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THE

CANADIAN NATURALIST

AND

Quarterly Journal of Science.

WITH THE

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MAP OF THE BAY CHALEUR REGION SHOWING GLACIAL STRIÆ, GRAVEL RIDGES, ETC.

(To illustrate article "On the Glacial Phenomena of the Bay Chaleur Region." See page [illegible])

THE

CANADIAN NATURALIST

AND

Quarterly Journal of Science.

PALÆONTOLOGICAL NOTES.

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

I. A NEW SPECIES OF PILOCERAS.

(Figs. 1, 2.)

This genus was established by Salter, in 1858,* for a very curious shell found in Scotland, in the Durness Limestone, one of the lowest members of the Lower Silurian or possibly within the limits of the Upper Cambrian. Salter found in this limestone two species of the genus, but one was too imperfect for description. The typical species *P. invaginatum* he regarded as the shell of a cephalopod mollusk allied to *Orthoceras*, but of very simple structure, having the chamber and siphuncle united into one organ. His definition of the genus was in these words: "siphuncle and septa combined, as a series of conical concave septa which fit into each other sheathwise."

In 1860, Billings described, in the *Canadian Naturalist*, † a species from the Calciferous Formation of Belleisle, under the name *Piloceras Canadense*. The specimens showed that the part described by Salter was not the external shell, but only the siphuncle, and that the shell, when complete, must have included a chambered portion surrounding this enormous siphuncle, which thus corresponded to the great siphuncle of the Lower Silurian shells known as *Endoceras*. Having thus ascertained the exist-

* Journal of Geological Society of London, Vol. XV.
† Vol. V.

ence of external chambers, Billings supposed that the sheathing divisions of the interior described by Salter had been filled with a solid deposit of carbonate of lime, so that this curious shell would seem to have had a sinker as well as a float. The specimen now to be described shows that this was probably an error, and that the shell had a double series of chambers, and was thus not a very simple form, as supposed by Salter, but really a shell of great complexity. Billings afterwards described three additional species from the Quebec group of Newfoundland.

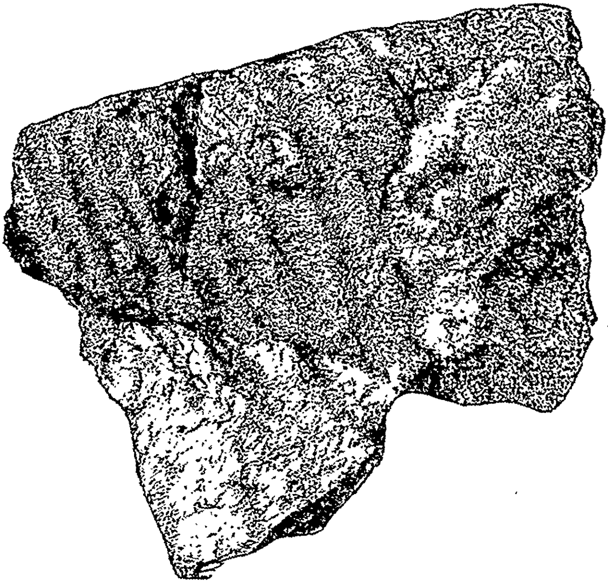

Fig. 1.—Siphuncle of *Piloceras amplum*, natural size, from a photograph. The chambers are seen in part on the stone at the lower side, but have not been correctly given by the engraver.

The present specimen was found in the Calciferous sandstone, a few miles south-east of Lachute, by Mr. Macpherson, a member of my class in Geology, in the course of an excursion to that neighborhood last autumn. It represents a species quite distinct from those described by Salter and Billings—probably an adult individual—and it illustrates in a very interesting manner the complex structure of this remarkable group of shells.

The siphuncle, which wants a portion of the apex, is a flattened cone, which, when complete, must have been about $5\frac{1}{2}$ inches in length, and $2\frac{1}{2}$ in its greatest diameter. It is marked, in the portion preserved, with about twelve diagonal ribs, indicating the lines of attachment of the partitions of the external shell, of which only portions of a few remain attached to the surface at one side. The lower part of the shell is divided by a vertical partition crossing its longer diameter. At the top this splits into a flattened cone, somewhat flatter than the siphuncle itself, and more obtuse, so that at the top it joins and unites with the rim of the siphuncle, The space below this inner cone is that supposed to have been solid; but in the present specimen it is filled with calcite, showing that it must have been an enclosed space. Farther the vertical partition presents, in section,

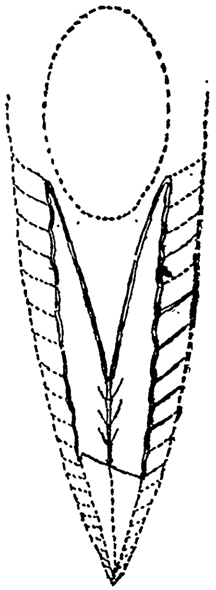

Fig. 2.—Transverse and restored vertical sections of *Piloceras amplum* reduced. The upper figure shows the proportions of the cross section. The lower figure is a section in the direction of the shorter diameter, showing the conical siphuncle, the siphuncular cavity, with remains of partitions, and the external chambers. The dotted lines are restored portions.

a series of swellings or ridges, and to these are attached the remains of what seems to have been membranous partitions, which must have formed successive interior cones as the siphuncle grew in size, terminating in the final one, which became completely calcified.

It would thus appear that the shell had a wide conical siphuncle which, as it grew in height, it partitioned off, with flattened cones within. The effect would be to give protection to whatever part of the body extended back into the siphuncle, to give great strength to the shell, and to form a double series of air chambers, that within the outer shell and that in the apex of the conical siphuncle, by which great buoyancy would be secured.

As Salter has already remarked, this shell has affinities with such shells as *Cameroceras* and *Endoceras*, though in magnitude of siphuncle it exceeds these types, as well as possibly in the property of possessing a double series of air cells. It is, however, not improbable, from the manner of the filling of the partitioned parts of the siphuncle of *Endoceras*, that this also was hollow in the living state.

I would propose for the present species the name *Piloceras amplum*, with reference to the great width of the siphuncle. Its description will be as follows :

Length of siphuncle, 12 centimetres ; longest diameter at the top, 6 centimetres : shorter diameter, 3.5 centimetres ; greatest angle of divergence of siphuncle, about 27°. Siphuncle annulated with raised lines, marking the attachment of the septa of the exterior shell. These lines are inclined to the axis of the shell at an angle of about 20°. They are, however, slightly curved and on the dorsal (?) side of the shell bend slightly downward. The internal cone of the siphuncle is 5 centimetres in depth. It is flatter than the siphuncle, ending at the apex in an edge, which is attached to a central shelly plate crossing the lower part of the siphuncle. This plate shows, at intervals, slight projections giving rise to delicate internal cones apparently membranous. The space between the inner cone and the wall of the siphuncle must have been empty and closed, as it has been filled not with the surrounding coarse dolomite, but with calcite, introduced by infiltration. Whether the siphuncle was central or lateral does not appear. There are, however, distinct marks of the partitions of the chambers all around it.

II. SACCAMMINA? (CALCISPHÆRA) ERIANA.

(An Erian Rhizopod of uncertain affinities.)

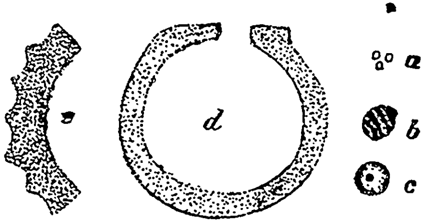

Fig. 3.—*Saccammina Eriana.* (*a*) natural size; (*b*) magnified, showing sculpture: (*c*) magnified, showing aperture; (*d*) section magnified, showing aperture: (*e*) section of portion of wall more magnified, showing structure.

Several years ago, specimens were sent to me by my friend Dr. Newberry, of New York, of a curious organism from the Devonian (Corniferous) limestone of Kelly's Island, near Sandusky, Ohio. They are minute globular bodies, one millimetre in diameter, and occur in great numbers in light gray limestone containing *Stromatopora*, crinoidal joints and corals, as well as multitudes of minute organic fragments. The exterior surface of the specimens is dull or granular in aspect, and either smooth or marked with slight spiral ridges, giving an appearance which at first sight suggests a resemblance to the spore-cases of *Chara*. On microscopic examination, they are found to be hollow spheres filled with calcite introduced by infiltration, having one small aperture; and the test or wall of the sphere presents a granular appearance as if composed of fine calcareous grains. Understanding that Dr. Newberry desired a note for publication in his Reports on the Survey of Ohio, I prepared and sent to him the following description, which, however, I have not yet seen in print:—

"*Saccammina Eriana.*—Test globular, about one millimetre in diameter, with one aperture. Wall composed of minute calcareous grains, smooth interiorly, on the outside smooth, irregular or fluted longitudinally. Corniferous limestone near Sandusky. Collection of Dr. Newberry.

