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DISCOVERY OF THE PREGLACIAL OUTLET OF THE BASIN OF LAKE ERIE INTO THAT OF LAKE ONTARIO; WITH NOTES ON THE ORIGIN OF OUR LOWER GREAT LAKES.

The above is the title of a lengthy paper by Prof. J. W. Spencer, of King's College, Windsor, N. S., read before the American Philosophical Society in March last.

We present our readers with the more important parts of the paper concerning the Preglacial Outlet of Lake Erie and a summary of the whole.

Basin of Lake Ontario. As is well known, Lake Ontario consists of a broad, shallow (considering its size) basin, excavated on the southern margin out of the Medina shales, and having its southern shores from one to several miles from the foot of the Niagara escarpment. The Medina shales form the western margin (where not covered with drift) to a point near Oakville. From this town to a point some distance eastward of Toronto, the hard rocks are made up of the different beds of Hudson River Epoch; while the soft Utica shales occupy the middle portion, and the Trenton limestones the portion of the Province towards the eastern end of the lake.

The country at the western end of the lake consists of slopes gently rising to the foot of the Niagara escarpment. Sometimes this elevation is by terraces, and again by gentle inclines, as between the foot of the encarpment at Limehouse (on the G. T. Railway) and the lake, where the difference of altitude above the water is more than 700 feet, without any very conspicuous features.

Basin of Lake Erie. The exceedingly shallow basin of Lake Erie has its bottom as near a level plane as any terrestrial tract could be. Its mean depth, or even maxima and minima depths from its western end for more than 150 miles, scarcely varies from 12 or 13 fathoms for the greater portion of its width. The eastern 20 miles has also a bed no deeper than the western portion. Between these two portions of the lake, the hydrography shows an area with twice this depth (the deepest sounding being 35 fathoms). This deepest portion skirts Long Point (the extremity, a modern peninsula of lacustrine origin), and has a somewhat transverse course. An area of less than 40 miles long has a depth of more than 20 fathoms. The deeper channel seems to turn around Long Point, and take a course towards Haldimand county, in our Canadian Province, somewhere west of Maitland. The outlet of the lake, in the direction of the Niagara river, has a rocky bottom (Corniferous limestone).

The study of this lake at first appears less practicable than that of Ontario, but, when its former outlet and its tributary rivers are described, the writer trusts that he will have made some observations, that may help to clear the darkness that hangs about the history of our interesting lake region, before the advent of the Ice Age.

The Dundas Valley and adjacent Cañons. We may consider that the Dundas valley begins at the "bluff" east of the Hamilton reservoir, and extends westward, including the location of the city of Hamilton and the Burlington Bay, at least its western portion. With this definition, the width at the Burlington heights (an old lake terrace 108 feet above present level of the water) would be less than five miles. At a mile and half westward of the heights, the valley suddenly becomes narrowed (equally on both sides of its axis of direction, by the Niagara escarpment making two equal concave bends, on each side of the valley, whence the straight upper portion extends, the whole resembling the outline of a thistle and its stem), from which place it extends six miles westward to Copetown, on the northern side; and three and a half to Ancaster, on its southern side. The breadth between the limestone walls of this valley varies somewhat from two to two and a half miles. The summit angles of the limestone walls on both sides are decidedly sharp.

Dundas town is situated in this valley, its centre having a height about 70 feet above Lake Ontario, but its sides rise in terraces or abrupt hills; and on ascending the valley, we find that between the escarpments are great ranges of parallel hills separated by deep gorges or glens, excavated in the drift by modern streams. This rugged character continues until the summit of the Post Pliocene ridges have a height equal to that of the escarpment. As the gorges ascend towards the westward they become smaller, until at some distance south-west of Copetown and Ancaster, the divide of the present system of drainage is reached. Some of these streams have cut through the drift, so that they have only an altitude above the lake (which is seven miles distant) of 240 feet, while the tops of the ridges immediately in the neighborhood are not much less than 400 feet high though they themselves have been removed to a depth of about another hundred feet, for the drift has filled the upper portion of the valley to the height of 500 feet above Lake Ontario. Even to the very sources of the streams, the country resembles the rivers of our great North Western Territories (or those of the Western States), cutting their way through a deep drift at high altitudes, which is not underlaid by harder rocks, showing deep valleys rapidly increasing in size and depth, as they are cleaning out the soft material, and hurrying down to lower levels—a strong contrast to the features in most other portions of our Province.

On the south side of the Dundas valley, a few unimportant streams, mostly dry in summer, have worn back the limestone escarpment, over which they flow, to distances varying from a few yards to a few hundred, making glens at whose head in springtime some picturesque cascades can be seen. At Mount Albion, six miles east of Hamilton, there are two of these larger gorges, whose waters, after passing over picturesque falls, 70 feet high, and through glens several hundred yards in length, empty into the triangular valley noticed before. On the north side of the Dundas valley, besides small gorges with their streams comparable to those on the south side, there are several of much larger dimensions; for example, that at Waterdown, six miles north of Hamilton. Still larger is Glen Spencer which has a *cañon* half a mile long, 300 feet deep, and between 200 and 300 yards wide at its mouth. At the head of this is Spencer Falls, 135 feet high, and joining it laterally there is another *cañon*, with a considerable stream flowing from Webster's Falls, which however, is of less height than the other. The waters feeding these streams come from northward of the escarpment, and belong to a system of drainage different from those streams which flow down through the drift of the Dundas valley and are of much greater length. At the foot of Spencer Falls, the waters strike the upper portion of the Clinton shaly beds. The Falls now are two feet deeper than twenty years ago. Yet the stream is small, and makes a pond below in the soft shales. But this difference in height does not represent the rate of wearing or recession of the precipice. That the stream is much smaller than formerly is plainly to be seen, for at present it has cut a narrow channel, from ten to fifteen yards in width, above the falls, and from four to six feet deep on one side of the more ancient valley, which is about 50 yards wide and 30 feet deep, excavated in the Niagara dolomites.

The surfaces of the escarpment in both sides of Glens Spencer and Webster present a peculiar aspect. That on the north-eastern side has a maximum height of 520 feet above the lake. On the same side, a section made longitudinally shows several broad shallow glens nearly a hundred feet deep crossing it and entering Glen Spencer. The surface of the rocks is glaciated, but not parallel with the direction of the channels. On the south-western side of the same *cañon*, we find that a portion of the thin beds of Upper Niagara limestone have been removed. This absence is not general, for it soon regains its average height of about 500 feet.

The Grand River Valley. The Grand River of Ontario rises in the County of Grey, not more than twenty-five miles from Georgian Bay. Thence it flows southward, and at Elora the river assumes a conspicuous feature. Here it cuts through the Guelph dolomites to a depth of about 80 feet and forms a *cañon* about 100 feet in width with vertical walls. At this place it is joined by a rivulet from the west, which has formed a tributary *cañon* similar to that of the Grand River itself.

The country in this region is so flat that it appears as a level plane. Farther southward the river winds over a broader bed, and at Galt the present river valley occupies a portion of a broad depression in a country indicating a former and much more extensive valley. In fact the old river valley existed in Preglacial times, for the present stream has re-excavated only a part of its old bed at Galt, leaving on the flanks of one of its banks (both of which are composed of Guelph dolomites), a deposit of Post

Tertiary drift, in the form of a bed of large rounded boulders mostly of Laurentian gneisses. The country for four miles south of Galt is of similar character, forming a broad valley, in which the present river flows. At this distance from Galt the river takes a turn to the south-westward; but at the same place, the old valley appears to pass in a nearly direct line with the course of the present bed (before the modern turn is made to the westward). As this portion of the valley now entered, has not to any extent been cleaned out by modern streams, it forms a broad shallow depression in the country extending for a few miles in width. Yet it is often occupied with hills composed of stratified coarse gravel belonging to that belt, which extends from Owen Sound to the County of Brant, and called by the Canadian Geological Survey "Artemesia Gravel."

It is through a portion of this valley that the Fairchild's Creek flows. Many streams derive their supplies of water from the Beverly swamps, which also feed the Lindsay Creek, that empties over Webster Falls and flows down Glen Spencer through the Dundas valley to Lake Ontario.

The G. W. Railway, at four miles south of Galt, enters this valley and continues in it or its branches as far as Harrisburg, though the deeper depression is near St. George (a short distance west of Harrisburg). After leaving what I consider its more ancient bed, south of Galt (unless the country between the present bed and Fairchild's Creek was an island), the Grand River flows southward to Paris and Brantford, having a deep, broad valley. At the latter place the valley may fairly be placed at a few miles in width, while further to the eastward the river winds in an old course which had formerly a width of four miles. In the region of Brantford the valley is bounded by a somewhat elevated plateau. At Paris, Neith's Creek enters the Grand River from the west, and has a valley almost comparable in size with that of the latter at this town. At Paris, the Grand River cuts through the plaster-bearing Onondaga formation. Similar rocks appear at various places along the river, at places where the river has cleaned out a portion of one side of its ancient valley.

At the Great Western Railway crossing, east of Paris, the bed of the river has an altitude of 495 feet above Lake Ontario, while at Brantford it is 410 feet (this elevation may not be perfectly accurate) above the same datum. From Brantford the river winds through a broad valley, with a general easterly direction, to Seneca, where the immediate bed is about quarter of a mile wide, flowing at the southern side of a valley, more than two miles wide, and 75 feet below its boundaries, which are 440 feet above Lake Ontario. At Seneca the bed of the present river-course is 365 feet above Lake Ontario or only 37 feet above Lake Erie. (The H. & N. W. Railway levels give Lake Erie as 328 feet above Lake Ontario, whilst the Report of the Chief Engineer of the Welland Canal states that the difference of level is 326¾ feet. As these two levels agree so nearly, and as the other figures refer to the railway levels, I have followed them here.) Eastward from Seneca the river continues to have its broad valley as far as Cayuga. To near this town the waters of the Welland canal feeder reach, at a height of about 9 (?) feet above Lake Erie.

From Seneca to Cayuga the direction of the valley is nearly south, but at the latter place it abruptly turns nearly to the eastward, and in a short distance it passes to a flatter country and flows over Corniferous limestone. After a sluggish flow, it enters Lake Erie, (passing through a marshy country) at Port Maitland more than fifteen miles in a direct line from Cayuga. It must be remembered that, from Seneca to Cayuga, the valley is broad and conspicuous. At only a short distance south of the river, at Seneca, the summit of the country is occupied by a gravel ridge.

Returning to the valley of Fairchild's Creek, we find the stream principally flowing in the former bed of the Grand River, abandoned a few miles below Galt since the Ice Age. This creek crosses the Great Western Railway at a level of fifteen feet below the crossing of the Grand River, at a few miles to the westward. Again, the Fairchild's Creek crosses the Brantford and Harrisburg railway at an altitude of 407 feet above Lake Ontario, or a little below that of the Grand River at Brantford, although it empties into it a few miles east of the city just named.

Fairchild's Creek is now of moderate size meandering through the drift for a width of two miles. This drift is in part stratified clay. The Grand River from Brantford eastward, is generally excavated from the drift deposits, although occasionally one side of the valley shows rocks of Onondaga formation, exposed by the removal of the drift in modern times. It is also desirable to call attention to the fact that in the region of Brantford, much of the Onondaga Formation is shaly and forms the surface country-rock, covering a broad belt, whilst from Seneca eastward the surface of the country is more generally covered with Corniferous limestone.

Country between the Grand River and Dundas Valleys. The watershed between these two present drainage systems is at only a short distance southwest of Copetown, and the distance in a direction from the Fairchild's to the Dundas side of this divide is less than seven miles, with an average altitude of less than 480 feet (the same as that of the Fairchild's Creek, as it crosses the Great Western Railway). The highest point that I have levelled is 492 feet above Lake Ontario. On receding westward from the divide, the country gradually descends to the Fairchild's Creek, which as it crosses the Brantford and Harrisburg Railway is 407 above the Lake. It is considerably lower where it enters the Grand River. The region between the divide and the Grand River is traversed from north-west to south-east by a considerable number of streams, all with relatively large valleys, cut in the drift, since the present system of drainage was inaugurated in Post Glacial times.

The country from Jerseyville (about 465 feet above lake) slopes gradually to the Grand River, from six to eight miles distant to the southward.

On examination, it may be seen that the country is too high to permit the Fairchild's Creek or Grand River, as they are at present situated, to flow over the height of land into the upper portion of the Dundas valley. As referred to before, the Niagara limestone forming the summit of the escarpment at Ancaster and eastward has a height of about 500 feet. These beds dip at only about 25 feet in a mile (to about 20 degrees west of south) and are not generally covered by a great thickness of drift, but in many places are exposed on or near the surface. Westward of Ancaster these limestones are nowhere to be found, but the country is covered only with drift. At a short distance west of this village, we find streams flowing north-easterly and easterly with very deep valleys in the drift, indicating the absence of the floor of limestone to a depth of over 250 feet below the surface of the escarpment. But on going westward we find that the streams have not cut to an equal depth, but are still running deeply through drift. Eventually we reach the divide, after which we find that other systems of streams also cut deeply in the drift running in a south-easterly direction to join the Grand River; but the Niagara limestone is absent from a considerable extent of country.

On the northern side of the Dundas valley the escarpment after reaching Copetown is buried by the drift. Although the line of buried cliffs recedes somewhat ,to the northward of the Great Western Railway, yet there are occasional exposures, as at Troy and other places in Beverly and Flamboro, where the underlying limestones come to the surface. At Harrisburg the limestones are known to be absent for a depth of more than 72 feet, as shown in a deep well in the drift.

In the town of Paris one well came upon hard rock at 10 feet below the surface, whilst another at 100 feet in depth reached no further than boulder clay. This last well must have been in a buried channel of Neith's Creek, as outcrops of gypsum-bearing beds of the Onondaga formation frequently occur near the summit of the hills. From what has just been written, it is easily seen that the Niagara limestones are absent from a more or less horizontal floor (which is over 500 feet above the lake, on both the northern and southern sides of the Dundas valley) which continues from Dundas westward to near Harrisburg, where it meets a portion of the Grand River valley. But almost immediately west of Ancaster we find streams running northward at right angles to the escarpment, and cutting through drift to the depth of almost hundreds of feet. In fact, if we draw a line from Dundas to northward of Harrisburg (a mile or two), and another from Ancaster southward to the Grand River, we have two limits of a region where the limestone floor has been cut away from an otherwise generally level region. The southern side of the area is the southern margin of the Grand River valley, between Seneca and Brantford; and the western boundary is composed of Onondaga rocks east of Paris (which perhaps forms an island of rocks buried more or less in drift).

The Buried River Channel in the Dundas Valley and its Extensions. That the Dundas valley is that of an ancient river valley now buried to a great depth with the *débris* produced in the Ice Age, becomes apparent on a careful study of the region. However, until a key was discovered the mystery of its origin was found to be very obscure. My own labors at studying this region may fairly be stated as the first systematic attempts at the solution of the present configuration of the western end of Lake Ontario and the adjacent valley. Assertions have been made that it was scooped out by a glacier, but this wild hypothesis was only a statement made without any regard to facts.

