
| 1846 | 55.5 | + 4.1 | 78.1 | 34.3 | 43.8 | 9 | 4.375 | 0 | 0.0 | ... | ... | 0.46 " |
| 1847 | 54.4 | + 3.0 | 72 5 | 27.8 | 44.7 | 12 | 2.040 | 0 | 0.0 | ... | ... | 0.29 " |
| 1848 | 54.1 | + 2.7 | 78.5 | 31.9 | 46.6 | 13 | 2.520 | 0 | 0.0 | N 40 W | 1.31 | 4.93ms. |
| 1849 | 48.0 | — 3.4 | 72.5 | 32.7 | 39.8 | 16 | 5.115 | 0 | 0.0 | N 51 E | 1.97 | 5.33 " |
| 1850 | 47.6 | — 3.8 | 76.3 | 31.1 | 45.2 | 7 | 0.545 | 1 | inap. | N 64 W | 2.05 | 6.32 " |
| 1851 | 51.3 | — 0.1 | 73.2 | 28.7 | 44.5 | 12 | 2.950 | 1 | 0.5 | N 32 W | 1.59 | 6.34 " |
| 1852 | 51 4 | 0.0 | 73.3 | [illegible] | 38.8 | 7 | 1.125 | 1 | inap. | S 82 W | 0.99 | 4.00 " |
| 1853 | 50.9 | — 0.5 | 78.4 | [illegible] | 40.0 | 17 | 4.420 | 1 | inap. | N 2 W | 0.83 | 5.16 " |
| 1854 | 52.2 | + 0.8 | 69.0 | 27.6 | 41.4 | 11 | 4.630 | 0 | 0.0 | E | 0.40 | 5.38 " |
| 1855 | 53.1 | + 1.7 | 74.8 | 33.9 | 40.9 | 6 | 2.565 | 2 | 0.9 | N 1 W | 2.76 | 5.93 " |
| 1856 | 50.5 | — 0.9 | 80.1 | 35.5 | 44.6 | 14 | 4.580 | 1 | inap. | N 4 E | 3.99 | 9.81 " |
| 1857 | 48.9 | — 2.5 | 72.5 | 27.9 | 44.6 | 15 | 4.145 | 1 | inap. | N 23 W | 1.14 | 8.13 " |
| 1858 | 48.9 | — 2.5 | 66 0 | 35.0 | 31.0 | 17 | 6.367 | 0 | 0.0 | N 42 E | 3.33 | 9.30 " |
| 1859 | 55.2 | + 3.8 | 76.2 | 41.5 | 34.7 | 11 | 3.410 | 0 | 0.0 | N 72 E | 1.59 | 5.70 " |
| 1860 | 55.5 | + 4.1 | 73.2 | 35.6 | 37.6 | 16 | 1 815 | 0 | 0.0 | N 26 E | 2.66 | 7.17 " |
| 1861 | 47.5 | — 3.9 | 72 0 | 29.1 | 42.9 | 12 | 3.380 | 1 | 0.5 | N 47 W | 3.60 | 9.17 " |
| Mean | 51.39 | ... | 74.80 | 31.83 | 42.97 | 11.3 | 3.241 | 0.5 | 0.10 | ... | ... | 6 62 |
| Diff. from Av'ge. | —3.89 | ... | —2.80 | —2.73 | —0.07 | + 0.7 | + 0.139 | + 0.5 | + 0.40 | ... | ... | + 2.55 |

# MONTHLY METEOROLOGICAL REGISTER, ST. MARTIN, ISLE JESUS, CANADA EAST—APRIL, 1861.

(NINE MILES WEST OF MONTREAL.)

BY CHARLES SMALLWOOD, M. D., LL.D.

*Latitude—45 deg. 32 min. North. Longitude—73 deg. 36 min. West. Height above the Level of the Sea—118 feet.*