"This little organism occurs in great numbers in whitish granular limestone, associated with fragments of crinoids and corals. Its test appears to be composed of very minute calcareous grains, and it can scarcely be anything else than a Rhizopod, probably allied to the modern *Saccammina globosa*, or to the Carboniferous *S. Carteri*, though much smaller than either, and differing in its tendency to external ornamentation. It is of course possible that a test of this kind might belong to an animal of very different character from *Saccammina*, but in the present state of knowledge of such forms, I think it quite justifiable to refer it to this genus."

In the conclusion of the above note I referred to the chara-like form of the test, and to its entire difference of structure from any vegetable organism. At a subsequent date I obtained additional specimens from Mr. Walker, of Hamilton, Ontario; and in my paper on *Stromatoporidæ*, published in the Journal of the Geological Society in 1879, I referred to it, under the above name, as associated with *Stromatopora*, and sometimes overgrown by its layers.

In the course of last summer, I received from Prof. Williamson, of Manchester, Part X of his valuable Memoirs on the Organisation of the Plants of the Coal Measures, and was surprised to find my little fossil noticed therein, with a new name and in quite a new connection. It appears that some bodies of similar appearance, but much smaller, had been found by Prof. Judd in Carboniferous limestone in Wales, and that they had been referred to the group of Radiolarians. This reference was disputed, apparently on good grounds, by Prof. Williamson. He had examined them, under the impression that they might be of vegetable origin, but finally had supposed it more likely that they were animal and foraminiferal, and had assigned to them the non-committal name of *Calcisphæra*. They had also, in the course of the discussion as to their nature, raised the chemical question whether it was possible that silicious tests like those of Radiolarians could be replaced by carbonate of lime: a change which, though perfectly possible, and sometimes realised in Palæozoic silicious sponges, is in the highest degree improbable in the case of these bodies. In the course of this investigation, Prof. Williamson had received from our mutual friend Mr. H. B. Brady, F.R.S., specimens of the little fossil from Kelly's Island, which, I think, I had sent to him, and these were referred by Williamson to the same genus with the Welsh specimens and named by him *Calcisphæra robusta*. He described the species as follows:

"Each organism is a hollow sphere. The sphere-wall is much thicker in proportion to its diameter than is the case among the Welsh specimens. Externally the transverse section of each sphere presents an undulating outline due to the intersection of prominences and ridges that characterise its surface. Sometimes these surround the entire section, but more frequently they are absent from limited portions of the periphery. Occasionally these ridges may be seen pursuing an oblique direction like the bands crossing the nucules of a *chara*. The central cavity is always occupied by crystalline infiltrated carbonate of lime. Though the sphere-wall often exhibits a granular texture, I discover a radiating structure in a sufficient number of the specimens to convince me that in this respect they have closely resembled some of the Welsh objects."

This description differs from mine in two important points: (1) It does *not* recognise the aperture, which is of course not easily observed except when specimens can be completely detached from the matrix. It exists, however, and is surrounded by a slightly flattened space or rudimentary flange. I may add *that the possesion of an aperture does not conflict with the filling* of the test with clear calcite, as the same substance occupies the spaces between the fragments contained in the enclosing limestone. (2) The supposed fibrous character of the test does not appear in my specimens. They are decidedly granular, even when viewed under high powers, though there is occasionally a tendency to linear arrangement in the constituent grains, perhaps indicating a porous structure. I have examined many specimens both by reflected and transmitted light, and feel confident that there is no truly radiating structure either of tubes or pillars. Farther, the minute grains of the test are similar in size and appearance *to the more minute fragments visible in the matrix*; and I cannot doubt that the test is granular and arenaceous, though it is of course possible that this granular texture may be a result of re-arrangement of particles in the process of fossilization. This, however, I do not think at all probable.

On the whole, I see no reason to depart from the conclusion that the organism in question is the test of a foraminifer, and this seems also to be the opinion of Williamson and Brady, who are the best possible authorities on such a question.

With regard to affinities, the flange-like orifice suggests relationship to the *Lagenæ*, while the globular form resembles

Orbulina, and the arenaceous character suggests nearness to *Saccammina*, which also approaches most nearly in geological time. The ridged surface is no doubt unusual in arenaceous tests, but a tuberculated surface is found in some, as, for instance, in that from the Challenger dredgings recently described by Brady, under the name *Thurammina papillata*. The name *Calcisphæra* would be unobjectionable, were it not for the difference of structure in the test of the forms referred to this genus, and which on this account appear to me to be possibly of different nature. In the mean time, therefore, I leave the question of name as it stands at the head of this notice.

Note. (March 14, 1881.)—In a letter just received from Mr. H. B. Brady, he says that he knows of no rhizopod test recent or fossil, precisely corresponding to the little Erian fossil above described. He says—"the more I examine your little fossil the more confident I am that it bears no relation to any rhizopod type that I know." It will thus appear that he does not admit its affinity to *Saccammina*, and that he even doubts as to its rhizopodal character.

III. New Devonian Plants from the Bay de Chaleur.

The following notes relate to the examination of plants collected by Mr. A. H. Foord, of the Geological Survey, at Scuminac, opposite Dalhousie, and by Mr. Weston, of the Geological Survey, near Campbellton.

Mr. Foord's collections are from the Sandstones containing *Pterichthys Canadensis* Whiteaves, and other fossil fishes, and which appear in a low anticlinal form overlaid unconformably by a great thickness of red sandstone and conglomerate of the Bonaventure Formation (Lower Carboniferous). The beds seen at this place are characterised by their fauna, as of Upper Erian (Devonian) age.

1. *Archæopteris Gaspiensis*, s. n.

Barren pinnæ densely leafy, with the pinnules broadly obovate and somewhat truncate at the apex, decurrent by a broadish base on the somewhat stout striated petiole, veins forked thrice and strongly curved toward the lower edge. In luxuriant fronds the pinnules are 2.5 centimetres long and 1.8 centimetre broad.

Fertile pinnae with about twelve pinnules, each having a long midrib with about 7 pairs of crowded oblong spore-cases about 3 millimetres in length, pointed or somewhat obtuse at top, straight at the sides and apparently dehiscent at the apex. The midrib projects some distance beyond the spore-cases.

This species differs from *A. Jacksoni*, Dn., in the arrangement of the spore-cases, which are also larger and more oblong, and the barren pinnules are broader. It differs from *A. Hibernicus*, Brongt., in the arrangement and form of the spore-cases and in its shorter pinnæ, with fewer and less obtuse pinnules. It differs from *A. minor*, Lesquereux, in the arrangement of the spore-cases, which in the latter are in groups of three and of larger size, while the barren pinnules are much narrower. The present species resembles *A. Maccoyana*, Goeppert, in the form of the pinnules, but the fructification of the latter species is not known, and it may be merely a varietal form of *A. Hibernicus*. The present species is no doubt that referred to in my report on the Devonian plants of Canada as found in the Gaspé sandstone,* but the fragments known at that time did not enable me to separate it from *A. Jacksoni*. It is for this reason, as well as because the beds in which it occurs at Bay de Chaleur represent the upper part of Logan's Gaspé sandstones, that I have given it the name *Gaspiensis*.

Ferns of this type are characteristic of the Upper Erian on both sides of the Atlantic, and do not occur in the Carboniferous proper; though forms resembling them occur in the lowest Carboniferous beds.

2. *Cyclopteris obtusa*, Lesquereux.

I refer to this species a large and beautiful fern, which is obviously identical with that from the Cattskill of Montrose, Pennsylvania, figured by Lesquereux in the "Coal Plants of North America" (Report of Pennsylvania Survey), pl. 49, fig. 7, and of which I have a specimen in my own collection from the same formation at Franklin, New York.

This species is characterised by very large obovate leaflets decurrent by a long narrow base upon the petiole. Whether it was a pinnate or bipinnate frond does not appear. The veins are fine, curved and several times forked. The terminal leaflet is cuneate and emarginate. Some of the large pinnules are 6 cen-

* Page 487.

timetres in length. This fern is referred by Lesquereux to my genus *Archæopteris*; but as its fructification is not known, and as this forms the most distinctive character of *Archæopteris*, I think it better to leave the species in the provisional genus *Cyclopteris*.