From the topography, it is be seen that the apparent length of the rock-bound valley is six miles, with a width of over two miles; then it widens suddenly to four miles (with concave curves on both sides), after which it gradually increases in width as it opens into Lake Ontario. The direction of the axis of the valley is about N. 70° E. The summit edges of the rock walls are sharply angular and not rounded or truncated. This angularity is not due to frost action since the Ice Age, to any extent, as is shown by the character of the talus. The rocks of the summit are frequently covered with ice markings, but I am not aware of any locality where they have been observed as being parallel with the true direction of the valley, but on all sides one can observe them (sometimes at only small angles of less than 30 degrees) making conspicuous angles with its axis. One exception may be made to this statement. On a projecting ledge of Clinton limestone, at Russel's quarry, near Hamilton, at a height of 254 feet above the lake, and 134 feet below the summit of the "mountain," after the removal of some talus, I observed that the surface was polished but with scratches so faint that they could scarcely be compared with those of fine sand-paper on wood; and the direction if determinable, was parallel with the overhanging escarpment. There are many tributary *cañons*, which are evidently of greater antiquity than the Ice Age, which could not have been excavated by the present streams, and are at all sorts of direction compared with the striated surface of the country.

The topography of the lower lake regions precludes the idea of a glacier flowing down the valley to the north-eastward. Again, as the direction of the ice was towards the south-west, the waters from the melting glaciers could scarcely flow up an escarpment many hundreds of feet in height. Even if the Niagara escarpment did not exist elsewhere, the non-parallelism of the striæ, and edges of the escarpment with their angular summits, is sufficient to prove the non-glacial origin of the valley in the hard limestone rocks. Moreover, at the eastern end of the narrower portion of the valley, there are two concave curves facing the lake, which of necessity would have been removed if such a gigantic grinding agent had been moving up the valley.

The glacier-origin of the valley being an absolutely untenable hypothesis, I sought for some fluviatile agent capable of effecting the present configuration of the region. At the time, no idea occurred that even the great valley of the present is only a miserable remnant of one of gigantic proportions obscured by hundreds of feet of drift. The question arose, could Lake Erie have ever emptied by this valley? This suggestion did not hold its ground for any length of time, because the present levels are all too high. Near Galt, the traces of the true origin first presented themselves. A branch of the Great Western Railway extends from Galt southward for about four miles in the valley of the Grand River, after which, without making any important ascent, it passes into the broad older valley, described above as that in which Fairchild's Creek now flows. After a careful examination of the region and of the railway levels, I came to the conclusion that it was an old buried valley. It then became apparent that if the Grand River had occupied the site of the Fairchild's Creek, that the latter probably flowed down the Dundas valley, and that the Grand River, being one of the largest of the rivers of Ontario, might have been a sufficient cause for the great excavation at the western end of Lake Ontario. Having procured all the levels that bore on the subject which were available, it became necessary to connect several places myself by instrumental measurements, which work was accomplished last July, with the aid of Prof. Wilkins. As the whole floor of Niagara limestones is absent, as has previously been shown, the proof that the ancient Grand River flowed down the Dundas valley was completed, and of this discovery there was published a local notice last August. Significant and interesting as this fact was, relative to the change of systems in our Canadian drainage, a still more important issue was involved. When taking the levels between the Dundas valley (modern) and the Grand River, it was found that the whole calcareous floor was removed from a basin several miles in width, and that all the wells were sunk to a considerable depth in the drift before water could be obtained. On glancing at the map it will be seen that the Grand River from Brantford to Seneca meanders through a broad course, which in its ancient basin is several miles in width, but that from Seneca the valley is narrower, and the course of the stream more direct, as far as Cayuga. At Seneca the valley is two miles wide and seventy-five feet deep. Also the bed of the Grand River at Seneca is in drift which is only 37 feet above the lake into which it now empties. This broad valley continues to Cayuga within a few miles of the lake, whence its former probable course was by nearly direct line to Lake Erie, now filled with drift, near the present bend in the river towards the eastward. At Cayuga the rock beneath the drift-bed of the river is below the lake level, on the margin of the ancient valley.

Having observed the connection between the Dundas valley, Grand River and Lake Erie, it dawned on me that I had established the knowledge of a channel having a very important bearing on the surface geology of the lake region. It now became apparent that Lake Erie had flowed by the Grand River (reversed) to a point west or north-west of Seneca, and thence by the Dundas valley, into Lake Ontario; also that the upper waters of the Grand River, previously discovered as passing down the Dundas valley, were really tributary to the outlet of Lake Erie, and joined it somewhere south of Harrisburg; and that the basin between Brantford (and the Grand River of to-day) and the Great Western Railway, at Copetown, formed an expanded lakelet along the course of the ancient outlet of Lake Erie, scooped out of the softer rocks of the Onondaga Formation before noticed. As the waters excavated a bed in a deeper channel, of course this lakelet would become an expanded and depressed valley, such as we often see amongst the hills of drift, at a short distance westward of Dundas. Possibly the Grand River divided and flowed around an island, the western side of which is occupied now by the town of Paris. At any rate, Neith's Creek, at that town formed a large tributary to the river then flowing down to Lake Ontario.

Along the course from Cayuga to Lake Ontario all obstacles to the outlet of Lake Erie appear to be removed. But along the present course of the Grand River, eastward of Cayuga, the waters flow over Corniferous limestone. But this difficulty is removed on observing that the river, filled with drift, approaches Lake Erie to within a direct distance of about six miles, but at this place it leaves its southward course and also its conspicuous valley and flows eastward, in the same manner as the Niagara River, above the Whirlpool, left its old choked-up outlet by the valley of St. David, and cleaned out a new channel for itself through several miles, in hard rock, from Queenstown southward.

We have seen that the Grand River bed is near the eastern margin of its ancient valley at Cayuga. From northward of this town at about half a mile to the westward of the river, a deep depression in the drift indicates the deeper portion of the ancient river as it left the modern channel direct for the Lake Erie basin. Also along this route the hard rock is known to be absent to a depth below the surface of Lake Erie.

In Ohio, the Geological Survey considers that Maumee River emptied into the Wabash. If the waters of Lake Erie ever passed by this route into the Mississippi river when they were at no higher level than at present, then there must be a channel buried to a depth reaching at least 170 feet above the lake, as that is the elevation of the divide between the upper waters of these two rivers.

The outlet of Lake Erie, indicated in this paper, is known at many places along its route to have no rock-bed for a distance below the surface of the higher lake, and to a probable depth sufficiently great to empty Lake Huron.

Again Mr. Carll has shown that the Alleghany drainage passed near Dunkirk into the Erie basin at a place just opposite to its outlet, as indicated by the present writer.

Much of the Dundas valley is underlaid by stratified Erie clay, which is known to extend to a depth of 60 feet below the surface of Lake Ontario, according to Dr. Robert Bell. In the upper part of the valley, streams have exposed some deposits of unstratified clay filled with angular shingle, derived from the thin beds of limestone forming the upper portion of the Niagara Formation. In the eastern portion of the valley, the Erie clay is overlaid unconformably by brown Saugeen clay or loam (stratified). In the upper portions of the valley the hills are capped by brown clays or sands. But along some of the hillsides excavated so deeply in the drift, we find old beaches resting unconformably on boulder clay.

Near the centre of the city of Hamilton, in the wider portion of the Dundas valley, a well was sunk to the depth of over 1000 feet. This well revealed a most interesting fact. Though known to me several years ago, I did not apply it until recently to its true bearing, since discovering the origin of the Dundas valley. Mr. J. M. Williams sunk this well, at the Royal Hotel, in Hamilton. He told me several years ago that he had to sink through 290 feet of boulders, before coming to hard rock, thus causing the outlay of a large sum of money in excess of his calculations. Unfortunately, this well-record has been lost by fire. At that time, the fact was so fresh in his memory (improved by the extraordianary cost of the well) that his statement could be relied on, he being experienced in well-borings. The mouth of this well is 63 feet above Lake Ontario, and therefore the hard rocks are absent for a depth of 227 feet below the lake surface.

As the valley is five miles wide at this place, and as the well is only about one mile distant from its southern side, it becomes apparent that the valley in the centre must have been much deeper. Moreover if we produce the southern side of that portion of the valley, which is over two miles wide, we find that the well is less than a quarter of a mile away from it. Now if we connect the top of the Medina shales (240 feet above Lake Ontario) with the base of the drift in the well, and produce it to the centre of the valley, it would indicate a central depth of over 500 feet. At the base of the drift there are nearly fifty feet of Medina shales, below which are the Hudson River rocks (more or less calcareous and arenaceous. mixed with the shales). This harder formation along the bed of the river would be less extensively removed by aqueous action than the overlying Medina shales, especially as the pitch of the waters would be much lessened. This graphic method of calculation seems as perfectly admissible here as it does in determining other constants of nature. However, I have placed the estimated depth in the section at about 70 fathoms below the lake surface, which depth is perfectly compatible with the soundings of the lake at no very great distance to the eastward. Even this depth gives only very gentle slopes from the sides of the river valley. It should be remarked that Burlington Bay is excavated from stratified clays in places to a depth of 78 feet. But this water is silting up comparatively quickly.

Now we have seen that the deep excavation in the Dundas valley and westward is cut through more than 250 feet of Niagara and Clinton rocks, mostly of limestone, and to a depth in the Medina shales, so that the total known depth of the *cañon* is 743 feet, but with a calculated depth in the middle of the channel of about 1000 feet. This depth for a *cañon* is not extraordinary for Eastern America. In Tennessee there are river valleys excavated to a depth of 1600 feet, and in Pennsylvania Mr. Carll reports others to be equally deep.

Again, this Preglacial river explains the cause of the present topography of the western end of Lake Ontario. The drainage by this river swept past the foot of the submerged escarpment of Lake Ontario, until it passed the meridian of Oswego.

With such an outlet, and with the ancient Grand River valley buried to an equal depth, we have an easy solution to the problem of the drainage of Lake Erie.

The following is Dr. Spencer's summary of the whole paper:

1. The Niagara escarpment, after skirting the southern shores of Lake Ontario, bends at nearly right angles in the neighborhood of Hamilton, at the western end of the lake; thence the trend is northward to Lake Huron. At the extreme western end of the lake this escarpment (at a height of about 500 feet) encloses a valley gradually narrowing to four miles, at the meridian of the western part of the city of Hamilton, where it suddenly closes to a width of a little more than two miles, to form the eastern end of the Dundas valley (proper). This valley has its two sides nearly parallel, and is bounded by vertical escarpments, which are capped with a great thickness of Niagara limestone, but having the lower beds of the slopes composed of Medina shales. On its northern side the escarpment extends for six miles to Copetown; westward of this village, it is covered with drift, but it is not absent. On its southern side the steep slopes extend for less than four miles to Ancaster, where they abruptly end in a great deposit of drift, which there fills the valley to near its summit, but which is partly re-excavated by the modern streams, forming gorges from two to three hundred feet deep. To the north-eastward of Ancaster these gorges are cut down through the drift to nearly the present lake level.

Westward of Ancaster, a basin occupying a hundred square miles, where the drift is found to a great depth, forms the western extension of the Dundas valley. With the north-western and western portions of this drift-filled area the upper portion of the Grand River and Neith's Creek were formerly connected. The Grand River, from Brantford to Seneca, runs near the southern boundary of this basin, then it enters its old valley, which extends from Seneca to Cayuga, with a breadth of two miles, and a depth, in modern times, of seventy-five feet, having its bed but a few feet above the surface of Lake Erie. Near Cayuga, the deepest portion of the river-bed is below the level of Lake Erie.

2. The Dundas valley and the country westward form a portion of a great *river valley*, filled with drift. Along and near its present southern margin this drift has been penetrated to 227 feet below the surface of Lake Ontario, thus producing a *cañon* with a lateral depth of 743 feet, but with a computed depth, in the middle of its course, of about 1000 feet.

3. The Grand River, at four miles south of Galt, has since the Ice Age, left its ancient bed, which formerly connected with that of the Dundas valley, as did also Neith's Creek, at Paris.

4. Lake Erie emptied by a buried channel a few miles westward of the present mouth of the Grand River, and flowed for half a dozen miles to near Cayuga, where it entered the present valley, and continued this channel (reversed) to a place at a short distance westward of Seneca, whence it turned into the basin referred to above, receiving the upper waters of the Grand River and Neith's Creek as tributaries, and then emptied into Lake Ontario, by the Dundas valley. This channel was also deep enough to drain Lake Huron.

5. Throughout nearly the whole length of Lake Ontario, and at no great distance from its southern shore, there is a submerged escarpment (of the Hudson River Formation) which, in magnitude, is comparable with the Niagara escarpment itself, now skirting the lake shore. It was along the foot of this escarpment that the river from the Dundas valley flowed (giving it the present form) to eastward of, or near to, Oswego, receiving many streams along its course.

5. The western portion of the Lake Erie basin, the southwestern counties of Ontario, and the southern portion of the basin of Lake Huron formed one Preglacial plane, which is now covered with drift or water (or with both) to a depth varying from fifty to one hundred feet, excepting in channels where the filling by drift is very great. A deep channel draining Lake Huron extended through this region, leaving the present lake near the Au Sable River, and entering the Erie basin between Port Stanley and Vienna, at a depth near its known margin of 200 feet, but at a probable depth in the centre sufficiently great to drain Lake Huron.

6. The Preglacial valleys (now buried) of Ohio and Pennsylvania—for example; the Cuyahoga, Mahoning (reversed), and Alleghany (deflected), formed tributaries to the great river flowing through the Erie basin and the Dundas valley.

7. The bays and inlets north of Lake Huron are true fiords in character, and are of aqueous origin.

8. The Great Lakes owe their existence to sub-aërial and fluviatile agencies, being old valleys of erosion of great age, but with their outlets closed by drift. Glaciers did not excavate the lakes and had no important action in bringing about the present topography of the basins.

9. The old outlet of the Niagara river, by the valley of St. David's, was probably an interglacial channel.

A BLASTOID FOUND IN THE DEVONIAN ROCKS OF ONTARIO.

By Henry Montgomery, M.A.,

Science Master in the Collegiate Institute, Toronto.

In the month of July 1879, while examining the Hamilton Group of the Devonian Series of rocks in the south-western part of the Province of Ontario, I had the good fortune to discover an apparently rare fossil Echinoderm imbedded therein. It was taken by me from a limestone quarry near Thedford or Widder village in the township of Bosanquet, county of Lambton. Soon afterwards I learnt that Dr. George Jennings Hinde had, a short time previously, obtained a specimen of the same species from the rocks of the same region, but it was not in so good a state of preservation as the one which I had found. It is regretted that, notwithstanding repeated and careful searches since that time, I have been unable to procure more than a single specimen of this form, which seems also to be exceedingly rare (if indeed it occurs) in the United States. Although it appears to be a variety of the Nucleocrinus lucina, a new species collected by Mr. C. A. White from the Hamilton shales, Livingstone Co., New York State, and described by Professor James Hall in 1862, yet it does not seem to have been described or even mentioned as occurring in Canadian rocks. Nor am I aware that any representative of the genus Nucleocrinus, and indeed it may be said, of the entire order Blastoidea (unless the Codaster or Codonaster Canadensis of Billings be referred to this order), has ever been described from the rocks of Canada. Therefore I have thought it advisable to publish figures and a description of the specimen alluded to, at the same time contrasting it with *Pentremites Godoni*, several excellent specimens of which, as well as of *P. pyriformis*, of the Sub-Carboniferous rocks of Illinois, are in my cabinet.