| Day. | Barom. corrected and reduced to 32° | | | Temp. of the Air.—F. | | | Tension of Vapor. | | | Humidity of Air. | | | Direction of Wind. | | | Horizontal Movement in Miles in 24 hours. | Mean of Ozone. (tenths) | Rain in Inches. | Snow in Inches. | Weather, &c. A cloudy sky is represented by 10; A cloudless sky by 0. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 6 A.M. | 2 P.M. | 10 P.M. | 6 A.M. | 2 P.M. | 10 P.M. | 6 A.M. | 2 P.M. | 10 P.M. | 6 A.M. | 2 P.M. | 10 P.M. | 6 A.M. | 2 P.M. | 10 P.M. | | | | | 6 A.M. | 2 P.M. | 10 P.M. |
| 1 | 30.508 | 30.288 | 30.200 | 10.4 | 29.2 | 26.1 | .018 | .123 | .105 | .69 | .77 | .75 | N E b E | N E b E | N E b E | 225.40 | 3.0 | ... | ... | Clear. | Cu. Str. 10. | Cirr. Str. 10.S. |
| 2 | 162 | 159 | 220 | 26.2 | 34.0 | 26.1 | .111 | .170 | .105 | .80 | .80 | .80 | N E b E | N E b E | N E b E | 224.70 | 5.0 | ... | 7.23 | Snow. | Snow. | Snow. |
| 3 | 246 | 319 | 347 | 25.1 | 38.2 | 27.1 | .117 | .185 | .111 | .87 | .80 | .75 | N E b E | N E b E | W N W | 52.80 | 3.0 | ... | 1.10 | Cu. Str. 10. | C. C. Str. 6. | Clear. Z. l., b. |
| 4 | 280 | 108 | 212 | 15.4 | 53.4 | 31.9 | .065 | .321 | .147 | .74 | .80 | .80 | S W | W S W | W S W | 2.60 | 2.0 | ... | ... | Clear. | Clear. | Do. |
| 5 | 190 | 173 | 347 | 23.7 | 57.6 | 33.4 | .100 | .236 | .162 | .79 | .53 | .84 | N E | S S W | N W b W | 61.00 | 2.0 | ... | ... | Do. | Do. | Do. ft. A.B. |
| 6 | 260 | 387 | 332 | 27.1 | 56.1 | 33.2 | .111 | .282 | .162 | .75 | .63 | .86 | S E b E | S E b E | S W | 81.40 | 1.0 | ... | ... | Do. | Do. | Do. |
| 7 | 257 | 202 | 329 | 24.1 | 50.3 | 31.0 | .105 | .186 | .116 | .75 | 51 | .64 | S b W | W S W | W b N | 85.10 | 2.0 | ... | ... | Do. | Do. | Do. A.B. |
| 8 | 247 | 381 | 300 | 21.1 | 42.9 | 30.0 | .080 | .092 | .136 | .71 | .34 | .83 | N E b E | N E b E | N E b E | 113.80 | 1.0 | ... | ... | Do. | Do. | Do. |
| 9 | 124 | 107 | 039 | 20.8 | 47.4 | 18.5 | .069 | .225 | .180 | 63 | .70 | .77 | N E b E | N E b E | N E b E | 59.80 | 1.0 | ... | ... | Do. | Do. | Do. ft. A.B. |
| 10 | 007 | 29.945 | 29.957 | 20.2 | 61.0 | 42.0 | .089 | .413 | .162 | .72 | .77 | .61 | N | N | S S W | 0.10 | 1.0 | ... | ... | Do. | Do. | Str. 2. Au. St. |
| 11 | 008 | 30.006 | 30.101 | 30.0 | 54.6 | 36.5 | .130 | .231 | .170 | .78 | .53 | .80 | N E b E | E S E | N E b E | 85.30 | 2.0 | ... | ... | Do. | Do. | Clear. ft. A. B. |
| 12 | 020 | 29.920 | 29.874 | 27.2 | 52.8 | 45.0 | .111 | .276 | 251 | .25 | .70 | .84 | N E b E | S b E | [illegible] E | 98.90 | 3.5 | In'p. | ... | Cu. Str. 2. | C. C. Str. 10. | Cirr. Str. 10. |
| 13 | 29.714 | 474 | 511 | 42.1 | 52.1 | 44.6 | .244 | .361 | .265 | .91 | .93 | .91 | S E b E | S E b E | S [illegible] W | 88.50 | 4.5 | 0.831 | ... | Rain. | Rain. | Fog. |
| 14 | 397 | 411 | 647 | 40.3 | 47.6 | 36.7 | .241 | .249 | .184 | .96 | .77 | .85 | S E b E | S E b E | W S W | 151.20 | 3.5 | In'p. | ... | Fog. | Cu. Str. 10. | Cirr. Str. 10. |