One of my plants from the Devonian of St. John is referred to Lesquereux's species *C. obtusa*. The identification was made on the evidence of the figure and description in Rogers' Report on Pennsylvania, which refer to a much smaller fern than the present species, with the pinnules somewhat different in form and attachment. As Lesquereux, however, applies his name to the large species now under consideration, which is certainly distinct from the St. John fern, I must withdraw the name from the latter. In doing so, I may take advantage of a suggestion made by Schimper, who thinks that the St. John species might be placed in the genus *Aneimites*. It may accordingly be renamed *Aneimites obtusa*, which will at least prevent confusion.

Cyclopteris Brownii, Dawson.

(Report on Fossil plants of Devonian and Upper Silurian, p. 48, fig. 172, Journal of Geological Society of London, vols. xvii and xix.—Figures and description.)

This beautiful fern was previously known only from Perry in Maine, where it occurs only rarely and in detached leaves. Mr. Foord's specimens shew its habit of growth in dense clusters of fronds attached to what appears to be a creeping rhizome with slender rootlets. It has evidently been a low-growing species, its flabellate leaves attached by somewhat broad bases to a root-stock probably prostrate. Unfortunately no fructification appears, so that the plant cannot be compared with modern species having the same habit of growth. I may state, however, that the veinlets widen and become more dense in approaching the outer margin of the frond in a manner which seems to indicate that the fructification was marginal, in the manner of the *Pterideæ*.

It seems probable that the fern from the Upper Devonian of Pennsylvania figured by Lesquereux in Fig. VII, p. 50 of the Coal Plants of N. America is identical with this species. He refers it to *Rhacophyllum* of Schimper, with the specific name *R. truncatum*, which will, in this case, be a synonym of *C. Brownii*. The genus *Rhacophyllum* is very loosely defined by

Schimper, and is evidently provisional, including, according to him, young or basal fronds of ferns referred to other genera. As there is no evidence of this in the case of the present species, I see little advantage in removing it from the equally provisional genus *Cyclopteris*, until its fructification shall have been discovered. Should it, however, be considered desirable to remove it from *Cyclopteris*, I would propose for it the name of *Platyphyllum*, for which the characters of this plant as given in the paper above cited and in this note may suffice as generic characters.

Caulopteris (?)

Among Mr. Foord's specimens is one that appears to represent the stem of a small tree fern. It is about one inch in diameter, flattened and showing on the exposed side somewhat reniform scars quincunctially arranged. The best preserved leaf-scars show marks of vascular bundles which suggest the idea that it may have given origin to the petioles of ferns; but there is nothing to indicate whether this stem belongs to either of the species found with it.

Plants from Campbellton.

Mr. Weston's collections are contained in a hard argillaceous sandstone or arenaceous shale resembling some of the beds of the lower part of the Gaspé sandstones, with which the flora also agrees.

The greater part of the vegetable remains collected by Mr. Weston are stems and branches of *Psilophyton princeps* and *P. robustius*, which are very abundant. There are also a few leaves of *Cordaites angustifolia*, and in the same shale with some of these, is a short stem with remains of alternate leaves or branches. This may possibly have belonged to the last named species.

There are also specimens of strobiles, about an inch in length and thickly covered with scales or spore-cases which appear to be in two rows, but this is probably deceptive and an effect of flattening. They very much resemble the strobiles of *Lycopodites Richardsoni* from Perry, but the scales are thicker and more obtuse. This is probably the fruit of some lycopodiaceous plant, and may provisionally be referred to the genus *Lepidostrobus*.

The beds containing these fossils evidently belong to a lower horizon in the Erian than that containing the fossils collected by Mr. Foord.

ON THE GASEOUS SUBSTANCES CONTAINED IN THE SMOKY QUARTZ OF BRANCHVILLE, CONN.

By Arthur W. Wright, Yale College.*

The existence in quartz of numerous cavities containing a liquid substance is a matter of familiar occurrence, and great interest has attached to the investigation of the character of these inclusions. Although the presence of carbon dioxide and water had been well established, the difficulty of separating the contents of the cavities in sufficient quantity has hitherto prevented a direct examination of them. The quartz from Branchville is remarkable for the great size and number of the cavities, the peculiar characteristics of which are described by Mr. Hawes in the preceding article.† The fortunate circumstance, noticed by him, that when exposed to a moderately high temperature it decrepitates and is speedily resolved into small fragments, made it possible to obtain with great ease and convenience enough of the enclosed substances for an extended examination. The material employed was derived from the collection of minerals from Branchville, of Professors Brush and Dana.

The temperature required for the disintegration of the quartz is much below that of red-heat, and the bursting of the solid material is evidently due to the increased tension of the gas, as it does not occur in those fragments which contain no cavities. The first trials were made with glass vessels, but the sharp fragments of the mineral were shot off with such violence as to destroy them immediately. Recourse was therefore had to a porcelain tube about one centimeter in diameter, glazed inside. This was carefully cleaned with pure distilled water, one end stopped with a plug cemented in, and the other provided with a perforated brass cap, into which could be screwed a piece through which passed a slender glass tube, the joint being rendered tight by a thin washer of india-rubber or paper. The closed end of the tube was filled for some 12 centimeters with pieces of clean glass rod,

* Reprinted from the Amer. Journal of Science of March, 1881.

† Dr. Hawes' interesting article is not reproduced here, as it would be incomplete without the illustrations.

and upon these rested a loose plug of calcined asbestus. The quartz, broken into fragments of such a size as to permit their entrance, was dropped into the tube, filling it to within 10 or 12 centimeters of the mouth. When heated in a Bunsen flame, the whole of the material could be brought to the requisite heat without causing any perceptible elevation of the temperature of the cement joints. This receptacle, when charged, was connected by means of the glass tube with a Sprengel pump, all joinings of the glass being made by fusing, and the whole was easily rendered absolutely free from leakage.

The pump having been kept in action until no gas appeared to pass down, heat was cautiously applied to the tube, and gradually increased until a little gas was liberated from the quartz. When this had been thoroughly pumped out, removing thus the last portion of air, the heat was again applied and continued until the cessation of the decrepitation showed that no more gas could be obtained. The mercury was then set running in the pump carrying the gas into the measuring tube used for the analysis. A preliminary examination showed the greater portion of the gas to be carbon dioxide, the remainder apparently consisting chiefly or wholly of nitrogen. A considerable amount of water was also found to be present. In the succeeding operations this was collected for examination by causing the gas as it issued to pass through a U-tube of small caliber which was placed in a freezing mixture. As the temperature of the refrigerating mass was such as to reduce the tension of vapor to less than one millimeter, nearly the whole of the water was thus retained.

For the more careful analyses two portions of the rock were selected representing the greatest differences in the material. The first, No. 1, was of a light gray color, somewhat milky in appearance, and contained many cavities easily visible without the aid of a lens. The weight of the material employed was 21·70 grams, which, divided by the specific gravity 2·63, gives for the volume 8·25 cubic centimeters. The second portion was of the darker variety having a smoky brown color, appearing nearly black in large masses. The gas cavities in this were not so conspicuous, and apparently were less numerous. The amount of the material placed in the tube for examination was 19·49 grams, and the volume 7·41 cubic centimeters. This portion is designated as No. 2 in the following paragraphs. The total quantity of gas collected from No. 1 was 13·61 cubic centimeters, or 1·65 times the volume of the quartz. From No. 2, 7·20 cubic centimeters of gas were obtained, or 0·97 times the volume of the material employed. From the first portion examined in the preliminary work 1·33 volumes were obtained.

The eudiometer having been transferred to the mercury cistern an absorption pellet moistened with the solution of potassic hydrate was introduced into it, causing a rapid diminution of the volume of the gas. When this operation was complete the residual gas had been reduced to a small bubble in the top of the tube, which could not be measured directly with sufficient accuracy. To find its volume a little of the potash solution or of distilled water was admitted giving a meniscus concave toward the top of the tube. The position of this was carefully noted, and the tube emptied. Mercury was now introduced until the surface of the meniscus occupied exactly the former position of the surface of the water, and the metal was then weighed. The mean of five separate measurements being taken the volume of the gas was thus readily calculated. The results of the determinations with the two different portions of the material gave

	I.		II.	Mean.
CO_2	98·34	CO_2	98·32	98·33
N	1·66	N	1·68	1.67
	100·00		100·00	100·00

Cuprous chloride produced no preceptible absorption, showing the absence of carbonic oxide. Potassium pyrogallate introduced into the tube with caustic potash solution produced a slight discoloration of the latter, but no change in the volume of the gas was visible, indicating that oxygen if present was not in recognizable quantity.