For assistance kindly extended to me in the study of this extinct form and its relations I am deeply indebted to my friend and instructor Dr. E. J. Chapman of University College, Toronto. Several very valuable hints were likewise furnished me by Dr. Hinde, F.G.S., New South Kensington Museum, London, England, and Mr. J. F. Whiteaves, F.G.S., Canadian Geological Survey.

Mr. Conrad named the genus Nucleocrinus (L. *nucleus* kernel of a nut, and Gr. *krinon* a lily) in 1842; Troost gave it the generic name Olivanites in 1849; and in 1852 Dr. Ferd. Rœmer called it Elæacrinus. In 1862 Dr. Hall gave the name *lucina* to a species gathered from the rocks of the State of New York. To this species, in the absence of specimens of lucina with which to compare it, I provisionally refer what may possibly be a *new* species of Nucleocrinus.

The echinoderm in question, found as already stated, in the Hamilton formation, Lambton Co., was associated with numerous corals, chiefly of the genera Cystiphyllum, Diphyphyllum, Eridophyllum, Heliophyllum, Stenopora, Favosites, Alveolites and Aulopora, with various Brachiopods (Spirifera, Spirigera, Strophomena, Strophodonta, Cyrtina, Chonetes, etc.), Gasteropods, and Bryozoa. It must be placed in that division of the Blastoidea possessed of a calcareous, jointed stem and a lateral interambulacral aperture. In general appearance it is somewhat barrel-shaped, being thicker a little above the middle than at either extremity, and considerably flattened at the summit and base. Its greatest length is about 4½ lines; and its greatest transverse diameter about 3¾ lines.

FIG. 1.

a. b. c.

FIG. 1. Nucleocrinus lucina (?). From the Hamilton shales, Ontario, Canada. *a.* View of base, twice the natural size, shewing point of attachment of stem, and the five radials bearing each a long, central elevation terminating in a concave projection over the end of the pseudambulacrum. *b.* Lateral view, one and three-fourths the natural size, shewing the anal orifice, and anal plate with its two adjacent inter-radials. *c.* View of upper surface, twice the natural size, shewing plates in the oral region, the lateral anal orifice, and the pore-plates of pseudambulacral areas.

FIG. 2.

a. b. c.

Fig. 2. Pentremites Godoni. From Lower Carboniferous rocks of Illinois, U. S. Natural size. *a.* View of base, shewing three large basals, and attachment of stem. *b.* Lateral view, shewing broad, petaloid, pseudambulacral areas, with large transverse striæ, very visible to naked eye. *c.* View of superior surface.

The plates or pieces of which the calyx is composed are: three basals, five radials, six inter-radials, one anal, several anteambulacrals and numerous pseudambulacrals. In Pentremites, in which the lateral opening is completely wanting, there is, of course, no anal plate, and there are only five inter-radial or deltoid plates present. The three basal plates of N. lucina (?) pass outwards from the centre of the topmost joint of the slender pedicle, are very small, irregular in shape, and almost altogether hidden by the stem. Above these are the five dorsally-ridged radial plates slightly forked upon their upper margins for the reception of the lower extremities of the five pseudambulacral areas. These five pseudambulacral fields with the five alternating interambulacral areas form the sides of the calyx. Each pseudambulacral area is much less "petaloid" in outline than the corresponding area of Pentremites, being greatly lengthened and comparatively narrow throughout, and terminate below in a deep pit or depression where the forked radial is raised into an arched eminence. The centre of the area is occupied by a longitudinal furrow, which with its two raised borders forms a long and extremely narrow lancet-plate. Outside the elevated ridges that bound this central furrow on each side is a row of plates or tables numbering about forty, perforated by minute but very visible apertures and known as pore-plates. The remainder or outer portion of the pseudambulacral area is believed to be made up of numerous transverse plates because of its surface shewing very many small yet distinct transverse grooves and elevations. These transversely-striated lateral portions constitute the greater part of the area, and, instead of gradually rising from the pore-plates and central lancet-plâte, gradually slope towards the outer edges, so that the whole pseudambulacrum is strongly elevated towards and about the middle line and depressed at its outer margins, as seen in Figure 1, a condition exactly the reverse of that which exists in Pentremites (Fig. 2).

Four of the interambulacral areas consist each of a single, long, narrow, triangular or deltoid plate termed the "inter-radial," its apex reaching the top of the calyx, and its base resting upon two radials beneath. The fifth interambulacral area, however, differs greatly from the others in being much broader (nearly twice as broad), in the possession of a distinct and comparatively large, circular opening near its summit, *two* deltoid or inter-radial plates separated by a long, triangular and externally con cave plate (Fig. 1 *b*.). The lateral and superior opening has been regarded as the anal aperture; and the long, concave plate, that tapers upwards and is quite prominent at its upper extremity where it forms the inferior boundary of the anus, has been styled the anal plate. The inter-radials of this area also differ in position from those of the other four interambulacral areas, their apices being directed downwards and reaching the radials at the base of the calyx.

On the superior surface of the specimen are to be seen five pairs of little apertures placed in a circle, and usually considered to have been genital in function; whilst in the centre of this circle and also of the summit of the calyx, is an aperture regarded as the mouth, and provided with small protecting plates. Hence, besides the foramina of the poral plates there are twelve openings, viz: the mouth, ten genital openings and the anus.

In comparison with Pentremites it is to be noticed that the radials of Nucleocrinus are much shorter and the inter-radials and pseudambulacra much longer than those of the former; that in Nucleocrinus an anal opening is present in one of the interambulacral regions; an anal plate is also present; and in consequence of the situation of the anal orifice and the anal plate there is an extra inter-radial or deltoid plate in the same area; that the two deltoid plates of this modified area are inverted in position; that the pseudambulacral fields are *convex*, and not concave, possess well marked pore-plates, and rather finely marked transverse grooves.

As the modified interambulacral area is not exhibited in the only figure given of lucina, *i.e.* Fig. 16, Plate 1, of the Fifteenth Report of the Regents of New York State University, it is impossible for me to institute anything like a complete comparison between lucina of New York and the Blastoid under consideration. Still, on comparing the latter with the figure of lucina one cannot fail to observe certain differences between them, in the lancet-plates, the prominently arched radials at the lower ends of the pseudambulacra, and the general shape of the calyx. The bringing to light of other specimens may, in the future, prove, what I strongly suspect, that this is a species quite distinct from lucina, and hitherto undescribed. In such event, this being the first species of Nucleocrinus discovered in this country, I would here propose for it the specific name *Canadensis*.

It is worthy of note that the genus Nucleocrinus in rocks other than American has thus far been altogether unknown to science.

The following are the species heretofore recognized:

1. Nucleocrinus *Verneuili*, Corniferous Formation, Troost, 1841.
2. " *angularis*, Corniferous Formation, Lyon, 1857.
3. " *Conradi*, Upper Helderberg Formation, Hall, 1862.
4. " *elegans*, Hamilton Formation (also said to have been found as low as the Upper Silurian), Conrad, 1842.
5. " *lucina*, Hamilton Formation, Hall, 1862.
6. " *Kirkwoodensis*, Sub-Carboniferous Formation, Shumard, 1863.

NOTE ON THE COMPOSITION OF DAWSONITE.

By B J. Harrington, B.A., Ph.D.

McGill College, Montreal.

In connection with the discoveries of Dawsonite which have been made at Pian Castagnaio in Tuscany,* a few remarks on the composition of this curious mineral may be deemed of interest. It will be remembered that the specimens originally described in 1874 were from joints in a white feldspathic dyke cutting the Trenton limestone near McGill College.† Since 1874 small quantities of the mineral have been observed in the joints of several other dykes in the same neighbourhood, and beautiful specimens have been obtained at the Montreal reservoir, in what is probably a continuation of the dyke near the college. In the latter instance the Dawsonite is associated with calcite, dolomite, pyrite, minute quantities of galena and occasionally of a black substance rich in manganese. In all cases the mineral occurs in more or less fibrous blades, which are often arranged in a radiated manner.

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* Two papers on the subject have appeared within the last few months in the Bulletin of the Mineralogical Society of France (IV., 28 and 155), the first, entitled "Sur un nouveau gisement de Dawsonite (hydrocarbonate d'aluminum et de sodium) et sur la formule de ce minéral," by C. Friedel; the second, "Sur le gisement de la Dawsonite de Toscanne," by Maurice Chaper.

† *Can. Nat.* II. vii. 305. "Notes on Dawsonite, a new Carbonate."

It reminds one of tremolite, and in the collection of minerals acquired by McGill College from the late Dr. Holmes of Montreal, there are several specimens of it which he had so marked.

The first specimens of Dawsonite analysed were found to contain between five and six per cent. of lime, and there was no evidence to prove that this was not one of the proper constituents of the mineral. Subsequently, however, it was found that the proportion of lime differed widely in different cases, while the ratio between the other constituents was constant. From this it was inferred that the lime really belonged to intermixed calcite which could not be completely separated. This view is fully confirmed by Friedel's examination of the Dawsonite discovered by M. Maurice Chaper in Tuscany, and the right of the mineral to rank as a good species may now be considered as fully established. Its special interest of course depends upon the fact that it is the only well defined carbonate containing aluminium which has yet been met with in nature.

The Tuscany Dawsonite is stated to occur in minute crevices, both in marl and sandstone, the latter being impregnated with dolomite. Among the minerals associated with it are calcite, dolomite, pyrite, fiorite and cinnabar; and it is said that the miners of the region look upon Dawsonite as a favourable indication in their search for cinnabar. The Tuscany mineral is evidently obtained in a purer condition than ours, and from his analyses Friedel concludes that the composition of the species is represented by Al_2O_3, Na_2O, $2\ CO_2$, $2\ H_2O$ or, as he also puts it, $Al_2\ (CO_2Na)_2\ (OH)_4$.

The following table gives under I. the results of Fridel's analyses; under II and III the original analyses of the mineral from McGill College; and under IV a recent one of that found at the Montreal reservoir. The last it will be seen indicates the presence of a large proportion of calcite :—

	I	II	III	IV
Carbon dioxide......	29.59	29.88	30.72	32 23
Alumina............	35.89	32.84	32.68	24.71
Soda	19.13	20.20	20.17	15.64
Water	12.00	11.91	(10.33)	9.06
Lime...............	0.42	5.95	5.65	16.85
Magnesia...........	1.39	tr.	0.45	tr.
Potash	....	0.38	....	....
Manganese dioxide...	....	....	....	0.23
Silica	....	0.40	....	0.84
	98.42	101.56	100.00	99.56

If from the above analyses we deduct the substances which may justly be regarded as impurities, including lime and magnesia in the form of carbonates, and then calculate the normal constituents for one hundred parts, it will be seen that the results agree well with the formula $Na_2 [Al_2] C_2O_8 + 2H_2O$:

	I	II	III	IV	FORMULA.
Carbon dioxide*	29.27	27.96	29.06	27.78	30.49
Alumina...........	37.88	36.42	36.70	36.12	35.55
Soda...............	20.19	22.41	22.65	22.86	21.48
Water	12.66	13.21	11.59	13.24	12.47

It has also been suggested that the formula may be written $3(Na_2CO_3) + (Al_2C_3O_9) + 2(H_6[Al_2]O_6)$.†

According to Friedel, the Tuscany Dawsonite when heated to 180° C. loses nothing but a little hygrometric water. Like the Canadian mineral it gives up both its "carbonic acid" and water at a red heat. The calcined residue also dissolves easily in hydrochloric acid. Neither the hardness nor the specific gravity of the European variety has been ascertained. For the Canadian mineral the original determinations were, H = 3, G = 2.40.

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* The atomic ratios for I and II are as follows:

C	.665	.636	2
$[Al_2]$	.369	.355	1
Na	.651	.723	2
O	2.764	2.696	8
H_2O	.703	.734	2

† Am. Jour. Sci. III. XXII. 157.

RESUMÉ ON WATER ANALYSIS: NEW METHODS AND RECENT RESULTS.

By J. BAKER EDWARDS, PH.D., F. C. S.

Public Analyst, Montreal.

Considering the many discrepancies of water analysis, the Society of Public Analysts of Great Britain have done good service to social science by co-operating with Mr. G. W. Wigner, one of its Secretaries and one of the editors of its organ "The Analyst," in discussing during the present year:

1. The Methods of Water Analysis.
2. Mode of Statement of Results.
3. Their Comparative Valuation.

Moreover, by the publication of monthly analyses of the "Public Water Supplies of Great Britain," they have conferred a benefit on the public. Mr. Wigner has long been a laborious "Water Analyst," and from his great experience on "Sea Side Waters," his opinion is entitled to considerable weight. As a result of his labours a Committee has been appointed by the Society of Public Analysts, which has drawn up and published a code of "Instructions for Water Analysis," in order to enable Analysts generally to co-operate, by adopting an uniform method of analysis and of the mode in which results shall be stated. It has still under consideration the mode of valuation of the relative impurities in potable waters submitted to the Society by Mr. Wigner in June last, which has subsequently been very generally approved. Comparative results having been thus rendered possible, a large number of English chemists have accepted the task of monthly water analysis in various districts, and these have been grouped together by Mr. Wigner in the recent September and October Nos. of "The Analyst," showing the average values of the impurities from January to June of the present year, and the valuations for July, August and September, severally, of 65 different water supplies in Great Britain, representing an enormous amount of exact and laborious work, which is much enhanced in value by this mode of bringing into comparative review differences which, without *uniformity of method, of statement, and of valuation*, would have no scientific interest whatever. Although the methods of research are *numerous* and *critical*, the Analysts of the Continent will, I feel sure, welcome anything like agreement on so vexed a question as water analysis, and will welcome these tabulated results. even if subsequent experience should lead to slight modifications of either *the methods or the valuations.*

Having lately had occasion to analyse for the Department of Public Works several samples of Ottawa water, I have carefully followed these methods and valuations, and I find much satisfaction in being thus enabled to classify them with British results so recently published, and from my own experience recommend to brother analysts in Canada and the United States the adoption of this general method, so that future tabulations of comparative values may include the whole of the waters of this Continent.

The following statement of results in the case of the Ottawa water supply will indicate the general method of analysis and mode of statement. For details the reader is referred to the elaborate " Code of Instructions " published in the June, July, and August numbers of " The Analyst," and also subsequently published in pamphlet form by the Society of Public Analysts.

Result of analysis of Ottawa water supply, taken Sept. 7th, 1881, by Messrs. Keefer, Lesage and Arnoldi.

	1. Color in 2 feet column	light yellow.
	2. Odor at 100 F.°	slightly peaty.
*	3. Chlorine as Chlorides	·4
	4. Phosphoric acid	none.
	5. Nitrates and nitrites	none.
	6. Ammonia free	·0050
	7. Albumenoid Ammonia	·0010
	8. Oxygen absorbed at 80 F. in 15 minutes.	·0040
	9. Hardness by Clarke's test	3·5°
†	10. Solids in solution	4.8
‡	11. Solids in suspension	4·2
§	12. Microcosms	chiefly vegetable.