| 15 | 747 | 740 | 914 | 31.6 | 40.9 | 32.4 | .140 | .145 | .143 | 84 | .60 | .70 | W b S | W S W | W S W | 209.80 | 2.0 | ... | ... | C. C. Str. 10. | Do. 3. | Clear. Au. B, |
| 16 | 93. | 879 | 790 | 26.9 | 40.3 | 33.3 | .093 | .145 | .162 | .64 | .60 | .84 | N E b E | N E b E | N E b E | 134.00 | 2.5 | ... | ... | Clear. | Cu. Str. 10. | Cu. Str. 10. |
| 17 | 245 | 247 | 127 | 30.4 | 34.2 | 32.7 | .130 | .175 | .156 | .78 | .89 | .85 | N E b E | N E b E | N W b N | 540.80 | 4.0 | ... | 3.35 | Snow. | Snow. | C. C. Str. 8. |
| 18 | 364 | 631 | 467 | 26.4 | 40.1 | 35.0 | .105 | .208 | .162 | .78 | .82 | .80 | W S W | S W | S W | 174.70 | 2.0 | ... | ... | Clear. | C. C. Str. 4. | Do. 4. |
| 19 | 550 | 642 | 739 | 33.4 | 45.8 | 32.9 | .144 | .204 | .137 | .78 | .68 | .74 | N N W | W S W | W S W | 28.40 | 3.0 | ... | ... | Do. | Do. 10. | Clear. |
| 20 | 814 | 900 | 801 | 31.7 | 52.1 | 39.2 | .130 | .251 | .195 | .74 | .63 | .82 | W b S | W S W | W S W | 29.70 | 3.0 | ... | ... | C. C. Str. 8. | Clear. | Cu. Str. 10. |
| 21 | 779 | 879 | 931 | 35.4 | 51.7 | 41.2 | .162 | .252 | .197 | .80 | .68 | .79 | W S W | W N W | W S W | 132.90 | 2.0 | ... | ... | Clear. | Clear. S'r H. | Str. 2. |
| 22 | 871 | 771 | 731 | 38.2 | 42.2 | 43.0 | .206 | .206 | .261 | .90 | .78 | .96 | E b N | N E b E | N E b E | 49.20 | 3.5 | 0.120 | ... | C. Str. 10. | Cu. Str. 10. | Rain. |
| 23 | 741 | 791 | 879 | 41.9 | 53.0 | 46.7 | .228 | .355 | .289 | .87 | .84 | .92 | S E | S W | E N E | 46.40 | 4.0 | 0.014 | ... | Do. 10. | C. C. Str. 10. | C. C. Str. 6. |
| 24 | 687 | 601 | 647 | 40.0 | 46.6 | 44.2 | .210 | .280 | .225 | .89 | .88 | .80 | N E b E | N E b E | S | 75.40 | 3.5 | 0.160 | ... | Rain. | Rain. | Cirr. Str. 10. |
| 25 | 517 | 674 | 967 | 40.1 | 48.2 | 41.0 | .215 | .242 | .212 | .91 | .74 | .82 | W S W | W | W b N | 229.80 | 2.0 | ... | ... | Clear. | Cu. Str. 4. | Do. 8. |
| 26 | 900 | 924 | 30.000 | 40.1 | 58.2 | 44.1 | .203 | .309 | .265 | .82 | .64 | .92 | W b N | W b N | S S W | 92.20 | 1.5 | ... | ... | C. C. Str. 6. | Clear. | Str. 2. |
| 27 | 900 | 742 | 29.667 | 35.7 | 58.7 | 39.2 | .138 | .372 | .195 | .76 | .78 | .82 | N E b E | N E b E | N E b E | 181.50 | 3.0 | ... | ... | Do. 8. | Cu. Str. 9. | Cu. Str. 9. |
| 28 | 412 | 394 | 514 | 38.4 | 55.0 | 46.3 | .165 | .355 | .305 | .72 | .84 | .96 | N E b E | E S E | S | 227.60 | 3.5 | 0.836 | ... | Do. 4. | Rain. | Rain. |
| 29 | 711 | 700 | 710 | 43.0 | 65.7 | 52.0 | .215 | .396 | .308 | .79 | .65 | .79 | W | S | S S E | 43.70 | 3.0 | 0.250 | ... | Do. 8. | Clear. | Clear. Ct. vis. |
| 30 | 747 | 640 | 639 | 43.0 | 49.0 | 45.4 | .254 | .303 | .209 | .92 | .89 | .88 | N b W | E S E | W N W | 50.60 | 3 5 | 0.710 | ... | Do. 10. | Rain. | Rain. |
| ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |

# MONTHLY METEOROLOGICAL REGISTER, ST. MARTIN, ISLE JESUS, CANADA EAST—MAY, 1861.

(NINE MILES WEST OF MONTREAL.)

BY CHARLES SMALLWOOD, M.D., LL.D.

*Latitude—45 deg. 32 min. North. Longitude—73 deg. 36 min. West. Height above the Level of the Sea—118 feet.*

| Day. | Barom. corrected and reduced to 32° 6 A.M. | 2 P.M. | 10 P.M. | Temp. of the Air.—F. 6 A.M. | 2 P.M. | 10 P.M. | Tension of Vapour. 6 A.M. | 2 P.M. | 10 P.M. | Humidity of Air. 6 A.M. | 2 P.M. | 10 P.M. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 29.651 | 29.752 | 29.950 | 35.3 | 46.0 | 33.0 | .149 | .192 | .131 | .74 | .62 | .70 |
| 2 | 937 | 897 | 923 | 24.2 | 42.9 | 33.0 | 096 | 171 | 156 | 73 | 62 | 85 |
| 3 | 979 | 920 | 900 | 29.0 | 46.7 | 39.9 | 128 | 208 | 190 | 77 | 66 | 77 |
| 4 | 902 | 907 | 910 | 30.1 | 52.4 | 44.7 | 156 | 282 | 231 | 85 | 73 | 80 |
| 5 | 897 | 720 | 914 | 30.1 | 67.0 | 50.8 | 180 | 470 | 258 | 77 | 73 | 71 |
| 6 | 716 | 576 | 482 | 39.0 | 60.0 | 48.1 | 180 | 433 | 291 | 77 | 85 | 80 |
| 7 | 29.900 | 174 | 160 | 50.9 | 55.1 | 49.1 | 283 | 375 | 322 | 78 | 63 | 92 |
| 8 | 29.263 | 380 | 480 | 47.0 | 57.0 | 48.3 | 280 | 208 | 200 | 88 | 69 | 78 |
| 9 | 671 | 714 | 766 | 44.4 | 60.0 | 50.0 | 218 | 261 | 265 | 76 | 51 | 75 |
| 10 | 770 | 714 | 591 | 45.2 | 65.9 | 52.1 | 234 | 265 | 264 | 80 | 42 | 69 |
| 11 | 534 | 680 | 689 | 46.0 | 65.9 | 56.0 | 221 | 350 | 336 | 72 | 58 | 75 |
| 12 | 693 | 750 | 839 | 54.0 | 63.7 | 55.0 | 277 | 392 | 319 | 75 | 69 | 81 |
| 13 | 853 | 708 | 612 | 45.1 | 67.9 | 54.2 | 251 | 362 | 362 | 84 | 55 | 87 |
| 14 | 556 | 520 | 503 | 51.0 | 58.1 | 53.7 | 343 | 469 | 269 | 95 | 94 | 90 |
| 15 | 643 | 679 | 701 | 47.5 | 59.0 | 53.2 | 291 | 265 | 321 | 89 | 76 | 80 |
| 16 | 600 | 478 | 618 | 48.8 | 58.4 | 48.5 | 302 | 337 | 285 | 82 | 70 | 85 |
| 17 | 639 | 748 | 929 | 39.8 | 51.7 | 50.0 | 201 | 302 | 272 | 86 | 32 | 78 |
| 18 | 806 | 946 | 30.010 | 44.1 | 51.3 | 48.3 | 224 | 252 | 285 | 79 | 68 | 85 |
| 19 | 30.009 | 980 | 29.901 | 43.1 | 68.7 | 52.5 | 245 | 506 | 264 | 92 | 75 | 69 |
| 20 | 29.857 | 820 | 862 | 44.3 | 64.2 | 51.8 | 248 | 285 | 296 | 83 | 48 | 79 |
| 21 | 902 | 857 | 882 | 48.6 | 58.1 | 52.2 | 235 | 365 | 339 | 85 | 76 | 86 |
| 22 | 950 | 990 | 960 | 45.0 | 67.6 | 56.2 | 251 | 310 | 315 | 84 | 62 | 71 |
| 23 | 30.102 | 30.100 | 30.026 | 51.0 | 77.1 | 61.2 | 277 | 402 | 413 | 75 | 53 | 77 |
| 24 | 29.970 | 29.821 | 29.757 | 55.3 | 72.0 | 61.0 | 349 | 480 | 433 | 81 | 62 | 85 |
| 25 | 505 | 476 | 537 | 54.2 | 76.2 | 60.8 | 390 | 516 | 338 | 93 | 70 | 65 |
| 26 | 624 | 600 | 405 | 60.0 | 74.2 | 60.3 | 396 | 442 | 403 | 76 | 55 | 79 |
| 27 | 122 | 29.883 | 29.938 | 54.4 | 56.0 | 40.5 | 383 | 427 | 315 | 90 | 97 | 89 |
| 28 | 236 | 29.432 | 29.654 | 46.0 | 57.0 | 44.2 | 265 | 413 | 282 | 92 | 90 | 93 |
| 29 | 741 | 730 | 909 | 46.7 | 55.0 | 49.0 | 305 | 390 | 285 | 96 | 93 | 85 |
| 30 | 30.003 | 963 | 30.153 | 46.1 | 71.0 | 57.2 | 269 | 378 | 302 | 88 | 51 | 66 |
| 31 | 2[illegible]32 | 30.102 | 027 | 51.0 | 68.9 | 48.2 | 258 | 536 | 242 | 71 | 77 | 74 |