To ascertain the presence of hydrogen or other combustible gases a number of tests were made. A spark passed through the gas directly produced no effect, nor upon the addition of oxygen or air alone could any combustion be produced. When the proper quantity of p ire electrolytic gas was added the explosion produced no apparent change in the volume. This, if, from the small amount of gaseous substances operated with, it might not safely be concluded that the hydrogen or hydrocarbons were entirely absent, shows that the quantity was exceedingly small. The residual substance then was nitrogen. In these operations, as already mentioned, the gas had passed through a tube placed in a freezing mixture. A later experiment, to be described in a succeeding paragraph, gave a somewhat different result.

The rock when broken or crushed with a hammer exhales a fugitive but unmistakeable odor of hydrogen sulphide, but the proportion of the gas was too small to be directly detected with the ordinary lead-paper even when directly applied as a cover to a diamond mortar in which a considerable quantity of the material had been powdered. But when a slip of the paper was introduced into a tube filled with the extracted gases, a slight but distinct coloration was produced. The same was true in a somewhat more marked degree with a paper moistened with mercurous nitrate, indicating sulphurous oxide. To test this more fully separate slips of filtering paper were wet with plumbic acetate, sodium nitro-prusside, and mercurous nitrate. When dry they were introduced into a small tube through which gas freshly liberated was made to pass. Snow applied for a few moments to the tube ensured the presence of sufficient water to moisten the paper slightly. The first underwent a slight discoloration, which after a time disappeared, the second assumed a pinkish tint, while the third was distinctly blackened, thus proving the presence of a trace of both the gases in question, a conclusion moreover which was verified by other and independent trials.

As both hydrogen sulphide and sulphurous oxide are absorbed by potasssic hydrate it was important to ascertain whether these gases were in sufficient quantity to affect the conclusion given above as to the amount of carbon dioxide. A portion of the gas collected in a clean tube was therefore submitted to a special examination. A pellet of ferric oxide formed upon the end of a platinum wire produced no effect at all, though kept in the gas for several hours. A similar pellet of manganese dioxide moistened with syrupy phosphoric acid likewise caused no perceptible effect, thus proving that these gases were not present in any measurable quantity.

An approximate estimation of the amount of water was made as follows: The U-tubes in which the water had been condensed were sealed after the gas had been thoroughly pumped out. The temperature of the freezing mixture was from —19° to—20° C., so that the tension of the residual vapor was less than one millimeter, which was confirmed by the reading of the guage of the pump at the end of the operation. The connecting tubes were fused off and the portion containing the water withdrawn. The amount of liquid thus obtained was considerable. The tubes were carefully weighed, then opened, and after an examination of the liquid, thoroughly dried, and weighed again. The weight of the water in No. 1 was thus found to be 13·4 milligrams, in No. 2, 12 milligrams, corresponding respectively to 13·4 and 12 cubic millimeters at 4°. The volume of the quartz in the first instance being 8·25, and in the second, 7·41 cubic centimeters, we have for the amounts contained in one cubic centimeter of the mineral, 1·63 and 1·62 cubic millimeters respectively, no correction being made for temperature, as the results are only approximate. This would indicate a comparative uniformity in the distribution of the water, while the amount of the gas varies. But such a conclusion is at best doubtful, inasmuch as the darker quartz is not as thoroughly broken up by the heat as the lighter variety, and the refrigeration of the tube No. 1. was not made complete at first, so that some water doubtless escaped with the gas uncondensed.

A small portion of the water removed with a minute pipette was dropped upon red litmus paper, where it produced a strong but fugitive alkaline reaction, implying the presence of free ammonia. This was confirmed by adding Nessler's test solution to the remainder of the liquid in the end of the tube, in which it caused the characteristic yellow coloration, and, in one instance a slight precipitate. Before the tubes were opened it had been noticed that the water, though to all appearance prefectly transparent and colorless, left a white deposit upon the glass where a drop of it had evaporated. When this was heated by the application of a small gas flame, it did not fuse, but appeared to shrink or to diminish in amount very slightly, while the glass around it and over it lost its transparency as if corroded. A similar but very slight action upon the glass where the moist gas had come in contact with it had previsouly been observed. This suggested the presence of fluorine. The glass of the tube in which the effect was most marked contained some lead, but the other showed it also to some extent. A special experiment with a tube free from lead, which had been most carefully cleaned, gave the same result, though in somewhat less marked degree. Its appearance would be accounted for by the supposition that the water of the cavities contained some hydro-fluo-silicic acid in solution, resulting from the decomposition of silicon fluoride, or, as ammonia was also present, from an ammonium compound of the acid.

As was mentioned in a preceding paragraph, no evidence of the presence of a hydro-carbon compound was discovered in the examination of the gas which had passed slowly through the cooled tubes. The tubes themselves, however, contained what appeared like minute drops of some oily substances, so small as to be scarcely visible without a lens, and quite insufficient for examination. In order to investigate this point more satisfactorily as also to obtain a greater quantity of the residual gas left by absorption of the carbon dioxide, an experiment was made as follows: A bolt-head of porcelain, glazed interiorly, and having a capacity of about 300 cubic centimeters, was employed for the reception of the quartz, of which 196 grams, making 7·54 cubic centimeters, were used. It was arranged that after the air had been pumped out, the gas from the quartz should pass through a strong solution of potassic hydrate contained in a large U-tube, all connections being made with fused glass joints as before. The greater portion of the carbon dioxide was thus absorbed. Unfortunately just at the close of the operation a slight crack in the porcelain vessel admitted some air, but the tube leading to the pump was sealed immediately, so that the amount mixed with the gas was not too great to permit a quantitative examination of the gas to be made. A portion of the latter being transferred to the eudiometer, and just sufficient electrolytic gas being admitted to ensure combustion, the volume of the gas after explosion was found to be considerably increased, with the production of carbon dioxide. Repeated tests gave uniformly the same result, but the expansion was greater at first than after the gas had been kept for two days in the pump. This must be regarded as evidence of the presence of the vapor of some condensable hydrocarbon having a large number of carbon atoms in the molecule.

The quartz on heating entirely loses its color, the coarse powder which is left being almost snow-white. Now, in the experiment just described, a dark brownish deposit was formed in the tube leading from the bolt-head, and the potash solution after the passage of the gas had become brown, the color being almost exactly the same as that of the quartz before the heating. After standing a day or two a small amount of a dark brown, nearly black, substance separated out as a precipitate and the liquid lost it color. The potash solution was now decanted and the dark deposit examined. Treated with alcohol it dissolved but partially, communicating its color to the liquid, and taking on a tarry consistency. On evaporating the alcohol. the substance was volatilized by more intense heat, with a strong bituminous odor, very much like that given off by cannel coal when burning. The brown deposit in the tube also gave off the same odor when strongly heated. These results imply that the smoky color of the quartz is due to the presence of a hydrocarbon of the nature of bitumen, which is driven off by heat, and the partial decomposition of which, at the high temperature reached, accounts for the heavy hydrocarbon found in the residual gas, or condensed upon the walls of the cooled tubes. These facts, moreover, are entirely in harmony with and confirm the conclusion of Forster* from an examination of the remarkable smoky quartz from the canton of Uri, that the color of the latter is due to the presence of some volatizable hydrocarbon, though they do not directly connect the ammonia with the latter, as his observations appear to do.

After the operation just described had been concluded, some pure distilled water was introduced into the bolt-head, and after standing for some time was then withdrawn. Tested with argentic nitrate it gave a considerable precipitate of argentic chloride, while when examined spectroscopically it afforded satisfactory evidence of the presence of sodium, but of no other metal. The water previousl_ examined was found to be free from both chlorine and sodium. The bolt-head had been scrupulously cleansed before use, and great care was taken in this, as in all the experiments, to prevent contact of the quartz with things that might communicate to it any impurity. This result would indicate that the cubical crystals observed by Mr. Hawes in some of the cavities were chloride of sodium. Search was also made for chlorine or chlorine compounds in the gas. A quantity of this freshly liberated was passed through distilled water. This, on the addition of argentic nitrate, was very slightly clouded, making the existence of a trace of some chlorine compound probable. Not unlikely a minute proportion of ammonium chloride is among the contents of the cavities.

The quantitative relation of the water to the gases obtained from the quartz may be made more evident if calculated for a temperature of 100° C. at which the former would be entirely converted into vapor. Taking the amount of water per cubic

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* Pogg. Ann., cxliii, 173, 1871.

centimeter at 1·62 millimeters as found above, this multiplied by 1694·3 gives 2·74 cubic centimeters for the volume of the water vapor at 100°. If we take the gaseous volume for one cubic centimeter of the quartz at 0·97 cubic centimeter, the result derived from No. 2 above, where the water determination was most satisfactory, the temperature of the room at the time of *measurement being about* 20° C., *we have for the volume at* 100° neglecting the correction for the barometric pressure which was not greatly different from 760 mm., 1·23 cubic centimeters. Reduced to parts in 100 these volumes give

CO_2	30·48
N	0·50
H_2O	69·02
	100·00

For the reasons mentioned above this must be regarded, so far as the water is concerned, as merely an approximate result.