The first mode of calculating the valuation of results is by fixing values to each of these impurities. Pure distilled water

* Quantities expressed in grains for Imperial gallon of 70.000 grs.
† Containing Alkaline Silicates.
‡ Chiefly Siliceous fragments.
§ Chiefly Diatoms and Sponge spicules and Algæ.

is taken as the standard of absolute purity—not taken for granted but ascertained by experiment. Variations from purity are assessed according to the following plan:

1. Appearance, blue clear 0; pale brown 1: pale yellow and green 2; dark yellow and dark green 4
2. Suspended matters, traces 1; heavy traces 2; turbidity 4
3. For odor, vegetable 1—2; animal 4
4. Chlorine ·5 gr. per gallon 1
5. Phosphoric acid, traces 2; heavy traces 4 to 8
6. Nitrogen as Nitrates, &c., ... ·100 gr. per gal. = 1
7. Ammonia..................... ·005 " = 1
8. Albumenoid .... ·001 " = 1
9. Oxygen absorbed in 15 minutes. ·002 " = 1
10. Do. " in 4 hours.... ·010 " = 1
11. Hardness before and after boiling 5° = 1
12. Total solid matter 5 grs. per gal. = 1
13. Heavy metals, traces................ = 6
    Do. heavy traces.......... = 12
14. Vegetable débris..................... = 4 to 8
15. Diatoms and Bacteria .... = 6 to 12
16. Hairs and animal débris............. = 10 to 20

This scale of valuation allows a considerable latitude for the exercise of judgment on the part of the Analyst and of allowance for exceptional cases. On this scale 10 is assumed to be the maximum for any one of these impurities, and if any single impurity exceeds 10 the excess is doubled and included in the addition. The classification of waters as more or less pure, after such valuation, is more difficult to agree upon, and will not be accepted without considerable discussion and probably some differences of opinion. Still the valuation of the results already obtained are of the utmost value, and will be increased by the continued publication of monthly returns to the year's end.

At present Mr. Wigner recommends the following grouping of waters:

Waters showing 15 or under are of exceptional purity.
" above 15 and under 40.... 1st class.
" " 40 " 65.... 2nd class.
" " 65 "... 90.... 3rd class.
" " 100....condemned as unfit for use.

Taking now the results obtained from the analysis of the Ottawa water, I value as follows:

1.	Color	1
2.	Odor	·5
3.	Chlorine	1·0
4.	Phosphates	none.
5.	Nitrates	none.
6.	Ammonia	·5
7.	Albumenoid	1·0
8.	Oxygen absorbed	2·0
9.	Hardness	1·0
10.	Solids in solution	1·0
11.	Solids in suspension	1·0
12.	Microcosms	1·0
		10·0

This water, therefore, stands very high on the British scale of purity. Some other examples of Ottawa water ranged as high as 12 for impurity but 11 may be taken as the mean value.

Now by the publication of these monthly returns based upon the same methods, I am enabled to give a comparative view of a series of English water supplies examined in the same month of September last. Thus—all exceptionally pure:

Rochdale valuation	= 9
Warwick	= 10
Canterbury	= 12
Swansea and Wolverhampton	= 15

First class:

Bolton	= 17
Shrewsbury	= 19
Brighton and Salford	= 21
E. eter and Leicester	= 23
Bury and Edinbro'	= 24
Portsmouth	= 27
Plymouth	= 28
Birmingham	= 29
Bristol and Whitehaven	= 30
London supplies	21 to 39

Second class:

Rugby	= 46
Liverpool	= 47
Darlington	= 50

Newcastle-on-Tyne	= 68
Kings and Lynn	= 110 (condemned.)

Ottawa supply 10 to 12

It would thus appear that Ottawa water ranks very high in purity as compared with the average water supplies of Great Britain even after filtration, and that, while this mode of additional precaution is open to the private consumer and is of the most serious importance in the prevention of disease, it is an open question as to how this can be best conducted in this country so as to be of general advantage, and it appears to me that (considering the exigencies in case of fire, the variability of climate, the severity of winter, and other considerations incidental to this country.) for the water impurities, present filtration is the only remedy, and household filtration the only practical remedy. I have therefore to recommend a plan of general household filtration which should be generally adopted and made compulsory on all water companies, in which water should be filtered from the main supply into houses or tenements or streets, and that taxes should be imposed for the use of filters as for the use of gas meters, added to the consumer's account on a pro rata basis. This project, I think, would prove effectual, and I hope may be found practical, and thus remove one of the many public grievances from the municipal shoulders of the corporate bodies of Canada.

On referring to the water analyses which I reported on the Montreal supply in 1879, and applying to these results the table of valuation, I find that notwithstanding the including of matters in suspension, Montreal water stands high by comparison. Thus,

March 1st,	standard of impurity	...... 11·5
April 21st,	" "	...... 16·5
July 30th,	" "	...... 15·5

Montreal water would therefore be exceptionally pure under such a system of filtration as I have suggested. That this is not utopian is, I think, proved by the fact that several modes of filtration have been patented which have considerable merit and one or other of which might be adapted to larger or small rates of filtration with satisfactory results.

That a simple flannel bag or felt filter is capable of removing a large quantity of the most objectionable kind of floating animal and vegetable matter is shown by the quantity removed in the flannel bag now exhibited, which has been in use for two days only over the supply pipe of the Parliament buildings at Ottawa, and which has removed upwards of four ounces of débris, river mud and vegetable matter, more than a score of snails, besides water beetles, worms and other not very minute animals. This is of course but a very partial filtration, but it is simple and within the reach of all. The models of filters on a large scale capable of effectually filtering very large supplies, I now exhibit to the Society.

No. 1. Howell's Patent—filters by capillary attraction through hempen cloths; it is built in sections, so that it can easily be taken asunder and cleansed. As a water-filter animal charcoal is placed between the sections, and such a filter would only require cleansing once a year or so.

No. 2. Foley's Patent, is manufactured by Robert Mitchell & Co. of this city. It contains sand and animal charcoal and is exceedingly effective. Under the ordinary pressure it filters the whole water supply of a house or public building, and is easily cleansed by reversing the currents of water, without disturbing the packing.

No. 3. Crocket's Patent, is designed for large quantities, such as district supplies, or "Station Filters." It is also cleansed by reversing the supply, and is an effective filter, applicable to public purposes and large volumes of water.

These designs show that there exist no insuperable difficulties in the filtration of water on the large scale in Canada; and such filtration would remove one-half of the solid matter, and therefore would render the water supply *twice as pure* as it is at present.

ON SOME FOSSIL FISHES, CRUSTACEA & MOLLUSCA FROM THE DEVONIAN ROCKS AT CAMPBELLTON, N.B., WITH DESCRIPTIONS OF FIVE NEW SPECIES.

By J. F. Whiteaves.

During the past summer Mr. R. W. Ells has been engaged in a continuation of his explorations in New Brunswick and on the north shore of the Baie des Chaleurs, on behalf of the Geological Survey of Canada, while Mr. A. H. Foord was occupied in making additional collections of the fossil fishes of Scaumenac Bay for the museum of the same institution. Towards the latter end of June Mr. Ells discovered remains of fishes, which he correctly supposed to belong to the genus *Cephalaspis*, in argillaceous and brecciated limestones* on the south bank of the Restigouche river, about half a mile above Campbellton. At the first opportunity this discovery was communicated to Mr. Foord, who at once visited the locality and devoted a week to a thorough examination of the fish-bearing beds. From these deposits he obtained a large number of specimens of *Cephalaspis*, a fine series of cranial shields and detached plates of a species of *Coccosteus*, fin spines of *Ctenacanthus* and *Homacanthus*, fish teeth, entomostraca, fragments of a large *Pterygotus*, a *Spirorbis*, and two small species of gasteropoda.

From the same rocks Principal Dawson has since collected a number of fossil fishes, &c., which he has kindly allowed the writer to examine and study. This collection, however, has not afforded any additional species to those already found by Mr. Foord, although some of the specimens in it, and especially two or three of the shells of gasteropods, are in an unusually fine state of preservation.

Before these discoveries were made, the only fossils that had been found in the Devonian rocks at Campbellton were plants, and on the evidence afforded by them Principal Dawson has concluded, first, that these deposits are probably of the same age as

* The rock is for the most part a dolomitic agglomerate, passing upwards into coarse shales, and associated with felsitic and trappean beds.

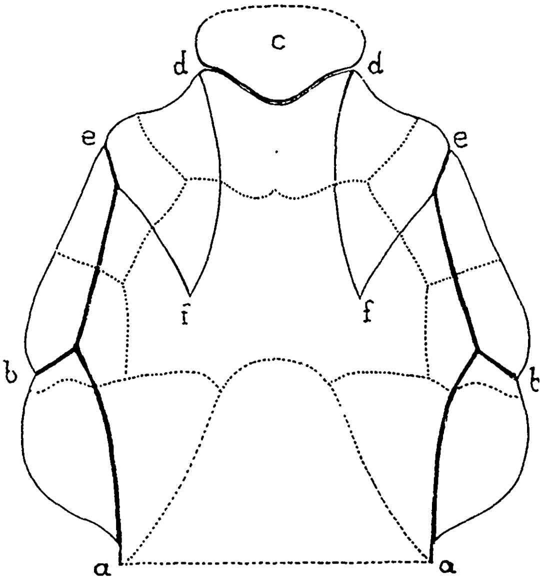
the Lower Gaspé sandstones, and secondly, that the former as well as the latter belong to a lower horizon in the Devonian system than the fish-bearing beds of Scaumenac Bay. The correctness of both of these conclusions seems to be corroborated by what is now known of the fauna of the Campbellton limestones and breccias, which are found to hold entomostraca, together with representatives of the genera *Coccosteus*, *Cephalaspis*, *Ctenacanthus*, *Pterygotus* and *Spirorbis* in common with the Gaspé sandstones. In Gaspé Bay these sandstones are known to rest directly and conformably upon limestones, the two lower divisions of which are stated by Mr. Billings to be representatives of the Lower Helderberg group, while the two upper have been regarded, by the same authority, as "nearly of the age of the Oriskany sandstone." From this statement and from the sections published in the Geology of Canada, it would appear that the greater part of the Gaspé sandstones occupy a very low position in the Devonian, but that they are separated from the extreme base of that formation by a thickness of at least 800 feet of limestone. At Scaumenac Bay, on the other hand, the fish-bearing beds are immediately overlaid by the sandstones and conglomerates of the Bonaventure formation of the Lower Carboniferous, and of the seven genera of fishes now known to occur in the Devonian rocks at this locality, not a single one of them has yet been found in the Gaspé sandstones or at Campbellton.

The following descriptions embrace the whole of the species collected at Campbellton by Mr. Foord, with the exception of the *Spirorbis*, entomostraca and some fin spines and fish teeth which have yet to be studied.

Fishes.

Coccosteus Acadicus. Sp. Nov.

Cranial shield. Flattened or depressed centrally and a little in advance of the centre, but always rising into a broad, low prominence on the median line at a short distance from the posterior margin: sides somewhat sloping. General outline that of an ovoid truncated at its broadest extremity, the truncation being posterior, the length and breadth nearly equal, and the greatest breadth behind the mid-length. Postero-lateral angles (*a.a.*) somewhat produced: lateral margins most convex posteriorly, slightly concave anteriorly, and with a small but distinct notch (*b*) a little behind the middle. When the rostral plate (*c*) is



Outline of a specimen of the cranial shield of *C. Acadicus*, shewing the rostral plate (*c*) in situ. Some of the superficial grooves restored from other specimens. Natural size.

absent, which is almost invariably the case, the anterior margin is concavely emarginate in the centre, the emargination being broad, transverse and bounded on each side by an obtusely angular projection (*d*). On the outer side of each of these projections there is an obliquely and shallowly concave, lateral emargination. In one specimen only (that from which the accompanying drawing was made) the rostral plate (*c*) fits into and completely fills up the central emargination of the front margin of the shield. This plate, which is nearly twice as broad as long, projects beyond the front margin of the shield, its two sides are narrowly rounded, but its anterior margin is broken. Test very thin. Sculpture consisting of numerous small, conical tubercles; which are smooth at their summits and marked with fine radiating grooves below. On some of the bony plates of the shield the tubercles are isolated and scattered, but in others they are arranged very distinctly in concentric lines separated by continuous furrows. Besides the tubercles, the surface is marked by certain superficial grooves, which are represented in the wood-cut by unbroken lines. The general direction of most of these grooves is longitudinal, and the most strongly marked are those which run from the antero-lateral (*e. e.*) to the postero-lateral angles (*a. a.*) and which are nearly parallel to the sides of the shield. Sutures scarcely perceptible: their apparent outlines being indicated in the figure by dotted lines.

Post-dorsomedian plate. Convex along the median line but highest in the centre, from which point there is a downward slope in every direction, the lateral slopes being most abrupt. Outline oblong but narrowing posteriorly so as to form a short beak. Anterior end somewhat rounded, sides parallel for more than two-thirds of their length, then attenuating rapidly into a point with obliquely concave sides. Maximum breadth equal to about one-third the entire length; apex of the beaked extremity curved slightly upwards. Tubercles arranged concentrically but not in distinct rows, those in the centre being the smallest, and those near the circumference being both distant and of comparatively large size.

Ventromedian plate. Flat; subrhomboidal, but with all the sides unequal and the margins of two of them (the right anteriorly and the left posteriorly) shallowly concave. Posterior extremity rather more produced than the anterior; length about one-third greater than the breadth. Tubercles arranged in distinct rows on three sides, but not on the left side of the posterior half, where they are nearly all isolated, those towards the centre being comparatively large and those near the centre very minute and densely crowded.

Pre-ventrolateral plates. Flat; longitudinally subreniform, a little longer than broad; outer margin concavely emarginate and inflected. Tubercles isolated, crowded and arranged obscurely in concentric, subparallel lines.

More than twenty well preserved and tolerably perfect specimens of the central shield have been collected, besides numerous fragments, but the suborbital plate is invariably absent, and the rostral plate is only preserved in place in one or two instances. The whole of these shields, too, appear to have been flattened by pressure, and if so, they may once have been longer in proportion to their breadth than they now are, and the anterior sinus into which the rostral plate fits, may have been narrower and deeper.

The few detached plates yet found are rarely perfect, though the sculpture of their outer surface is always beautifully shewn.