| Day. | Direction of Wind. 6 A.M. | 2 P.M. | 10 P.M. | Horizontal Movement in Miles in 24 hours. | Mean of Ozone. 10ths | Rain in inches | Snow in inches. | Weather, &c. A Cloudy sky is represented by 10; A cloudless sky by 0. 6 A.M. | 2 P.M. | 10 P.M. |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | N N W | N W | N W | 205.40 | 2.5 | Inap. | ... | Clear. | Clear. | Clear. Frost. |
| 2 | W N W | W S W | W | 223.60 | 1.0 | ... | ... | Do. Frost. | Do. | Do. |
| 3 | N b W | S S W | S S W | 100.50 | 2.0 | ... | ... | Do. | Do. | Do. |
| 4 | S b E | S S E | S S E | 60.30 | 1.5 | ... | ... | Do. | Do. | Do. ft. Au. B. |
| 5 | S W | S | S | 154.00 | 1.5 | ... | ... | Do. | Do. | Do. |
| 6 | N N E | E b [illegible] | E N E | 138.90 | 2.0 | ... | ... | Cu. Str. 4. | C. C. Str. 6. | Rain. |
| 7 | S b W | S W | S W | 437.40 | 3.5 | 2.212 | ... | Do. 6. | Do. 10. | Cirr. Str. 10. |
| 8 | W S W | S S W | N W | 284.10 | 3.5 | 0.016 | ... | C. C. Str. 6. | Cu. St. 6. | Do. 10. |
| 9 | W b N | S W | S W | 105.00 | 1.0 | ... | ... | Do. 8. | Do. 6. | Do. 8. |
| 10 | S S W | S E | E S E | 114.50 | 1.0 | ... | ... | Clear. | Clear. | Clear. |
| 11 | N E b E | S S E | S S W | 53.70 | 2.5 | ... | ... | C. C. Str. 8. | C. C. Str. 10. | C. C. Str. 9. |
| 12 | N E b E | N E b E | S S W | 29.70 | 3.0 | 0.160 | ... | Rain. | Cirr. 4. S'r H. | Clear. |
| 13 | N E b E | S E | S S E | 178.70 | 2.5 | Inap. | ... | Clear. | C. C. Str. 8. | Cu. Str. 8. |
| 14 | S S E | S S W | S W | 230.90 | 3.0 | 0.820 | ... | Rain. | Rain. | Do. 10. |
| 15 | W b S | S S W | S S E | 0.30 | 2.0 | ... | ... | Cu. St. 10. | Clear. | Clear. |
| 16 | S S W | W S W | S S W | 232.40 | 2.0 | 0.262 | ... | Rain. | C. C. Str. 4. | Cu. Str. 8. |
| 17 | W S W | W | W N W | 551.00 | 3.0 | 0.100 | ... | Do. | Cu. Str. 9. | Do. 4. |
| 18 | W | W b N | N N W | 250.70 | 2.5 | Inap. | ... | Cu. Str. 10. | C.C.Str.6.S.H. | Do. 9. |
| 19 | W | S S W | S W | 90.70 | 2.0 | ... | ... | Clear. | Do. 4. | Do. 8. |
| 20 | S W | N N E | N N E | 59.40 | 2.0 | ... | ... | Do. | Do. 8. | Do. 4. |
| 21 | N b E | S W | W S W | 145.80 | 2.5 | Inap. | ... | Cirr. 8. | Cu. Str. 10. | Clear. |
| 22 | N E b E | W N W | W b S | 67.80 | 2.5 | ... | ... | Do. 4. | Clear. | Do. |
| 23 | W | W S W | S W | 60.70 | 2.0 | ... | ... | Clear. | Do. | C. C. Str. 9. |
| 24 | W S W | S S E | S S E | 184.20 | 2.5 | Inap. | ... | Do. | Cu. Str. 10. | Cu Str. 4. |
| 25 | S S E | S W | S W | 93 [illegible] | 3.5 | 0.360 | ... | Cu. Str. 10. | C. C. Str. 4. | Do. 4. |
| 26 | W S W | W | S S W | 47.40 | 2.0 | ... | ... | C. C. Str. 4. | Do. 4. | Do. 4. |
| 27 | S S E | N E b E | S S W | 152.30 | 3.5 | 2.986 | ... | Rain. | Rain. | Showers. |
| 28 | S W | W N W | W | 230.30 | 5.0 | 1.360 | ... | Do. | Do. | Do. |
| 29 | W | W N W | W | 221.70 | 4.0 | 0.436 | ... | Cu. Str, 10. | Cirr. Str. 4. | Clear. |
| 30 | W | W S W | W S W | 237.60 | 2.0 | ... | ... | Cirr. 4. | Clear. | Do. |
| 31 | W S W | W S W | S W | 242.20 | 2.0 | ... | ... | Clear. | Do. | Do. |