For the gases alone, leaving out of view the bituminous matter, which is not known to be specially connected with the cavities in the material, and probably is not, we have the following summary:

CO_2	93·33
N	1·67
H_2S	*trace*
SO_2	"
H_3N	"
F	"
Cl ?	"
	100.00

The ammonia, if derived from the gas cavities, undoubtedly existed there in combination with the carbon dioxide, as ammonium carbonate. From the considerations mentioned above the fluorine and chlorine detected by the tests applied also represent compounds of these elements with some of the other substances present. The results of the investigation show that the contents of the cavities are chiefly water and carbon dioxide, with a small portion of nitrogen, thus essentially confirming the conclusions derived from microscopical examination.

NOTE ON THE GEOLOGY OF THE PEACE RIVER REGION.

By G. M. Dawson, D.S., A.R.S.M., F.G.S.

(Abstract of paper read before the Natural History Society, Montreal, Feb. 28th, 1881.)

Till 1875 we may be said to have known absolutely nothing of the geology of the Peace River region. In that year, Mr. Selwyn, the Director of the Geological Survey, starting from McLeod's Lake in British Columbia, descended the Parsnip and Peace Rivers to the confluence of the Smoky River, returning by the same route. The geological notes published in the report of the expedition have constituted the basis of subsequent work. In 1879, it was determined to ascertain more completely the character of the Peace and Pine River passes as railway routes, and the prospective value of the Peace River basin. The author of the paper was a member of the expedition of that year, and the information obtained at this time, with that formerly alluded to, enables a clear general idea of the geological features of the district to be formed. These are of interest as representing the furthest northern portion of the interior continental region yet known with any precision, the country examined lying chiefly between the 54th and 57th parallels of north latitude.

The Rocky Mountain range is here narrow and comparatively low, the higher peaks seldom exceeding 6,000 feet. It is chiefly composed of limestone, in massive beds, in some of which fossils of Devonian age have been found, the most abundant form being *Atrypa reticularis*, a shell widely spread in the Devonian rocks of the Mackenzie district further north. The beds of the mountains have general westerly dips, and overturned folds probably occur. On the east side of the range, on both Peace and Pine Rivers, hard dark calcareous beds are found holding *Monotis subcircularis*, a form characteristic of the "Alpine Trias" of Nevada and California, and found also in several places on the British Columbian coast. To the east of these beds of the mountains, and resting quite unconformably on them, are the Cretaceous rocks, which, between the mountains and eastern outcrop of the Devonian rocks on the lower Peace, occupy a basin with a width of nearly 350 miles, implying a Cretaceous sea of that width.

The Rocky Mountains have here formed a shore-line in Cretaceous times, and the Cretaceous rocks along their eastern base are *almost entirely sandstones and conglomerates*, the constituent fragments of which can be traced to the cherts and quartzites accompanying the limestones. The mountains are bordered to the east by foot-hills, in which, on the upper part of Pine River, for a distance of fifteen miles from the older rocks, the Cretaceous sandstones are folded and disturbed. The disturbance, however, gradually diminishes on receding from the mountains, and the beds at length become flat, or are affected by very slight and broad undulations only. Shaly materials increase in importance eastward, and the Cretaceous series eventually resolves itself into the following sub-divisions, which are placed opposite their supposed representatives in the Western States:

Upper, or Wapiti River Sandstones	Fox Hill (and Laramie?)	
Upper, or Smoky River Shales	Pierre,	Colorado.
Lower, or Dunvegan Sandstones	Niobrara,	
Lower, or Fort St. John Shales	Benton,	

The correlation as above shown is based partly on palæontological evidence, partly on lithological resemblance. The synchronism of the upper shales with the Pierre group is quite definitely proved by the fossils. No fossils have been obtained from the overlying sub-division. The fossils of the Lower Sandstones are peculiar, consisting chiefly of fresh-water and estuarine forms and land plants. In the lower shales the most characteristic fossil is a large *Ammonite* resembling *Ammonites* (*Prionocyclus*) *Woolgari*, but according to Mr. Whiteaves specifically distinct. No beds so low as the Dakota horizon have yet been discovered here, though they may exist.

The lithological resemblance of the shales of the upper and lower sub-divisions to those of the Pierre and Benton groups is exceedingly close. It is conjectured that these mark periods of general submergence, when sediment-bearing currents passed freely through the interior continental valley. In the Dunvegan sandstones we may see an indication of the elevation of land surfaces to the north and west, which interrupted these currents and allowed the contemporaneous deposition of the Calcareous Niobrara beds of the South.

The fossils of the Lower or Dunvegan sandstones are of special interest, giving us a number of fresh-water molluscs and land plants of a stage of the Cretaceous previously almost unrepresented in these respects. The fresh-water molluscs clearly resemble those of the Laramie group, and the plants, while showing a close analogy with those of the Dakota group, help to fill a gap in time between these and those of the Vancouver (Chico) Cretaceous and the Laramie and Fort Union.

In 1872, Prof. Meek described a series of beds at Coalville, Utah,* which appear to have been formed at the edge of the Cretaceous sea at the mouth of a small river, and hold fresh-water molluscs. The fossils from these beds represent a stage somewhat higher in the Cretaceous than those of the Dunvegan rocks, but closely resemble them as well as those of the Laramie series. Meek writes:—"The group of fossils found in the dark indurated clay G is, in several respects, a very interesting one, not only because every species is new to science, and all of them entirely different from any yet found in any other locality, or even in any other beds of this locality (with possibly one or two exceptions), but on account of their modern affinities. Here we have, from beds certainly overlaid by 1000 feet of strata containing Cretaceous types of fossils, a little group of forms presenting such modern affinities that, if placed before any palæontologists unacquainted with the facts, they would be at once referred to the Tertiary."

In the Peace River district we have, instead of a merely local intercalation of this character, a widely extended series of Cretaceous beds persistently holding fresh-water and estuarine types of molluscs and land plants.

The chief evidence of the Tertiary age of the Laramie and Fort Union beds, after that afforded by the plants, has been found in the Tertiary aspects of the molluscs, most of which are fresh- or brackish-water forms. Hitherto little has been known of the fresh-water fauna of the undoubted Cretaceous; but if this should prove to have, as now appears probable, a "Tertiary" aspect throughout, it will tend to break down the molluscan evidence of the Tertiary age of the Laramie, and unite this formation still more closely with the underlying beds.

March 1, 1881.

* U. S. Geol. Survey of Territories, 1872, p. 435.

ON A NEW SPECIES OF PTERICHTHYS, ALLIED TO *BOTHRIOLEPIS ORNATA* EICHWALD, FROM THE DEVONIAN ROCKS OF THE NORTH SIDE OF THE BAIE DES CHALEURS.*

By J. F. Whiteaves.

The nomenclature of some of the Devonian Placoderms of the sub-order Ostracostei of Huxley is still in a state of great confusion. Thus, *Pterichthys* Agassiz and *Bothriolepis* Eichwald, are both quoted by Pander as synonymous in part with *Asterolepis* Eichwald, while the *Asterolepis* of Agassiz and Hugh Miller is regarded by the same authority as synonymous in part with *Homostius* Asmuss, and in part with *Heterostius*. On the other hand, Prof. R. Owen claims †that *Pterichthys* should be retained in preference to *Asterolepis* and *Bothriolepis* Eichwald, on the ground that "no recognizable generic characters were associated" with the latter names; and, as this view has been very generally accepted by paleontologists, it will be adopted provisionally in these notes.

The only remains of fossil fishes yet recorded as occurring in the Paleozoic rocks of North America which may prove to be referable to the genus *Pterichthys*, are some isolated scales from the Catskill group of Tioga County, Pennsylvania, described by Prof, Hall in 1843 as *Sauripteris Taylori*, but which Dr. Newberry thinks have the characteristic sculpture of *Bothriolepis*. The name *Pterichthys Norwoodensis*, although inadvertently cited by Mr. S. A. Miller, on page 238 of his "American Paleozoic Fossils," should have been rejected long ago, for in the first volume of the Second Series of this Journal, dated 1846, Drs. Norwood and Owen showed that the specimen for which it was suggested is the type of their genus *Macropetalichthys*, and of a species which they described as *M. rapheidolabis*.

In the summer of 1879, Mr. R. W. Ells, M. A., of the Geological Survey of Canada, had the good fortune to find, in a concretionary nodule of argillite from the north side of the Baie des Chaleurs immediately opposite Dalhousie, a mould of the plastron

* Reprinted from the American Journal of Science for August 1880.