In some respects the Campbellton *Coccosteus* very closely resembles the *C. cuspidatus* of Agassiz, but in others there are such marked differences between the two forms that it is thought most prudent, for the present, to distinguish the Canadian species by a local name. No detailed description of *C. cuspidatus* has ever been published, and the illustrations that give the best idea of its characters are the figures on plate 3 of the "Old Red Sandstone." Assuming that these figures are essentially correct. the shape of the post-dorsomedian plate of the Campbellton *Coccosteus* (which Agassiz, who calls it the dorsal plate, regards as offering one of the best specific characters) and that of the diamond shaped ventro-median are almost exactly similar to those of *C. cuspidatus.* But on the other hand, in many of the plates of *C. Acadicus*, and especially in some which have not been separately described on account of the uncertainty of their homologies, but which are supposed to be isolated dorso-median plates of exceptionally large individuals, the tubercles are arranged in very distinct concentric lines, with continuous and comparatively broad grooves or spaces between them; an arrangement not indicated at all, or at most very obscurely, in the figures of *C. cuspidatus.* Again, the superficial grooves on the cranial shield of *C. Acadicus* are much more like those of *C. decipiens* as represented in a wood-cut in the "Foot Prints of the Creator," (third edition, figure 11) than they are like those in the figure of *C. cuspidatus* in the "Old Red Sandstone." In the *C. Acadicus* the most conspicuous of these grooves are constantly those which run from *a* to *e* on the accompanying diagram, and from the centre of each of these lines to the lateral notches at *b. b.* Making allowances for distortion, precisely similar grooves are to be seen in Miller's woodcut of the "cranial buckler" of *C. decipiens*. but they are entirely absent in his figure of the cranial shield of *C. cuspidatus.* Further, in the Campbellton *Coccosteus* other superficial grooves run from *c. c.* and *d. d.* to *f. f.* in such a way as to inclose a triangular space on either side, with a wide space between their inverted apices at *f. f.* This again, is just the arrangement in the "cranial buckler" of *C. decipiens*, whereas in *C. cuspidatus* the apices of the two triangles are not separated by a space but connected by a curved, transverse groove. It would seem, therefore, that the *C. Acadicus* may be distinguished from *C. decipiens* by the different shape of its post-dorsomedian plate, from *C. cuspidatus* by the different arrangement of the grooves on the outer surface of its cranial shield, and from both by the peculiar sculpture of its bony plates.

Cephalaspis Campbelltonensis. Sp. Nov.

Head shield (the only part known) large, somewhat pointed in front, obliquely rounded at the sides anteriorly, and produced behind into moderately elongated, slightly incurved cornua. Maximum breadth about seven inches. Orbits varying in outline from nearly circular to longitudinally broad ovate, sub-central, approximated, placed at distances from each other varying in different specimens from once to thrice the diameter of the orbit itself. Antorbital prominences rounded-conical; interorbital prominence also conical but somewhat elongated longitudinally; postorbital valley bounded by two narrow raised ridges, each of which starts from a prominence immediately behind the orbit: about halfway between the orbits and the posterior margin these ridges coalesce so as to form a single, broad and prominent but somewhat obscurely defined, posterior ridge.

Outer surface, which is very rarely preserved, polished and almost smooth to the naked eye. When examined under a lens it is seen to be minutely and densely pitted, the pits being very irregular in their shape, size and method of arrangement. Where the enamel is removed the surface is divided into numerous well marked polygonal areas.

Large fragments of the head-shield of this species are abundant in the Campbellton breccia, but the most perfect specimens yet obtained do not shew the outline of the posterior margin of the shield at all clearly. The orbits and the prominences and depressions in the central portion of the shield are often well defined, but the specimens are always crushed and nearly always exfoliated. Portions of the true outer layer of the test have been seen only on the central portion of the outer margin of the sides of one large fragment, and on the extremities of the cornua in two or three other specimens.

The genus *Cephalaspis* has been divided by E. Ray Lankester into three subgenera, viz., *Eucephalaspis*, *Hemicyclaspis* and *Zenaspis*, but as *Hemicyclaspis* is stated to be devoid of cornua it is clear that the *C. Campbelltonensis* cannot belong to this subgenus. Of the two which remain, *Eucephalaspis* and *Zenas-*

pis have precisely similar head shields, but the body of *Zenaspis* has a dorsal scute placed immediately behind the posterior spine. In the absence of any knowledge of the body of the Campbellton species, therefore, it is uncertain to which of these two subgenera it should be referred.

Including the *C. Dawsoni* of Lankester, from Gaspé, all the specimens of *Cephalaspis* hitherto described are said to be characterized by a surface ornamented by raised tubercles, so that the *C. Campbelltonensis* may be readily distinguished by its minutely pitted sculpture. In general outline the head shield of the present species appears to be very much like that of the *Eucephalaspis Powriei* from the Old Red Sandstone of Forfarshire.

Ctenacanthus latispinosus. Sp. Nov.

Compare *C. ornatus*, Agassiz. Recherches sur les Poissons Fossiles, Vol. 3, page 12, Table 2, figure 1.

Fin spines small (as compared with those of most of the other species of the genus) compressed laterally: either elongated, slightly curved and tapering rapidly from a rather broad base to an obtuse point,—or comparatively short, straight and triangular. Posterior margin somewhat concave, and bearing on its upper portion certainly one row and presumably two rows of short, conical hooklets, which curve obliquely downwards. Anterior margin thin, straight or gently convex, and unarmed. Surface marked on each side by from 15 to 20 longitudinal ribs, which swell out at regular intervals, of about one-third of a line apart, into subangular, equidistant nodes.

Length of the largest spine collected, about two inches and a half: maximum breadth of the same at the base, about three quarters of an inch.

The few spines of this species collected by Mr. Foord are all partly imbedded in the matrix, so that the grooving of the posterior margin is hidden from view, and only one row of hooklets is exposed.

Homacanthus. Sp. Undt.

Compare *H. arcuatus*, Agassiz. Poissons fossiles du Vieux Grès Rouge, page 113, Table 33, figures 1-3.

Fin spine rather large (for a *Homacanthus*) compressed laterally, distinctly curved, slender, elongated and tapering very gradually from a narrow base to an apparently obtuse point. Upper portion of the posterior margin armed with one or more rows of conical hooklets, which curve obliquely downwards. Surface ornamented by longitudinal ribs, with fine oblique striations.

Length about 17 lines, breadth at base about 3 lines.

Only one imperfect and badly preserved specimen was obtained, one side of which is buried in the matrix. It differs from the spines of *Ctenacanthus latispinosus* in its more slender proportions, more arcuate form, and apparently also in its surface ornamentation. As far as can be ascertained at present this spine appears to be very similar to the *H. arcuatus* of Agassiz, in almost every respect but that of size, the Campbellton species being much the larger of the two.

CRUSTACEA.

Pterygotus. Sp. Undet.

The occurrence of this genus at Campbellton is indicated by a fragment shewing the characteristic sculpture of semi-circular plicæ,—and by a single ramus of the chela of an antenna, which must have belonged to a very large species. This ramus, which is not quite perfect at either extremity, is about two inches and a quarter in length, and nearly half an inch in breadth at its largest end. It bears on its inner margin four or five unequal-sized, but comparatively large teeth, one of which is of much greater dimensions than the rest,—with a number of smaller ones between them. All the teeth are compressed and longitudinally striated: most of them are ovate-lanceolate in outline, the basal portion being slightly constricted,—but some of the small ones are simply conical.

MOLLUSCA.

Cyclora valvatiformis. Sp. Nov.

Shell very small, depressed turbinate, broader than high, spire much depressed: whorls three and a half, ventricose, rounded, increasing very rapidly in size, so that the greater part of the shell is formed by the last one, sutures deep; umbilicus between one-third and one-fourth of the diameter of the body whorl, deep in the centre and rounded at the margin. Mouth nearly circular but slightly angular posteriorly, next to the suture; lip thin and somewhat spreading. Surface nearly smooth, marked only by a few faint striæ of growth.

This species was found in great abundance both by Mr. Foord and Principal Dawson, the most perfect specimens being those which were obtained from weathered surfaces. The resemblance of this little shell to the *Cyclora minuta* of Hall, from the Hudson River Group of Cincinnati, is certainly very close. The only differences that can be noticed between them at present, judging by Meek's detailed descriptions of Hall's species, are that the aperture of *C. valvatiformis* is slightly subangular behind and the lip somewhat expanded, whereas the phrases used to describe the corresponding parts of the shell of *C. minuta* are simply—"aperture circular, lip thin." It is scarcely likely, however, that a shell which occurs associated with remains of *Coccosteus* and *Cephalaspis*, on the same small hand specimens of rock, is identical with a species from such a different geological horizon as the Hudson River Group.

Cyclora turbinata. Sp. Nov.

Shell very small, turbinate or turbinate-conical, about one-third higher than broad, spire elevated: whorls four or four and a half, ventricose, rounded, increasing rather slowly in size, sutures rather deep: body whorl also rounded, base imperforate, aperture sub-circular, slightly angular behind: lip thin and somewhat spreading.

Length three lines, maximum breadth two lines.

Not more than about half a dozen specimens of this little shell have been collected. The species is invariably found associated with the *C. valvatiformis*, from which it differs in its much more elevated spire and closed umbilicus. Like *C. valvatiformis*, the present species is somewhat similar to one of the diminutive gasteropoda of the Hudson River Group of Ohio, the *Cyclora parvula* of Hall, but the body whorl of the latter shell is described as subangular, and its umbilicus as not quite closed.

NOTE ON A FERN ASSOCIATED WITH *PLATEPHEMERA ANTIQUA*, SCUDDER.

BY J. W. DAWSON, LL.D., F.R.S.

The oldest remains of insects known to geologists, those of the Erian (Devonian) shales of St. John, New Brunswick, occur in beds rich in plant remains. It was indeed solely by means of the extensive quarrying operations carried on by Messrs. Hartt and Matthew in these beds in search of fossil plants, that the insect remains were discovered. In less thoroughly explored beds, fossils so rare and so obscure could not have been found. It is natural therefore that fossil plants should occur on the same slabs with the insects. On one of these, holding a fragment of the wing of *Platephemera antiqua*, there appears a considerable portion of a frond of *Pecopteris (Aspidites) serrulata*, Hartt, a common species in these beds, and also a small fragment of a leaf of the still more common *Cordaites Robbii*. It appears that Dr. Geinitz of Dresden saw this specimen in 1866, and not being at that time familiar with the ferns of the Devonian of New Brunswick, very naturally supposed that the frond was that of the closely allied *P. plumosa* of Brongniart, and on this ground he was induced to hint a suspicion that the specimen was of Carboniferous age. Dr. Scudder referred to this opinion of Geinitz in his paper on Devonian insects in the Geological Magazine, Vol. V.; and gave reasons sustaining the Devonian age of both fern and insect. I did not think it necessary to refer publicly to the matter, but took occasion to explain the true state of the case in a private letter to Geinitz; and in my report on the Devonian plants of Canada I quoted Hartt's description in full, and noticed the distinctness of his species from *P. plumosa*.

I find, however, that this doubt has been revived by Dr. Hagen in a paper on Devonian insects in the Bulletin of the Museum of Comparative Zoology for the present year (Vol. viii. No. 14). Dr. Hagen does not profess to be an authority in fossil plants, but fortifies his statements by a letter from Mr. Lesquereux, which does not however touch the question at issue, as he does not appear to have compared the specimen or Hartt's species with

P. plumosa; and though he insinuates a doubt as to the validity of some of my Devonian species, even this does not apply, since the species in question was carefully described by the late Prof. Hartt, and accepted by me after study of his material, which included several very considerable portions of well preserved fronds.

Though doubts and suspicions thus cast on work carefully and exhaustively done, in so far as material exists, should not seriously affect the minds of naturalists, I have thought it desirable to set the matter at rest, as far as possible; and have therefore, through the kindness of Dr. Scudder and the Curator of the Boston Society of Natural History, obtained access to the original specimen, and would now state the actual facts.

The fern on the specimen in question (No. 8496 of the Boston Society's collection) is undoubtedly *Pecopteris serrulata* of Hartt, and exhibits in a tolerable state of preservation six secondary pinnae of one side of a primary pinna of the species. To a hasty observer, supposing the specimen to be a piece of Carboniferous shale, it would be natural to refer the fern to *P. plumosa* of Brongniart or to *Aspidites silesiacus* of Goeppert, which it perhaps more closely resembles; and since its fructification is still unknown, it may quite as likely belong to the group or sub-genus *Aspidites* in which Goeppert and Schimper place *P. silesiaca*, as to that of *Cyathites* in which Schimper places *P. plumosa*.

The distinctive characters indicated by Hartt are principally the form and insertion of the pinnæ. the slender crenuiate revolute, lanceolate pinnules, and the simple veinlets. Perhaps the most obvious characteristic is the peculiarly elongated acuminate points of the primary and secondary pinnæ, in which this species seems to differ from all its near allies. In the specimen in question, though only a portion of one side of a primary pinna is seen, and its characteristic elongate termination is absent, yet one of the secondary pinnae shows this character very well, and the simple veins and crenate revolute margins may be made out with a lens in a good light. I do not think that any palæobotanist, in view of these characters, would decide to identify this fern with *P. plumosa*, unless indeed he were of opinion that the whole group to which that species belongs should constitute one broad specific type extending from the Devonian to the Permian, a view to which I should have no objection, provided sufficient connecting links can be found.

It is farther to be observed that this fern occurs with a group of species which I have shown to be distinct not only from those of the Coal Formation but from those of the Millstone Grit and those of the Lower Carboniferous Coal-measures or Horton series (sub-Carboniferous of some American geologists), which sub-floras are well developed in the Acadian provinces, and overlie stratigraphically the beds holding the fern which is the subject of this note and its associated fossils.

I may add here Hartt's description of the plant and my note on it, from my Report of 1870:—

"PECOPTERIS (ASPIDITES ?) SERRULATA, Hartt.—(Pl. XVIII, Figs. 207 to 209.)—Acad. Geol. p. 553, Fig. 92.—M.D., St. John, New Brunswick."

"Tripinnate; pinna short, alternate, close or open, lanceolate, very oblique, situated on a rather slender, rounded, sub-flexuose rachis; pinnules small, linear lanceolate, crenulate, revolute, moderately acute, oblique, sessile, decurrent, widest at the base, open, separated from one another by a space equal to the width of a pinnule, slightly arched towards the point of pinna; longest at base of pinna, decreasing thence gradually to the apex; terminal pinnule elongated. Median nerve entering the pinnule very obliquely, flexuous, running to the apex. Nervules very few, oblique, simple, and somewhat rarely forking at the margin."

"Numerous additional specimens of this species confirm Prof. Hartt's determination of its distinctness from *P. plumosa*, Brongt. It perhaps more strongly resembles Goeppert's *P. Silesiaca*; but this last has broader and more closely arranged pinnules decurrent on the petiole. It may be taken as a Devonian representative of the delicate Pecopterids of which the species above named are Carboniferous types. Mr. Hartt's specimens enable me to represent its habit of growth. Schimper quotes under this name a Carboniferous species of Lesquereux. But Lesquereux's species is *Alethopteris serrula*." (This was subsequently corrected by Schimper in the Supplement to his Palæontologie Vegetale.)

NATURAL HISTORY SOCIETY PROCEEDINGS.

Session 1880–81.

The last regular monthly meeting for the session 1880–81 was held on Monday evening, April 25th. Principal Dawson occupied the chair. The minutes of last meeting were read and sustained.

The Council presented a report recommending the transfer to Mr. Wolferstan Thomas of the mitoyenne wall on the north side of the Society's building and the narrow strip of land adjoining, so as to enable Mr. Thomas to connect his buildings in course of erection with the Museum.

A motion was made by Mr. G. L. Marler, seconded by Mr. W. Muir, and carried unanimously, approving of the report, and authorizing Mr. Marler to sign the agreement with Mr. Thomas.

Mr. Muir, the cabinet-keeper, stated and exhibited what additions had been made to the museum, namly, a prairie wolf and a remarkable specimen of the hare by donation; a Canadian lynx and a number of birds by purchase. The thanks of the Society were voted to the donors.