REMARKS ON THE ST. MARTIN, ISLE JESUS, METEOROLOGICAL REGISTER FOR APRIL.

| | | |
|---|---|---|
| Barometer ......... | Highest, the 1st day | 30.508 |
| | Lowest, the 17th day | 29.127 |
| | Monthly Mean | 29.882 |
| | Monthly Range | 1.381 |
| Thermometer ...... | Highest, the 29th day | 65°.7 |
| | Lowest, the 1st day | 10°.4 |
| | Monthly Mean | 38°.99 |
| | Monthly Range | 55°.3 |

Greatest Intensity of the Sun's Rays........ 77°.3
Lowest Point of Terrestrial Radiation........ 9°.1
Mean of Humidity ........ .780
Rain fell on 9 days, amounting to 2.921 inches; it was raining 60 hours and 42 minutes, and was accompanied by distant thunder on 1 day.
Snow fell on 3 days, amounting to 11.68 inches; it was snowing 46 hours and 35 minutes.
Most prevalent wind, the N. E. by E.
Least prevalent wind, the N.
Most windy day, the 17th; mean miles per hour, 22.53.
Least windy day, the 10th; mean miles per hour, 0.40.
Aurora Borealis visible on 7 nights.
The Electrical state of the Atmosphere has indicated moderate intensity.
Swallow *Hirundo Bicolor*, first seen 23rd day
Frogs *Rana fontanalis*, first seen 24th day.
Wild Geese *Anser Canadiensis*, first seen passing N. W. 23rd day.
Song Sparrow *Frangilla Melodia*, first heard 4th day.
Thatcher's Comet seen 29th.

REMARKS ON THE ST. MARTIN, ISLE JESUS, METEOROLOGICAL REGISTER FOR MAY, 1861.

| | | |
|---|---|---|
| Barometer ...... | Highest, the 31st day | 30.232 |
| | Lowest, the 27th day | 28.883 |
| | Monthly Mean | 29.721 |
| | Monthly Range | 1.349 |
| Thermometer ... | Highest, the 26th day | 74°2 |
| | Lowest, the 2nd day | 21°3 |
| | Monthly Mean | 51°86 |
| | Monthly Range | 42°9 |

Greatest intensity of the Sun's rays........ 85°0
Lowest point of Terrestrial Radiation........ 19°3
Mean of Humidity ........ .770
Rain fell on 15 days, amounting to 8.642 inches; it was raining 49 hours and 32 minutes, and was accompanied by thunder on 1st day
Most prevalent wind, W. S. W.
Least prevalent wind, N. N. W.
Most windy day, the 7th day; mean miles per hour, 18.22.
Least windy day, the 15th day; mean miles per hour 0.01.
2 Solar Haloes were visible.
Aurora Borealis visible on 1 night.
The Electrical state of the Atmosphere has indicated feeble intensity.
Shad *Alosa Prostabilis*, first caught 30th day.
Amount of evaporation 2.93 inches.

CORRECTIONS AND ADDITIONS.—In the May Number of the Journal, page 301, line 4 from bottom,—for "Geo. J. Brush, Professor of Mineralogy," read "Professor of Metallurgy." In the present Number, page 328, add *Helix concava* and *Planorbis parvus* to the species there enumerated; and transpose the words "very common" (line 8 from bottom) to the end of the preceding line.