† Palæontology, Second Edition, page 141.

or ventral surface of a true *Pterichthys* (as defined by Prof. Owen) with one of the pectoral spines in situ. At the earliest practicable opportunity, Mr. Ells revisited the locality, and in the first week of June last obtained three exquisitely preserved specimens of the buckler of the same species and several fragments, also some isolated scales of a *Glyptolepis*. The finest example of the Canadian *Pterichthys* collected by Mr. Ells had a large piece broken off the left margin when it was found, but with this exception the whole of the upper surface of the helmet and buckler is finely exposed (the plastron being partly covered by the matrix), and the outline of the orbital opening is clearly defined. A few weeks later, Mr. T. C. Weston, also of the Canadian Survey, collected an additional number of fine specimens of the *Pterichthys* from this locality, some of which illustrate admirably the shape, sculpture and mode of articulation of the pectoral spines. Associated with these there are, in Mr. Weston's collection, a nearly perfect but badly distorted specimen of a *Glyptolepis* fully seven inches in length, some fragments of *Psilophyton*, and a spore case of a *Lepidodendron*.

Taken collectively, the specimens thus far obtained of the Canadian *Pterichthys* show nearly all the characters of the helmet, buckler, plastron and pectoral spines, in the most satisfactory manner, but no vestiges of the tail have yet been detected, nor of any of the fins other than the two pectoral spines. The nature of the mouth and of its dentition, if it had any teeth, are unknown, and the small isolated plate in the orbital cavity (the "os dubium," of Pander, the "median" plate of Owen) has not yet been observed. In the number, outlines and disposition of the plates on the upper and lower surface of the head and body, and in the shape and mode of articulation of the pectoral spines, the Canadian fish agrees, in every essential point, with Pander's well known figures of a typical *Pterichthys*, but the sculpture of the entire surface of the former is precisely like that of *Bothriolepis ornata* Eichwald, which is thus described by Agassiz:* "Les ornements de cette espèce consistent en petits enfoncemens circulaires placés les uns à côté des autres et séparés par des carènes qui, par leur juxta-position, paraissent hexagonales à-peu-près comme les vitraux ronds des anciennes fenêtres, avec l'entourage en plomb qui les réunit. Les creux ont à-peu-près la gran-

* Monographie des Poissons Fossiles du Vieux Gres Rouge, &c., p. 99.

deur d'une bonne tête d'épingle, et ils sont placés en séries linéaires plus ou moins régulières, formant des lignes ondulées sur la surface de l'écaille. Pour la plupart, ces creux sont isolés les uns des autres, quelquefois aussi plusieurs se confondent en formant un sillon plus ou moins long. Les carènes intermédiaires sont tranchantes et minces, mais elles se maintiennent au même niveau; l'on ne pourrait donner une meilleure image de cette sculpture des plaques, qu'en enfonçant des épingles, la tête la première, sur le gyps encore frais, car il en résulterait le même dessin. En examinant ces plaques à la loupe, on voit au fond de chaque cellule osseuse un petit trou central, qui mène dans un canal médullaire de l'intérieur de l'écaille. Evidemment ces trous étaient destinés à donner passage aux fins vaisseaux sanguins qui montaient à travers l'écaille pour se ramifier dans l'épiderme qui couvrait la plaque." All the markings so carefully described in the above passage, even to the minute perforations through the plate in the centre of each pit, can be made out with perfect ease in most of the specimens collected by Messrs. Ells and Weston.

The Canadian *Pterichthys* is so closely allied to the *Bothriolepis ornata* that it is by no means certain whether the two are specifically distinct or not. Apart from its peculiar sculpture, the specific characters of of *B. ornata* are very imperfectly ascertained, the species having been founded exclusively on a few large isolated plates of a placoderm, from the Devonian rocks of Russia and Scotland. Until more perfect examples of *B. ornata* shall have been described and figured, it will be impossible to institute an accurate comparison between it and the nearly related Canadian form. There are, however, good reasons for supposing that the European species attained a much larger size than the Canadian, for Agassiz says that the plates of *B. ornata* are from three to six inches in length, and judging by this, the approximate length of its helmet and buckler together may be roughly estimated at from six to twelve inches at least. The largest isolated plate of the *Pterichthys* from the Baie des Chaleurs yet obtained (one of the ventro-laterals) is only two inches and a half long, while the smallest of two perfect specimens of the united helmet and buckler from the same locality is a little over two inches in length, and the largest (the fine specimen collected by Mr. Ells) is just six inches.

Under the circumstances, the writer thinks it most prudent to give to the Canadian *Pterichthys* a local and provisional name, with a brief diagnosis of its most salient characters, as follows: premising that a more detailed description of the species, accompanied with figures, will appear at an early date in one of the publications of the Canadian Geological Survey.

PTERICHTHYS (BOTHRIOLEPIS) CANADENSIS, nov. sp.—Plastron nearly flat. Helmet moderately arched above, most prominent immediately behind the orbital cavity where it rises into a ridge or blunt keel, which is continued, at intervals, with greater or less distinctness, along the median line of the buckler. Buckler slightly arched, median keel strongest in the centre of the dorsomedian plate, and in the posterior half of the post-dorsomedian. General outline of the helmet and buckler combined elliptic-ovate, their united length being nearly, but not quite, twice the maximum breadth of the buckler. Dorsomedian plate large, hexagonal, apparently rather wider than long; its upper margin slightly concave on both sides and somewhat pointed in the middle, its lower margin being concave. Orbital cavity situated nearly in the centre of the helmet, transversly reniform or bean-shaped in outline, much wider than high. Upper margin of the orbital cavity broadly, regularly and very shallowly concave, the lower being correspondingly convex, while the two lateral extremities are symmetrically and rather narrowly rounded.

Pectoral spines extending nearly to the posterior end of the buckler, thin and compressed vertically; moderately broad laterally where they are articulated to the ventro-lateral plate, and widening to about their mid-length, where they exceed the breadth at their articulation by about one line. From the widest point the breadth of the spines is again gradually reduced up to the joint separating the two segments of which they are composed, from whence they taper gradually to an acute point. The two segments are divided, nearly transversely, by a ball and socket joint, the ball being in the anterior and the socket in the posterior or terminal segment. The anterior end of each spine seems also to be furnished with a ball and socket joint, as there is a strongly inflected cavity in the ventro-lateral plate to receive the anterior end of the spine which latter terminates in a rounded protuberance. On the inner and outer lateral margin of the pectorals there is a row of crowded, nearly erect, conical, tooth-like, hollow spines. These are directed towards the articulation of the spine with the ventro-lateral plate up to about the mid-length of the anterior segment, and from thence they begin to point towards the posterior termination of the spine.

Sculpture of the helmet, buckler, plastron and pectoral spines very closely resembling that of the plates of *Bothriolepis ornata* but much finer and more delicate.

ON SOME REMARKABLE FOSSIL FISHES FROM THE DEVONIAN ROCKS OF SCAUMENAC BAY, P. Q., WITH DESCRIPTIONS OF A NEW GENUS AND THREE NEW SPECIES.

By J. F. Whiteaves.

Immediately after the preceding paper was written, Mr. A. H. Foord, of the Geological Survey of Canada, went down to the Baie des Chaleurs and spent two months and a half of the summer of 1880 in a careful and systematic examination of the fish-bearing beds of the Devonian rocks of the north bank of the mouth of the Restigouche river. The exact locality at which the *Pterichthys* and other fossil fishes were found by Messrs. Ells and Weston is not the Baie des Chaleurs proper but Scaumenac Bay, Bonaventure County, Province of Quebec. On the shores of this bay a series of shales, sandstones and conglomerates, now known to be of Devonian age, are overlaid, apparently unconformably, by the red sandstones and conglomerates of the "Bonaventure Formation." The geological structure of both banks of the Restigouche river was examined by Dr. Abraham Gesner in 1842, who also was the first to notice the existence of fossil fishes and plants in the shales and sandstones of Scaumenac Bay. Referring to the latter, Dr. Gesner says,* "In these sandstones and shales I found the remains of fish and a small species of tortoise, with fossil foot prints": the sculptured plates of *Pterichthys* being evidently regarded by the Doctor as portions of the carapace or plastron of a small tortoise.