The Secretary read extracts from a lengthy paper by Mr. R. Chalmers, of New Brunswick, on the Glacial Phenomena of Baie des Chaleurs.

Dr. Dawson said the facts stated in the paper were a large contribution to our knowledge of that region, but he intimated that he did not quite agree with some of the author's theories.

Mr. W. Muir gave a detailed explanation of a new and improved method he had discovered of obtaining oblique light for the microscope. He said:

Not having an instrument with a swinging substage, my substage having only rack and rotary movement, and not satisfied with the working of the spot lens (as usually furnished) and Wenham's paraboloid, I was led to experiment with various means of oblique illumination; among others placing the Amici prism underneath, and to one side of the stage. I was surprised at the brilliancy of the effect produced, and concluded that if so brilliant an effect were produced by oblique rays from one point only, much more brilliant would be the effect if I could procure a condenser that would throw a complete circle of oblique rays on the object. I took my small bull's eye condenser of $1\frac{3}{8}$ in. diameter and 1 in. focus, placed on it a disk $\frac{5}{8}$ in. diameter, capable of being raised or lowered. and by means of an adapter placed it in my substage, using the flat mirror and either the 1 inch or 2 inch objective. I obtained an effect (particularly with the inch objective) which surpassed my most sanguine expectations. In transparent tissues such as the maple leaf insect, there were clearly revealed lines and structure that could not be seen otherwise, and in insects partially transparent, a perfect *flood* of oblique light with a dark ground was thrown on the structure, producing marvellous effect and giving wonderful clearness of definition to the finest lines. With my 1 inch objective I could see, on the two minute lancets of the mosquito (having the saws at their ends) running from root to the saw a beautiful fringe of exceedingly minute, long hairs, hooked at the ends, sharp and well defined, having a dia. $\frac{1}{30000}$ in. or .846659μ. and set 11,000 to the inch, which owing to their transparency I had never seen before. The markings and rounded structure of *Pleurosigma angulatum* are seen with the inch objective and binocular. By raising the disk the field is darkened, and by different focussing of the condenser, various effects are produced. With this mode of illumination, it is necessary to see that the flat mirror is in the axis of the instrument.

I placed on the centre of the disk a projecting pin which enabled me to put and retain on it different plates or diaphragms shutting out whatever portions of the circle of light desired. As a condenser for high powers the apparatus described is unsurpassed. I intend trying a condenser $1\frac{1}{4}$ in. dia., $\frac{5}{8}$ in. focus with $\frac{1}{2}$ in. spot, in the hope that with still more oblique rays, even a more brilliant effect will be attained.

After some remarks from Dr. Baker Edwards, those present adjourned to the library, where a number of microscopes were exhibited by members of the Microscopical Club, and by Mr. Muir who showed the excellent results that could be obtained by his method of illumination.

ANNUAL MEETING.

The Annual Meeting for the Session 1880–81 was held on Wednesday evening, May 18th, 1881. The President, Principal Dawson, occupied the chair. The minutes of the last annual meeting were read and sustained.

Having presented Major Latour with the Society's Bronze Medal for his many important services to the Society, the President delivered his

ANNUAL ADDRESS,

in the course of which he said that the year just closed had been distinguished more for the improvements made in the Museum of the Society and in its financial position than for extent of scientific work, though the latter had not been inconsiderable. The Society had sustained a great loss by the removal to Ottawa of several very efficient members connected with the Geological Survey and it was the more important on this account that it should endeavour to increase its membership and more particularly to attach to itself young men who take an interest in science. He referred to the discoveries resulting from the labors of Mr. Ells, Mr. Whiteaves, Mr. Foord and Mr. Weston in the upper part of Baie des Chaleurs. The remarkable association in that locality, within a very limited space, of Upper Silurian, Devonian and Lower Carboniferous rocks, was in itself of much interest, and the remarkable group of Upper Devonian fishes worked out by Mr. Whiteaves, and described by him at one of their meetings, completed a link of connection between the fossils of this country and of Great Britain. The plant remains of this locality also, connecting as they did the Gaspé sandstones with the Perry beds and with the Cattskill series of New York, were of the highest interest. A communication received latter in the session, from Mr. R. Chalmers, on the Postpliocene of the same region, has further added to our knowledge of this interesting region, on the confines of New Brunswick and Quebec. In connection with more Western regions, Dr. Selwyn, of the Geological Survey, has presented a paper on discoveries of fossil plants in the Lignite tertiary of Roches Percées, in the Western Territories. Another interesting geological subject was that of the structure of the Peace River District, as explained by Dr. G. M. Dawson, and more especially the recognition in that region of the Cretaceous series represented farther south, holding not only valuable beds of coal, but also fossil plants, seeming to connect some of the distinct floras recognised by American palæontologists to the southward. Having referred to the papers of Dr. Osler on Fresh Water Polyzoa, Mr. Donald on Baking Powders and Dr. Edwards on the qualities of certain Well-water, he said that much interest had been added to the meetings by the specimens submitted by their zealous curator, Mr. Muir, to whom they were also indebted for an illustration of a new illumating lens for the microscope, which he himself had invented. A Committee had been working throughout the Session in arranging for the visit of the American Association for the Advancement of Science in 1882, and it was hoped that their efforts would be successful in bringing about a scientific meeting even more successful than that of 1857.

In the absence of Mr. Whiteaves, who has removed to Ottawa, Mr. G. L. Marler read the following

REPORT OF THE CHAIRMAN OF COUNCIL.

Your Council has to regret the loss; since last annual meeting, of several of your most active members by the removal to Ottawa of the Geological Survey. Your Society has, by such removal, been deprived of a number of very active members, and your Council takes this opportunity of tendering to these gentlemen its sincere thanks for the valuable services they have rendered the Society, and hopes that although removed from this city they will not cease to interest themselves in the Society's proceedings, but will continue their connection with it as corresponding members. To attain this end your Council recommends that these gentlemen be regularly elected corresponding members.

During the Session now about to close your museum has received large additions both by purchase and donation. The specimens in the museum have been cleaned and remounted. This has added very materially to their appearance and value. Improvements have also been made in the building, and though much has been done, much yet remains to be done to carry out the proposed alterations and to make the building and its contents more worthy the objects for which they exist.

The land adjoining the building on the north side having passed out of the hands of the Royal Institution, and building thereon having been commenced, certain necessary expenses will in consequence fall on your Society. Arrangements have been made between your Society and the proprietor of the land adjoining your building to the north, to cede to him the few inches of land lying between your property and his, and for the sale of that portion of the north wall which he intends using and the land on which it rests. This will oblige your Society to alter the slope of the roof, to close three of the windows and to make other alterations; this arrangement has been made under your resolution approved of by your Council.

The usual free course of Somerville lectures was duly given to the number of six. Your Council recommends that the thanks of your Society be tendered and conveyed to the gentlemen who so kindly and ably gave their valuable time and labour in the preparation and delivery of these lectures, which, as proved by the large attendance, were well received and much appreciated. The lectures were as follows:

1881.

Feby. 3rd. On Mind in Nature. By Principal Dawson.

Feby. 10th. On Magnetism and Electricity as aids to Intelligence. By Dr. Barnes, Point St. Charles.

Feby. 24th. On Sugar and its Varieties. By Dr. J. Baker Edwards.

March 3rd. On the Brain as a thinking organ. By Dr. Osler.

March 10th. On Tobacco and its effects on the Brain, the Nervous System and organs of Vision. By Dr. Buller.

March 13th. On the Whence and Whither of a Sunbeam. By H. Sugden Evans, Esq., F.C.S.

Your Council thinks that the change of Janitor has been beneficial to your Society, and hopes that it may not be long before your resources will enable your Society to employ permanently a regular Taxidermist. This is now almost a necessity as the Museum must henceforth attract more attention from the public owing to removal to Ottawa of the Geological Survey. Your Council has also to report that the annual field-day took place as usual, Lachute being the place selected for exploration; the day was everything that could be desired, and the Council would not only recommend that these field-days be kept up but would suggest that several be held through the summer.

As Treasurer of the Society, Mr. Marler presented the subjoined

TREASURER'S REPORT.

Your Treasurer has much pleasure in reporting that notwithstanding the large amount expended in improving the Museum and adding to it a large number of valuable and rare specimens, your Society has been able to reduce the mortgage on the property by paying a sum of $250, leaving only a balance of $250 to be paid, and there yet appears to your credit a balance of $74. Like every other institution your Society is feeling the influence of the good times upon which our country is now entering. This is seen from the fact that members who were in arrears with their membership fees are now making payment of the same. Your Treasurer hopes therefore to be able to show at an early date the mortgage on the building paid off and a considerable balance on hand.

G. L. MARLER in account with THE NATURAL HISTORY SOCIETY OF MONTREAL,
from May 19th, 1880, to May 18th, 1881.

Dr.		*Cr.*	
1880. May 18.		1881.	
To balance on hand	$268.61	By Printing and Advertising	$135.12
		" Additions and repairs	270.00
1880–81.		" Petty repairs, furnishing, etc	43.96
To Government grant	700.00	" Salaries, gratuities and labour	457.00
" Donation from Mr. Hy. Joseph	10.90	" Gas and Water	147.25
" Rent of Rooms	510.50	" Editing *Naturalist*	50.00
Entrance Fees to Museum	75.80	" Excursion	30.00
Members' Fees	409.63	" Plumbing and Gasfitting	15.16
		" Hire of Piano, old account	10.00
		" Directory, John Lovell	2.50
		" Wood and Coal	129.82
		" Insurance	35.00
		" Repairs, (windows in upper part, &c.)	236.04
		" Interest on debt	30.00
		" Dawson Brothers' account	55.25
		" Hy. Joseph, Esq. on account of debt	252.95
		" Balance on hand	75.39
	$1975.44		$1975.44

Outstanding Debt on Mortgage, $250.00.

Examined and found correct, L. A. HUGUET LATOUR, *Auditor.*

G. L. MARLER
Treasurer.

Mr Muir then presented the

REPORT OF THE CABINET KEEPER AND OF THE LIBRARY COMMITTEE.

This report may be arranged under three divisions.

1.—Work on the Building.
2.—Work in the Museum.
3.—Report of Library Committee.

1st. Work on the Building.—On the left hand side of the entrance hall. a convenient store-room has been added, the ceiling of which gives a floor suitable for the accommodation of several specimens formerly in the Museum.' The side entrance has been enclosed by a ceiling and partition, forming an inside porch, adding greatly to the comfort of the place in winter; and the head of the rear stairway leading up to the gallery has been floored over, increasing the accommodation offered by the gallery. Eleven windows have been put in on three sides of the gallery, giving increased cheerfulness and light; curtains have also been placed on the sky-lights. The large wall cases, twenty-seven in number, have been cleaned and painted, the shelves made narrower and better adapted to show the specimens thereon. The north and south sides of the gallery fronts have been raised, levelled and supported. The benches in the Lecture Hall have been repaired and strengthened by bolts.

2nd. Work in the Museum.—The whole of the birds, (1194 in all), the mammals, reptiles and fishes have been thoroughly dusted and cleaned; the birds have been re-mounted on handsome black walnut stands and painted blocks and the old soiled labels replaced by new ones; the fishes have been removed to the aquarium room, and the mammals re-arranged and put in the space thus left vacant. The whale, two of the alligators, and the large seal have been removed to the floor covering the store-room to the left of the main entrance hall, and the floor cases, formerly in the aquarium room, have been brought into the main room. Mr. John S. Brown having offered to stock and take charge of the aquaria for the Society, two aquaria loaned by Messrs. Wm. Muir and Jas. Ferrier, jr., together with those belonging to the Society, have been placed in position, and it is hoped that before the season is over a good representation in this department will be one of the attractions of the Museum. Mr.

Brown has also generously offered to pay the cost ($6) of tables upon which to place the aquaria.

The following is the list of birds found to be so much injured that they were destroyed:

Grass Finch *Poecetes gramineus.*
Purple Martin, *Progne purpurea.*
Red-shouldered Hawk, *Buteo lineatus.*
* Lesser Red Poll, *Ægiothus linaria.*
Common Crow, *Corvus Americanus.*
Yellow-throated Fly Catcher, *Vireo flavifrons.*
Cat Bird, *Galeoscoptes Carolinensis.*
Brown Thrush, *Harporhynchus rufus.*
Red-eyed Fly Catcher, *Vireo olivaceus.*
* Sparrow Hawk, *Tinnunculus sparverius.*
* Shore Lark, *Eremophila cornuta.*
Satin Grakle (female), *Kitta holosericea.*
Great Northern Shrike (old male), *Collyrio Borealis.*
" " " (female) " "
Dipyllodes magnifica. New Guinea. J. F. W.

* These three have been replaced—and it is to be hoped that if any of our members can aid us in replacing the others they will do so.

The following are the additions to the Museum since June, 1880:

DONATIONS WITH NAMES OF DONORS.

Apatite crystal, from Bob's Lake, Bedford, Ont. W. J. Morris, Esq.
Moss, coated with mineral matter, from Colorado. Dr. Kennedy.
Collection of English Plants. Col. G. E. Bulger, F.L.S., F.Z.S.
A fine *Limulus polyphemus.* Miss E. Mathewson.
Grey Squirrel, *Sciurus Carolinensis.* N. P. Leach, Esq.
Albino Robin, *Turdus migratorius.* "
Barred Owl, *Syrnium nebulosum.* J. A. Ogilvy, Esq.
" " " " Jno. Nichols, Esq.
Horned Grebe, *Podiceps cornutus.* "
Great Blue Heron, *Ardea herodias.* Geo. Edwards, Esq., Thurso.
Blue Jay (2), *Cyanura cristata.* G. L. Marler, Esq.
A Remora or Sucking Fish. Geo. F. Phelps, Esq.
A Bull-head Fish. "
Head of a male Salmon. Robt. J. Fowler, Esq.
A box made out of a plank from the Royal George, and a lock of Grace Darling's hair. Capt. Dutton, S. S. Sardinian.
Wild Goose (2), *Bernicla leucopareia.* G. L. Marler, Esq.
Brant Goose, *Bernicla Brenta.* "
American White-footed Goose, *Anser albatus.* "
Hare (mongrel). P. Keutzing.
Prairie Wolf. Chas. Selwyn, Esq.
44 Specimens of *Lepidoptera.* P. Keutzing.

PURCHASES.

BIRDS.

Belted Kingfisher, *Ceryle Alcyon.*
Coot, *Fulica Americana.*
Baltimore Oriole, *Icterus Baltimore.*
Sparrow Hawk, *Tinnunculus sparverius.*
Shore Lark, *Eremophila cornuta.*
Loggerhead Shrike (male and female) *Collyris Ludovicianus.*
Bonaparte Gull (Young), *Larus Bonapartii.*
Black-bellied Plover (2), *Squtarola helvetica.*
Loon, *Colymbus glacialis.*
Spruce Partridge, *Tetrao Canadensis..*
Hooded Merganser, *Lophodytes cucullatus.*
Goshawk, *Astur atricapillus.*
Goshawk (old) "
Horned Grebe, *Podiceps cornutus.*
Royal Tern, *Sterna Regia.*
Brewers Duck, *Anas Breweri.*
American Avoset, *Recurvirostra Americana.*
Great Marbled Godwit, *Scolopax fedoa.*
Red-necked Grebe (2), male and female, *Podiceps rubricollis.*
" " young, "
Ruddy Duck (2), male and female, *Fuligula rubida.*
Greater Blackhead Duck (2), male and female, *Fuligula marila.*
Snowy Owl (2), *Stryx Nyctea.*
Herring Gull, *Larus argentatus.*
Killdeer (young), *Ægialitis vociferus.*
Harris Woodpecker (2) male and female, *Picus Harrisi.* Vancouver's Island.
Yellow Rail, *Rallus noveboracensis*, Labrador.
Arctic Towhee (male), *Pipilo arctica.*
Fork-tailed Fly Catcher, *Muscicapa savanna.*
Horned Grebe (winter plumage), *Podiceps cornutus.*
Great Northern Diver, *Colymbus glacialis.*
Black-throated Diver, *Colymbus arcticus.*
Snow Bunting (2), *Plectrophanes nivalis.*
Black-throated Blue Warbler, *Dendroica Canadensis.*
" " Green " " *virens.*
Black and Yellow, " " *maculosa.*
Green Black Cap Fly Catcher (male, winter plumage), *Muscicapa pusilla.*
Mealy Red Poll (summer plumage) *Ægiothus exilipes.*
Little Minaret, *Pericocotus peregrinus.*
Wild Pigeon, *Ectopistes migratoria.*

MAMMALS.

Canadian Lynx, *Lynx Canadensis.* St. Jerome.
Racoon (old female), *Procyon Lotor.*
" (young), "
Mink, *Putorius vison.*
Weasel (2), *Putiorus vulgaris.*
Prairie Dog, *Spromophilus ludovicianus.*

Skins presented on a former occasion by the Smithsonian Institute and now mounted:

California Grey Squirrel, *Sciurus fossor.*
Thirteen Striped Squirrel (2), *Spermophilus tridecemlineatus.*
Mice (7)—various species.

Skins re-mounted:

Red-shafted Woodpeckers (2), *Picus querulus?.*
Swift Parakeet, *Melopittacus undulatus.* Australia.
Hardwicke Shrike, *Collyrio.*
Yellow Bird (female), *Chrysomitris tristis.*

3rd. Report of Library Committee.—List of books, pamphlets and periodicals received into the library during the year ending May 1st, 1881:

American Journal of Science. Vol. 19, Nos. 110, 113; Vol. 20, Nos. 115, 116, 117, 118, 119, 122, 123.
Boston Society of Natural History. Vol. 20, Part 3.
American Philosophical Society. Vol. 18, No. 105.
Canadian Antiquarian and Numismatic Journal. Vol. 8, Nos. 3, 4; Vol. 9, No. 3.
Canada Medical and Surgical Journal, for the year.
Canadian Entomologist, "
Le Naturaliste Canadien, "
Statutes of Canada. Vols. 1 & 2. 1880.
Geological Record for 1877, by Wm. Whitaker. London, 1880.
United States Fish Commission Report; from Smithsonian Institute.
Scientific Proceedings of the Royal Dublin Society, from Nov. 1877 to July, 1880.
Scientific Transactions of the Royal Dublin Society, from Nov. 1877 to June, 1880.
Academy of Natural Sciences of Philadelphia. Parts 1st and 2d. Jany. 1880 to Sept. 1880.
Proceedings of the Rhode Island Historical Society, 1879–1880 and 1880–1881.
Transactions of the Connecticut Academy of Arts and Sciences. Vol. 1, Part 2, 1867 to 1871.
Annals of the Lyceum of Natural History. Vol. 11, No. 13.

Annals of New York Academy of Science, late Lyceum of Nat. His. Vol. 1, Nos. 11 to 13.

Contributions to Archæology of Missouri ; from St. Louis Academy of Science. Part 1. Pottery. 1880.

Proceedings of the American Philosophical Society, 100th Anniversary, at Philadelphia. March, 1880.

Geological and Natural History Survey of Minnesota, 8th An. Report, 1879.

The American Antiquarian.

The American Naturalist. Vol. 14, Nos. 8 to 12 ; Vol. 15, Nos. 3 to 5.

Annals of the Museo Nacionalde. Mexico, 1880.

Journal of the Linnæan Society of London. Vol. 14, No. 80 ; Vol. 15, Nos. 81 to 83 ; Vol. 17, Nos. 103 to 107.

Proceedings of the Royal Society of London. Vol. 29, No. 197 to 205. June 1879 to June 1880.

Transactions of the Edinburgh Geological Society. Vol. 3, Part 2. 1879.

The Glasgow University Calendar, 1880–1881.

Science Gossip ; for the year.

Quarterly Journal of Microscopical Science, for the year.

Journal of the Royal Microscopical Society, for the year.

Journal and Proceedings of the Royal Society of New South Wales. Vol. 12. 1878.

Transactions of the Philosophical Society of Adelaide, South Australia. Vol. 1, 1878 ; Vol. 2, 1879 ; Vol. 3, 1880.

Geological Survey of Canada. Report of Progress. 1878–1879.

Annual Report of the Entomological Society of Ontario for 1880.

Bulletin of the Essex Institute. Vol. 12, No. 769.

Ninth Annual Report of the Curators of the Wesleyan University, Middleton, Conn., U. S., 1880.

Nature. London. A Weekly Journal ; for the year.

Archives Neerlandaises des Sciences Exactes et Naturelles—Societé Hollandaise des Sciences, Haarlem.

Archives Musée Teyler.

Nederlandsch Meteorologisch Inarbackvoor, 1879.

Sitzungs-Beritche der Naturwissen schaftlichen Gesselschaft Isis in Dresden, 1879 and 1880.

Zeitschrift der Deutschen geologischen Gesellschaft—Berlin, 1879. 2 Vol. One No. April to June 1880.

Leopoldina. Dresden. Jany. 1878, Jany. 1879.

Nova Acta Academæ Cæseræ Leopoldina-Carolinæ, Germanical Naturæ curiosorum. Dresden and Halle, 1878.

Brachiopodes Etudes Locales. Extraits du Silurien du centre de la Bohemé. Vol. 5. Par Joachim Barrande. Paris.

Memoires de L'Academie des Sciences, Arts et Belle-Lettres des Dijon. 1878–1879.

Beritche uber die Verhandlungen der Koniglick sachsischen Gesselschaft der Wissenchaften Zur Liepzig. 1879.

Abhandlungen der Mathematish-physischen classe der Konigl, clas 12, Nos. 2 to 4. Leipzig, 1879-1880. Also, No. 2, 1879.

Annals of the Museo Nacionalde. Mexico. Part 2. 1880.

Bulletin de la Societé Imperiale des Naturalistes de Moscow. Nos. 1, 2, 3, 4. 1879.

Acta Horti Petropolitani. Tomus VI, Fasciculu 2. St. Petersburg.

Bulletin et Memoires de Université Imperiale de Kazun (en Russe) 1879. No. 1 to 6.

Transactions of the Edinburgh Geological Society. Vol. 3, Part 3. 1880.

Proceedings and transactions of the Nova Scotian Institute of Natural Science. Vol. 5, Part 2. 1879-1880.

Report of the Wisconsin Naturalist Society, German. 1880-1881.

Annual Report of the Department of Mines, New South Wales. 1880.

Do. do. do. for 1880. With maps.

Transactions of the American Philosophical Society. Vol. 15, New Series, Part 3.

Proceedings of the Royal Geographical Society. London. Vol. 3. No. 4.

In concluding my report allow me respectfully to suggest to the Council the following necessary and desirable repairs, improvements and additions in the Museum and building, besides those rendered necessary by the construction of the building on the northern side:

1st. The drains will require to be lowered, to enable them to drain the water from the under part of the furnaces.

2nd. In the heating department a new furnace or furnaces will be required (the old ones are worn out), which, in addition to the present heating arrangements, shall convey a shaft for hot air to the floor of the Museum.

3rd. The excessively crowded condition of the Hall on the occasions of the Somerville lectures revealed the necessity of providing for the more rapid influx of fresh air and egress of heated air. Increased accommodation can also be partially provided by arranging the folding doors on the north-east corner of the Hall so that they can be thrown open if desired.

4th. The addition to our stock of birds and mammals during the past year and the likelihood of equal addition during the coming year necessitates the acquirement of more wall cases in the Museum.

The Secretary then read the

REPORT OF EDITORS OF THE "CANADIAN NATURALIST."

The Editors of the "*Naturalist*" would report that this Journal has been issued as usual during the past year, four numbers having appeared since last annual meeting. They regret to state that but scanty material has during the past year been placed at their disposal by members of the Society. They would again urge upon members the necessity of doing all in their power to contribute and procure articles suitable for the Society's publication.

It was agreed on motion of Dr. DeSola that the reports now read be received and adopted and printed in the *Naturalist* and that a Membership Committee be appointed to enlarge the subscription roll and increase the interest in the Society.

Dr. A. R. C. Selwyn was proposed as an honorary life member; Dr. Ross was proposed as on ordinary member, and Dr. Robert Bell, Dr. G M. Dawson, Messrs. Foord, Ells, Richardson and Whiteaves, as corresponding members.

The election of officers was then proceeded with, resulting as follows:

President—Principal J. W. Dawson, LL.D., F.R.S.

Vice-Presidents—The Rev. Dr. DeSola, Mr. J. H. Joseph, Prof. P. J. Darey, Dr. T. Sterry Hunt, Major H. Latour, Dr. A. R. C. Selwyn, Dr. Hingston, Prof. B. J. Harrington and Mr. D. A. P. Watt.

Recording Secretary—Prof. F. W. Hicks, M.A.

Corresponding Secretary—Dr. J. Baker Edwards.

Treasurer—Mr. G. L. Marler.

Cabinet-Keeper and Librarian—Mr. Wm. Muir.

Council—Messrs. Thomas Craig, J. T. Donald, J. Bemrose, H. M. Sanborn, Dr. Osler, the Rev. Mr. Empson, M. H. Brisette, John S. Brown and S. Bagg.

Library Committee—Messrs W. Muir, J. Bemrose, J. S. Brown and J. T. Donald.

Editors of Canadian Naturalist—Professor B. J. Harrington and Mr. J. T. Donald.

Mr. Wm. Muir gave notice of motion to alter the by-law concerning annual membership fee.

The meeting then adjourned until June 16th.

The adjourned annual meeting was held on June 16th. Principal Dawson in the chair.

The minutes of the meeting of May 18th having been read and sustained, it was moved by Mr. J. H. Joseph, seconded by Prof. F. W. Hicks, and resolved: that in accordance with notice given at the meeting on the 18th ult., "the annual subscription to the Society be reduced to four dollars including the subscription to the *Naturalist* and to three dollars without the *Naturalist*.

The chairman of Council and the Recording Secretary were requested to issue a circular announcing the change in the subscription and urging members to endeavor to increase the membership list."

Messrs. Geo. Craig and P. Keutzing were proposed as ordinary members, after wl ich the meeting adjourned.

SESSION 1881–82.

The first meeting of the Society, for this session, was held on the evening of November 7th—Principal Dawson occupied the chair. Minutes of last meeting being read and sustained, it was resolved, on motion of J. S. Brown, Esq., seconded by J. H. Joseph, Esq., "To sell to Mrs. F. W. Thomas the portion of the Society's lot intervening between its building and the line of Mrs. Thomas' property, to the depth of the buildings on Mrs. Thomas' lots, and the mitoyenneté of so much of the wall of the Society's building as is used by Mrs. Thomas. This, in consideration of Mrs. Thomas paying the Society one-half the value of the portion of the wall and of the ground on which it is erected—the valuation of the wall to be made by Mr. Hutchinson—and the ground to be valued at $1.20 per square foot, English; and in further consideration of the Society's being suffered to retain the use of such of the windows as now overlook Mrs. Thomas' land, so long as the Society's building is used for the present purposes of a Museum, curator's residence and Lecture Room. But should it be converted to private uses, the Society will be bound to close its openings overlooking said Mrs. Thomas' land; the Society to bar their windows so that access to Mrs. Thomas' land may be prevented, and that the President and Treasurer be authorised to carry this resolution into effect, and to sign all necessary deeds, and to receive the price and grant discharge therefor."

It was also resolved, "That use of Lecture Room be granted free of expense, except for gas and heating, to the ladies of the Industrial Rooms, for holding a bazaar sometime in December, the details to be arranged by the Treasurer."

Messrs. G. W. Craig and P. Keutzing were elected members of the Society, and Mr. M. C. Baker was proposed for ordinary membership.

Major Latour proposed as honorary member His Excellency Dr. Renard, Conseiller d'état actuel de Moscou.

A collection of Resins, presented to the Museum by J. Lorne McDougall, Esq., was exhibited, and it was announced that Dr. Edwards and Mr. Donald would report on the same at a future meeting.

Dr. Dawson congratulated the Society on the result of the invitation to the American Association, and stated that in due time a meeting of influential citizens would be called to make suitable arrangements for entertaining the Association.

Dr. J. Baker Edwards presented a paper entitled "Resumé on Water analysis: new methods and recent results," which will be found in full at page 87.

Dr. W. Osler then read a series of "Microscopic Notes," which will be published in a future number.

The second meeting was held on Nov. 29th. The President occupied the chair.

The minutes of the previous meeting were read and approved.

Mr. Muir called the attention of members to several important additions recently made to the Library and to the Museum, the latter consisting of specimens purchased by the Society and mounted.

Mr. Muir then moved, seconded by the Rec. Secy., "That the President and Secretary be requested to draw up and forward, in the name of the Society, a resolution of condolence, expressing the sorrow of the members of the N. H. Society at the death of the late Lieut.-Col. Bulger, to whom the Society is very largely indebted for additions to the Museum."

Moved by Dr. Edwards, seconded by Prof. Darey, "That the use of the Museum and Library be permitted to the Auxiliary Association of Christ Church Cathedral, on the evening of Dec. 1st, on condition that they pay the expense of lighting, &c., as arranged by the Treasurer."

His Excellency Dr. Renard, Conseiller d'état actuel de Moscou, was elected an honorary member, and Malcolm C. Baker, Esq., Montreal, an ordinary member.

Dr. Edwards presented the report prepared by himself and Mr. Donald, on the Resins presented to the Museum by J. Lorne McDougall, Esq.

The collection consists of specimens of the following "gums": Zanzibar, Manilla, Kowrie, Damar, Benguela, Angola, Sierra Leone Copal, Asphaltum, Orange Shellac and Bleached Shellac. Dr. Edwards described the sources of these "gums," and Mr. Donald furnished information obtained from Messrs. McDougall, Logie & Co., concerning their uses and commercial values.

The Recording Secretary read the paper entitled "Notes on Fossils recently found near Campbellton, Baie de Chaleurs," forwarded by Mr. Whiteaves.

During the reading of the paper the subject was illustrated by means of diagrams and specimens from his own collection, by Principal Dawson, who at the conclusion described at length the geology of the locality in which the fossils had been found.

Presidents of the Natural Society of Montreal, 1827—1881.