From these deposits Mr. Foord succeeded in obtaining an extensive and interesting collection of fossil fishes. Of the entire number of specimens collected, fully four-fifths are referable to

* Report on the Geological Survey of New Brunswick, 1843, p. 64.

the genus *Pterichthys*, which, at this locality, seems to be represented by only one species, the *P. Canadensis*. Some of these are nearly perfect and want only the fins proper and the tail, while others are mere isolated plates or detached portions of the pectoral spines. The new material obtained by Mr. Foord shows that the cranial plates of *P. Canadensis* were furnished with curious appendages, which will be described more in detail a little farther on. In addition to these specimens of *Pterichthys*, there are examples of eight or nine species of fossil fishes in the collection, belonging to at least seven genera. The following is a brief description of the cranial appendages of the Canadian *Pterichthys* and of the characters by which most of the other species may be distinguished, including the definition of a supposed new genus.

PTERICHTHYS CANADENSIS.

One specimen of *P. Canadensis* shews that the species had two labial appendages, or barbels, attached to the front margin of the head, though, unfortunately, the terminal plates of the anterior extremity of this specimen are so much distorted that it is scarcely possible to ascertain to which of them the barbels were attached. These barbels are almost exactly similar in shape to those represented by dotted lines in the ideal representation of the genus *Pterichthys* on Plate 6, fig. 1, of the "Monographie des Poissons Fossiles du Vieux Grès Rouge," which Agassiz claims to have seen in his *P. latus*,—but in *P. Canadensis* the barbels are very close together at their bases.

In two specimens of a *Pterichthys* from the red beds at the summit of the series, both of which are probably referable to *P. Canadensis*, two remarkable, flattened-conical dermal processes are clearly visible on the helmet, one on each side of the orbital cavity. One of these specimens measures four inches in length, exclusive of the tail, of which, as usual, not a vestige remains; and in this individual the dermal processes on the helmet are half an inch long and two lines and a half broad near their base. Posteriorly, each process appears to fit into the angle formed by the junction of the "prelateral" with the "nuchal" and "post lateral" plates of Prof. Owen. Anteriorly, they are each directed obliquely outwards and forwards across the "prelaterals," which they partly cover. They taper gradually from their base to an obtuse point, are ornamented with a sculpture precisely similar to that of all the other plates and are pressed close to the surface of the helmet.

DIPLACANTHUS.

Two specimens, one shewing scales and longitudinally grooved fin spines and the other a large portion of the body, of a small, smooth-scaled *Diplacanthus*, very like the *D. striatus* of Agassiz and possibly identical with that species.

PHANEROPLEURON CURTUM, Sp. Nov.

General outline, inclusive of the fins, varying in different specimens from subovate to fusiform: length also varying from a little more than twice to rather more than three times the height. Head small, between one-fourth and one-fifth the entire length, and apparently obtuse in front. Cranial plates minutely pitted or irregularly corrugated. Scales thin, cycloid, imbricating, sculptured on their exposed surfaces with exceedingly fine radiating lines, which are visible only under a lens. Dorsal fin single, very long and large, commencing at a point considerably in advance of the middle, at first not much elevated above the dorsal margin, but increasing rapidly in height towards the tail, with whose upper lobe it ultimately becomes confluent. Maximum height of the dorsal nearly equal to the length of the head. Caudal fin heterocercal: anal and caudal fins both extending as far outwards from the body as the posterior end of the dorsal does, and separated at their bases by a very narrow interval. Anal fin narrow and elongated, ventrals also long and narrow, and separated from the anal by a space considerably wider than that which intervenes between the anal and caudal. Pectorals unknown. Ribs very slender and well ossified: interspinous bones contracted in the middle and gradually expanding at each end.

Of this species four crushed and distorted but otherwise nearly perfect specimens were collected, which want only the ventral and pectoral fins. Many fragments of this fish also were obtained, one of which shews the shape and position of one of the ventrals. The variation in the outline of different individuals and in the proportions which their length bears to their height, is evidently largely due to the distortion to which they have been subjected. The smallest specimens are the least distorted, and in these the length is much greater in proportion than it is in the larger ones. Thus, the smallest individual collected by Mr. Foord is about thirty-four lines long and ten lines high, while the largest is a little more than six inches long and three inches and a quarter high.

As compared with the *Phaneropleuron Andersoni* of Huxley, from the Old Red Sandstone of Dura Den, the only previously known species of the genus, the *P. curtum* appears to differ in its smaller size, and more especially in its much greater height or depth as compared with its length. Judging by the figures in the tenth Decade of the "Memoirs of the Geological Survey of the United Kingdom," the length of *P. Andersoni* is equal to about five and a half times its height, whereas in adult or presumably adult specimens of *P. curtum*, the length does not much exceed twice the height. On a cursory examination the dorsal, caudal and anal fins of the present species appear to be continuous, but a closer scrutiny shews that the bases of the caudal and anal fins are separated by a short space.

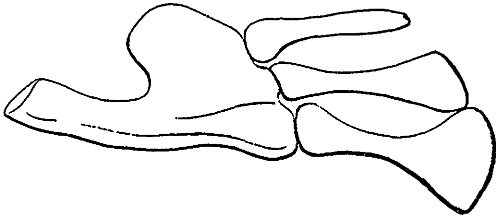
EUSTHENOPTERON,* Gen. Nov.

Generic Characters. Dermal plates of the head densely and irregularly corrugated externally, the corrugations varying in size in different parts of the same plate, but rarely or never coalescing with each other so as to form a complete network. The larger corrugations have a tendency to become tubercular. Teeth, at least the smaller ones, compressed-conical, with a sharp cutting edge on each side. Scales of the body, cycloid, imbricating; their exposed surfaces marked either with minute, close-set, irregular, radiating, tubercular ridges,—or more rarely with a semi-circular area of concentric rows of small, distant, isolated tubercles, upon a surface ornamented with exceedingly fine, wavy, radiating lines. Dorsal fins two, separated by an interval about equal in length to the height of the body between them. Pectoral fins unknown. Ventrals small, short, broad and placed a little behind the first dorsal. Anal fin large and broad, placed opposite to the second dorsal. Caudal fin also large and broad, heterocercal, with an unusually well developed upper lobe.

Vertebral centres not ossified: neural and hæmal spines and inter-spinous bones well developed and completely ossified. Neural and hæmal spines anterior to the second dorsal and anal and for a short distance behind them, blade-like and flattened, with more or less acute margins. Neural spines of the upper lobe of the tail simple, much elongated, subcylindrical and

* From ευ-σθένης, stout, and πτερον, a fin, in reference to the strongly developed anal and second dorsal.

slightly curved. Fin rays of the lower lobe of the tail supported by nine or ten osselets, each of which is articulated by a transverse joint to one of the modified hæmal spines. On the anterior or lower side of this lobe and nearest to the anal fin, the osselets are very stout and greatly elongated, but they rapidly decrease both in length and size as they approach the posterior termination of the vertebral column. The hæmal spines of the tail, like the osselets, are contracted at or about the middle, and expanded at each end, but the hæmal spines are invariably much shorter than the osselets. All the fin rays, including those of the tail, are composed of a great number of rectangularly divided, short articulations. Fin rays of the second dorsal and anal fin each proceeding from three osselets of unequal size, which are articulated to short prominences, separated by corresponding concave emarginations, in the posterior half of the greatly expanded outer extremity of a broad interspinous apophysis, in the manner shown in the accompanying wood-cut.*



Outline of interspinous apophysis and osselets of the second dorsal fin of *Eusthenopteron Foordi*. Natural size.

EUSTHENOPTERON FOORDI. Sp. Nov.

Specific Characters. Fish large, attaining a length of two feet or more; first dorsal fin very long, narrow and tapering to an acute point behind.

In the sculpture of its cranial plates, in the shape and orna-

* *In a paper read before the Natural History Society,* of which an abstract is given on page 440 of the last volume of this journal, these bones, which were then nearly covered by the matrix, were supposed to be the supports of the ventral fins, in consequence of their general resemblance to the so-called ischium and metatarsals of *Asterolepis*, as figured and described in Hugh Miller's "Footprints of the Creator." Their true nature, however, became at once apparent after a subsequent removal of part of the matrix.

mentation of its scales, and in the fact that the fin rays of its second dorsal and anal fins are both supported by three osselets articulated to a broad interspinous apophysis, this genus somewhat closely resembles the *Tristichopterus* of Sir Philip Egerton. But the vertebral centres of *Tristichopterus* are said to be ossified and the osselets of the lower lobe of the tail are described as "springing from eight or nine interspinous bones," whereas in *Eusthenopteron* the vertebral centres are not ossified and the caudal osselets are articulated to the hæmal spines. Moreover the bony supports of the anal and second dorsal fins are much larger and more fully developed in *Eusthenopteron* than they are in *Tristichopterus*. Thus, in *Eusthenopteron* the length of the osselets of the anal fin is equal to four-fifths of that of the apophysis to which they are attached, and the breadth of the much dilated outer end of the same apophysis is equal to rather more than one-half its length. In *Tristichopterus*, on the other hand, the osselets of the corresponding fin are less than half the length of the apophysis from which they spring, and the slightly expanded outer extremity of the apophysis is not much more than a third of its entire length.