1827-28.—Stephen Sewell.
1828-29.—Honorable Chief Justice Reid.
1829-30.—Honorable John Richardson, M.C.E.
1830-31.—Honorable Lewis Gugy.
1831-32.—Honorable Toussaint Pothier.
1832-33.— " " "
1833-34.—Revd. J. Bethune.
1834-35.—William Robertson, M.D.
1835-36.—Alexander Skakel, A.M,
1836-37.—Andrew F. Holmes, M.D.
1837-38.— " " "
1838-39.— " " "
1839-40.—
1840-41.—Andrew F. Holmes, M.D.
1841-42.—William Badgley.
1842-43.—John Brondgeest.
1843-44.— " "

1844–45.—M. McCulloch, M.D.
1845–46.—John Brondgeest.
1846–47.—J. Crawford, M.D.
1847–48.—A. H. David, M.D.
1848–49.—A. C. Sewell, M.D.
1849–50.—A. H. David, M.D.
1850–51.—John Ostell.
1851–52.— " "
1852–53.—A. Charles Sewell, M.D.
1853–54.—Major R. Lachlan.
1854–55.—Revd. W. T. Leach, D.C.L.
1855–56.—The R. R. the Lord Bishop of Montreal and Metropolitan.
1856–57.—Principal J. W. Dawson, F.G.S.
1857–58.— " " " "
1858–59.— " " " "
1859–60.—The Lord Bishop of Montreal (Fulford).
1860–61.— " " " "
1861–62.— " " " "
1862–63.— " " " "
1863–64.—Principal J. W. Dawson, LL,D., F.R.S.
1864–65.— " " " " "
1865–66.—Charles Smallwood, M.D., LL.D., D.C.L.
1866–67.—T. Sterry Hunt, LL.D., F.R.S,
1867–68.—Revd. Abraham De Sola, LL.D.
1868–69.—Principal J. W. Dawson, LL.D., F.R.S.
1869–70.—Sir William E. Logan, LL.D., F.R.S.
1870–71.—Principal J. W. Dawson, LL.D., F.R.S.
1871–72.— " " " " "
1872–73.—George Barnston.
1873–74.—Principal J. W. Dawson. LL.D., F.G.S.
1874–75.—A, R. C. Selwyn, F.R.S., F.G.S.
1875–76.— " " " "
1876–77.—Principal J. W. Dawson, LL.D., F.G.S.
1877–78.— " " " " "
1878–79.— " " " " "
1879–80.—A. R. C. Selwyn, F.R.S., F.G.S.
1880–81.—Principal J. W. Dawson, LL.D., F.G.S.

MISCELLANEOUS.

A Fossil Phyllopod Crustacean from the Quaternary Clays of Canada.—We have received through the kindness of Principal J. W. Dawson, LL.D., of Montreal, a valve in partial preservation of an Estheria quite unlike any existing American form. The following account of its discovery is from Principal Dawson :

" It was found at Green's Creek on the Ottawa river, in nodules in the Post-pliocene clay, holding skeletons of *Mallotus villosus* and other northern fishes, and shells of *Leda* (*Portlandia*) *arctica*, *Saxicava rugosa*, &c.; also leaves of Populus, Potamogeton, &c. The deposit is of the age of the Leda clay of the St. Lawrence (middle glacial) and belongs to a period of submergence when in the bay or estuary then representing the Ottawa river, northern marine animals were imbedded in deposits into which was also washed the débris of neighboring land, and of fresh water streams. *The climate at the time was colder than at present, and the area* of land less, so that if this Estheria still lives, it is most likely to be found in the vicinity of the Arctic coast."

This Estheria is entirely unlike any northern American or European species, differing decidedly from *Estheria morsei* or *E. caldwelli* and *E. clarkii* It rather approaches *E. jonesii* from Cuba in the form of the shell and style of marking of the valves. It does not resemble closely any of the fossil forms figured in Jones' Monograph of fossil Estheriæ. The markings, however, present some resemblances to *E. middendorfii* Jones, but differ in the want of anastomosing cross wrinkles between the ridges.

One valve and portions of others were preserved; but none of them show the beaks (umbones), though the form of the remainder of the shell indicates that they were situated nearer the middle of the valve than usual, *i. e.*, between the middle and the anterior third of the shell. The shell is deep, probably more so than in *E. jonesii*, though the valves have evidently been flattened and and somewhat distorted by pressure, but apparently the head-end was more truncated than in *E. jonesii*, as the edge of the shell and the parallel lines (or ridges) of growth along the head-end are below bent at right angles to the lower edge of the shell. The raised lines of growth are very numerous and near together; they are of nearly the same distance apart above near the beaks *as on the lower edge. The very numerous lines of growth are* thrown up into high sharp ridges, the edges of which are often rough, finely granulated, and often the valleys between are rugose on the surface. In one or two places a row of papillæ for the insertion of spinules may be seen where the shell has been well preserved, and between many of the lines of growth there are irregular superficial ridges. Length 10 mm.; depth 7.5 mm.

The valve is evidently that of an Estheria, much truncated anteriorly, and with the lines of growth much thicker, higher and closer together than in any North American species known to us, and may prove when better specimens are found, to be allied to the tertiary Siberian *E. middendorfii*.

The species is named in honor of the discoverer, J. W. Dawson, LL.D., who has so persistently and ably investigated the Leda clays of Canada. *A. S. Packard, jr.*—*(From the American Journal of Science.)*

GEOLOGICAL SOCIETY OF LONDON.

Extract from proceedings; Nov. 16, 1881.

UNIFICATION OF GEOLOGICAL NOMENCLATURE.

Prof. HUGHES said that he proposed to issue to the Committee of organization for Great Britain a full Report of the proceedings of the Bologna Congress; but in anticipation of that, he begged to offer to the Geological Society a brief statement of the results.

It would be within the recollection of the Fellows of the Society that, at the Geological Congress of Paris in 1878, two principal subjects were proposed for discussion at the Bologna Congress, and each was referred to an International Commission named by the Congress:—

1. The Unification of Geological Nomenclature.
2. Geological Cartography.

On the 2nd of April, 1880, the International Commission for the Unification of Geological Nomenclature was convened at Paris by the President of the Paris Congress and the President elect of the Bologna Congress, and the Commissioners present at that meeting, having regard to the impossibility of drawing up any thing like a complete report upon so vast a subject before the meeting of the Congress, and feeling that there would be much advantage gained by settling the meaning of the terms commonly used to designate the larger and smaller divisions of the materials which make up the crust of the earth, and the portions of time to which they are assigned, recommended that, first of all, these questions of a general character should be considered, such as the definition of epoch, period, formation, rock, &c., &c. A *résumé* of the reports of the different nationalities was drawn up by the General Secretary, M. Dewalque, and presented to the Congress, and the discussion was taken upon it. America and England were considered as one from the very first, a happy result of the friendly feeling that exists on all points between the two nations, and at Bologna cordially upheld by their distinguished guest of that evening Dr. Sterry Hunt.

The conclusions arrived at were briefly—that the term Group should be applied to the largest geological division of rocks, System to the next, Series to the third in order of magnitude, Stage to the fourth, and the French word Assise was placed in the fifth place, it being left to other nationalities to use whatever word in their own tongue seemed most conveniently to represent this smallest defined term. The Time-words were, in descending order of magnitude—Era, Period, Epoch, Age—Era corresponding to Group, Period to System, Epoch to Series, Age to Stage. It was pointed out that the German and English use of the word *formation* for a set of deposits which it was desired to group together under one head, *e.g.* Carboniferous formation, could not be adopted by the French, with whom this word always had reference to the origin of the mass, and was considered an abbreviation of the *mode of formation*. This had been already fully recognized by the English Committee, in the minutes of one of the meetings of which the following resolution appears:—"The term Formation having been used by Continental geologists to denote the action by which a thing is formed, and its mode of formation, and its use in the sense accepted in England being given up in America, the Committee recommend that the term be employed as rarely as possible in the English sense, and that such words as group, rock, bed, &c., be substituted for it." It was pointed out by the German geologists that there were many nations who could not adopt "terrain," and therefore this word was also excluded from the more strictly defined terms. MM. Beyrich and Von Moeller explained that the word *series* could not be conveniently introduced into German or Russian, and it was therefore agreed that the words *section* and *Abtheilung* should be admitted as synonyms of *series*. It will be observed that there is a consistency in the group of words adopted in English, they are all what may be called synthetic; the analytic words such as division, subdivision, section, &c. remain undefined.

He regretted that they were not able to transpose the words Group and Series, as it certainly would be more convenient to to use *series* for the larger, and *group* for the smaller division; but it was not a matter of great importance.

In the course of the discussion, various speakers pointed out, by way of illustration, what they would include under these heads, and it was clear that there was very much to be done before any equivalent value could be attached to the subdivisions of different ages, or of the same general age, in widely separated areas.

The English Committee had commenced work upon this question, and he had laid before the Congress the Reports of the Sub-committees which had furnished him with the results of their inquiries, as well as some special reports forwarded to him by individuals. The Congress did not, however, pass on to the discussion of these matters; but the manner in which the English Committee were organizing their work met with the approval of the Congress, and a vote was passed that the other countries should adopt a similar plan, and form sub-committees for the investigation of the several groups. He was further unofficially requested to get the reports printed as soon as possible, in order to facilitate discussion, and with a view to arriving at an understanding upon the simpler questions before the next meeting of the Congress. This was appointed to be held at Berlin in 1884. The following Congress will be held in England.

PRE-CAMBRIAN ROCKS.

Dr. T. STERRY HUNT gave some account of the pre-Cambrian or Eozoic rocks of Europe as compared with those of North America. He had on several occasions studied them, both on the continent and in the British Isles, especially with Dr. Hicks in Wales in 1878. In North America the recognised base is a highly granitoid gneiss, without observed limestones, which he has called the Ottawa gneiss, overlain, probably unconformably, by the Grenville series of Logan, consisting chiefly of granitoid gneisses, with crystalline limestones and quartzites. These two divisions make up the Laurentian of Canada, and correspond respectively to the Lewisian and the Dimetian of Hicks. Resting in discordance on the Laurentian, we find areas of the Norian or Labrador series (Upper Laurentian of Logan), chiefly made up of anortholite rooks, granitoid or gneissoid in texture, with some true gneisses. The Huronian is seen to rest unconformably on the Laurentian, fragments of which abound in the Huronian conglomerates. To the lower portion of the Huronian the speaker had formerly referred a great series of petrosilex or hälleflinta rocks, described as inchoate gneisses, passing into petrosilex-porphyries, occasionally interstratified with quartzites. This series, in many places wanting both in Europe and America, he is now satisfied forms an underlying unconformable group—the Arvonian of Hicks. Above the Huronian is the great Montalban series, consisting of grey tender gneisses and quartzose-schists, both abounding in muscovite, occasionally with hornblendic rocks. The Pebidian of Hicks includes both the Huronian and the Montalban, to which latter belong, according to the speaker, certain gneisses and mica-schists both in Scotland and in Ireland, as he had many years since pointed out. In some parts of North America he found the Montalban resting unconformably on Laurentian. Above the Montalban comes the Taconian (Lower Taconic of Emmons), a series of quartzites and soft micaceous schists, with dolomites and marbles. All these various series are older than the Lower Cambrian (Menevian) strata of North America; and it may be added that the Keweenian or great copper-bearing series of Lake Superior there occupies a position between the Montalban and the Cambrian.

In the Alps the speaker recognizes the Laurentian, Huronian and Montalban, all of which he has lately seen in the Biellese, at the foot of Mont Viso, in Piedmont. The Huronian is the great *pietre verdi* group of the Italians, and much of what has been called altered Trias in this region is, in his opinion, probably Taconian. The Montalban forms the southern slope of Mont St. Gothard, and is the muscovite gneiss and mica-schist of the Saxon Erzgebirge. Here Dr. Credner and his assistants of the Geological Survey have described abundant conglomerates holding pebbles of Laurentian rocks imbedded in the Upper or Montalban gneiss. The pre-Cambrian age of this has been shown by Credner, who has proved by careful survey that the so-called younger or Palæozoic gneisses of Naumann are really but a continuous part of the older series. Late surveys also show that the crystalline rocks of the Taunus are really Eozoic and not, as formerly maintained, Devonian in age.

The speaker insisted upon the fact that where newer strata are in unconformable contact with older ones, the effect of lateral movements of compression, involving the two series, is generally to cause the newer and more yielding strata to dip towards and even beneath the edges of the older rock, a result due to folds, often with inversion, sometimes passing into faults. This phenomenon throws much light on the supposed recency of many crystalline schists.

The following communications were read:—

1. "Additional Evidence on the Land Plants from the Pen y-glog Slate quarry, near Corwen." By Henry Hicks, Esq., M.D., F.G.S.

The author stated that since the date of his former paper (Quart. Journ. Geol. Soc., August, 1881) he had ascertained that plant-remains occurred in the slaty beds down to the base of the quarry, though much obscured by cleavage. The larger specimens are in the form of anthracite. Mr. Carruthers states that there is sufficient evidence to show that they are the remains of vascular plants, with some resemblance to the Lycopodiaceæ. Some of the fragments are from 4 to 5 inches wide, and the author had traced trunks some feet in length. He thought they had drifted to the position where they were now found. Leaf-markings generally are not preserved; but from the wrinklings still remaining on some specimens, he thought it probable they had been covered with leaves spirally arranged. Some fragments show scars arranged irregularly on the surface; probably these are fragments of roots. The plant seems to some extent to combine the characters of *Stigmaria*, *Sigillaria*, and *Lepidodendron*. Further details of the appearance of the specimens were given. For one which appears to differ from all hitherto described he proposes the name of *Berwynia Carruthersii*.

2. "Notes on *Prototaxites* and *Pachytheca* from the Denbighshire Grits of Corwen, North Wales." By Principal Dawson, LL.D., F.R.S., F.G.S.

The author stated that he had obtained specimens of the Plant-remains from near Corwen, and that among them there were two kinds, one dark, the other light-coloured. In the former, the long cells and woody fibres are filled with rods of transparent siliceous matter, and the walls represented by a thick layer of carbon. The lighter kind consists of the siliceous rods alone, which are thus in the same state as the asbestos-like silicified Coniferous wood of the Californian gold-gravels. In both the siliceous rods show traces of the irregularly spiral ligneous lining of the cell-walls. From these and other characters the author refers the specimens to his genus *Prototaxites*, which, he says, is not an Alga, but a woody terrestrial plant. The author did not state that *Prototaxites* actually belonged to the Taxineæ, but that its fossilized wood showed a resemblance to that of some fossil Taxineæ. The remains discovered by Dr. Hicks differ, as already recognized by Mr. Etheridge, from *Prototaxites Logani*, Daws.; and the species may be named *P. Hicksii*.

Of *pachytheca* the author stated that he had specimens from the Upper Silurian of New Brunswick, and these and the Welsh specimens seem to belong to the genus *Ætheotesta*, Brongn., and to be nearly allied to *Æ. devonica*, Daws., from the Devonian of Scotland. These fossils occur associated with *Prototaxites*, not only at Corwen, but in the Upper Ludlow of England, in the Upper Silurian of Cape Bon Ami, and in the Lower Devonian of Bordeaux quarry opposite Campbellton in New Brunswick, and as the author maintains *Ætheotesta* to be a seed, and Brongniart compared it with the seeds of the Taxineæ, this may be taken as additional evidence in favour of the Taxine or, at any rate, Gymnospermatous nature of *Prototaxites*.

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