The generic and specific characters of *E. Foordi* have been drawn up from a number of more or less imperfect specimens. The posterior half of the exoskeleton of the species is well seen in a specimen about one foot long, in which, however, the caudal, anal and second dorsal fins are imperfect. The bony supports of these fins and about five inches of the vertebral column are beautifully preserved and well exposed in another specimen. The only parts of the head found so far are fragments of the jaw, with teeth, and some isolated cranial plates, one of which is evidently the operculum.

In associating this species with the name of its discoverer, the writer desires to acknowledge his obligation to Mr. A. H. Foord for valuable assistance in the study of the various specimens described in this paper.

GLYPTOLEPIS MICROLEPIDOTUS, Agassiz. 1844.

One specimen of a small-scaled *Glyptolepis*, which cannot at present be distinguished from the above-mentioned species. The fins of the side of the body exposed to view are well preserved and one of the slender, acutely elongated and lobate pectorals is clearly defined. The shape and sculpture of the cranial plates are not well shewn and the teeth are not visible. The scales of the body, most of which are either split or broken at the edges, average less than two lines in diameter. Besides the specimen collected by Mr. Foord, another nearly perfect example of the same species was obtained by Mr. Weston in Scaumenac Bay, and both of these have been compared with specimens of *G. microlepidotus* from the Old Red Sandstone of Scotland. The characters of the Canadian and Scotch species certainly appear to be very similar, but the few Scotch specimens accessible to the writer shew only the general shape of the body of the fish and the size and sculpture of its scales, the fins and tail being entirely wanting.

GLYPTOLEPIS.

Two split nodules of shale which exhibit on their inner surfaces a number of large detached scales, slender rib bones, an operculum and a fragment of a jaw, with teeth, of a second species of *Glyptolepis*, probably nearly related to the *G. leptopterus* of Agassiz. The scales, which are nearly an inch long, are sculptured with the wavy costæ and semi-lunar or crescentic area of backwardly directed points characteristic of the genus, and the ribs are hollow in the centre. The teeth are short, conical, somewhat compressed and perfectly smooth.

CHEIROLEPIS CANADENSIS. Sp. Nov.

Maximum length eighteen inches: greatest height less than one-fourth of the length: general outline elongate-fusiform. Head equal to about one-fourth the entire length: cranial plates exquisitely sculptured with delicate, irregular corrugations which are crossed obliquely by minute ribs quite invisible to the naked eye. In some of the cranial plates the corrugations consist of wavy ridges of varying length, separated by corresponding but much wider grooves. Occasionally the ridges appear to be made up of a series of confluent tubercles. In other plates the corrugations or ridges anastomose so as to form a dense but irregular network. Margin of orbital cavity circular. Teeth conical, slender, of unequal size. Scales of the body minute, ganoid, rhomboidal, about one-third of a line long, and sculptured with acute ribs which radiate longitudinally from the posterior angle of each scale. Scales of the fins and tail rectangular and acutely ribbed at their edges. In the central portions of the fins and tail the scales are twice as long as broad, but near the outer margins of the fins they become much narrower and more elongated. Dorsal fin single, triangular and placed very far backwards: the base of its posterior ray nearly but not quite extending to the commencement of the upper lobe of the tail. Tail heterocercal, its upper lobe fringed by a row of backwardly directed, flattened spines or "fulcral scales," which diminish in length towards the posterior termination of the lobe. Ventral fins situated considerably in advance of the mid-length and separated from the pectorals by a short interval. Anal fin placed much farther forwards than the dorsal and separated from the ventrals by a space slightly exceeding in length the height of the body at the commencement of the anal.

The above name is suggested provisionally for a species of *Cheirolepis*, which resembles the *C. macrocephalus* of McCoy and the *C. Cummingiæ* of Agassiz in the shape and sculpture of the scales of its body and fins. The ventral fins of *C. macrocephalus*, however, are described by McCoy as "nearly central, of moderate size, half their length distant from the anal," whereas the ventrals of *C. Canadensis* are placed much farther forwards and are separated from the anal by a much longer space. The ventrals of *C. macrocephalus*, too, are represented by McCoy as being rather nearer to the anal than they are to the pectorals, but those of *C. Canadensis* are very much nearer to the pectorals than they are to the anal. In *C. Cummingiæ*, according to Hugh Miller, "the large pectorals almost encroach on the ventrals, and the ventrals on the anal fin" but this, as already stated, is by no means the case with *C. Canadensis*. The dorsal fin of *C. Canadensis*, also, is placed much farther backwards than is that of *C. Cummingiæ*, and the anal farther forwards.

Of this species four fine and well preserved specimens were collected by Mr. Foord, two of which are nearly perfect.

Besides those already described, there are two or three species of fossil fishes in Mr. Foord's collection, belonging to different genera, also some isolated teeth and detached bones, whose affinities have not yet been satisfactorily ascertained.

The analogies between the fossil fauna of the fish-bearing beds of Scaumenac Bay and that of the Old Red Sandstone of Scotland and Russia are very striking. The *Pterichthys Canadensis* is still doubtfully distinct from the *Bothriolepis ornata* of Europe: the fragments of a *Diplacanthus* obtained by Mr. Foord have apparently much the same characters as the *D. striatus* of Agassiz, and the genus *Phaneropleuron* can now be shown to occur in the Devonian rocks of Canada as well as in those of Scotland. *Eusthenopteron* has at least some features in common with *Tristichopterus:* one species of *Glyptolepis* from Scaumenac Bay seems to be identical with the *G. microlepidotus* of Agassiz, from Lethen Bar, while the other bears a general resemblance to the *G. leptopterus* of the same author; and, lastly, the *Cheirolepis Canadensis* here described is certainly closely allied to two Scotch species.

The existence of fossil plants, as well as of fish remains, in the Devonian shales and sandstones of Scaumenac Bay was noticed by Dr. Gesner in 1842, and from these rocks Mr. Foord also obtained a series of specimens of four species of ferns, which will be found described on pages 8–11 of the present number of this journal.

These deposits may have been of fresh water or estuarine origin, for no traces of any marine invertebrata have yet been detected in them, and the fossil fishes which they contain are invariably found associated with land plants.

Montreal, March 14th., 1881.

DESCRIPTION OF A NEW SPECIES OF PSAMMODUS FROM THE CARBONIFEROUS ROCKS OF THE ISLAND OF CAPE BRETON.

By J. F. Whiteaves.

Psammodus Bretonensis, Sp. Nov.

Palatal teeth extremely thin, subrhomboidal, a little longer than broad, the two longest sides nearly parallel and almost straight. Of the two shortest sides one is obliquely and shallowly concave at the margin, with one of the angles rounded off and the other produced into a short beak: while the opposite side is obliquely convex at the margin, with both of its angles rounded. The upper surface of the beaked angle of each tooth is somewhat elevated, and this elevation extends nearly to the centre, the remaining portion being quite flat. To the naked eye this surface appears glossy and polished, but, when examined under a lens, with a good light, it is seen to be faintly and rather distantly punctured. The teeth appear to have been placed in linear rows, in such a way that the convex margin of the short side of one tooth fits into the concave and beaked opposite margin of the next one. Measuring from the centre of the sides, the length of one of the teeth is three lines, and the breadth two lines and a half. The average thickness of the teeth is about a quarter of a line.

Locality: East bank of Scott Brook, nine or ten miles north of St. Peters, Cape Breton Island. Collector: Mr. Hugh Fletcher, B. A., of the Geological Survey of Canada.

The only remains of this species yet obtained are a number of palatal teeth and impressions of palatal teeth, on the surface of a small flat slab of impure limestone. Most of these teeth are detached and isolated, though in one part of the slab there are impressions of four in an unbroken row.

P. Bretonensis appears to be most nearly allied to a *Psammodus* from the Joggins, of which a single tooth is represented by figure 54 (on page 109) of the second edition of the "Acadian Geology," unaccompanied by any description or specific name,—but this figure represents a much larger, thicker and more equilateral tooth than any of those of the present species.

Montreal, March 31st., 1881.

ON THE GLACIAL PHENOMENA OF THE BAY CHALEUR REGION.

BY ROBERT CHALMERS.

[Read before the Natural History Society of New Brunswick, March 1st, 1881.]

The following notes contain a brief summary of the results of observations made by me at intervals during the last seven years on the glaciation and older drift deposits of a portion of the northern section of the Province of New Brunswick.

The area specially examined and to which my observations have been for the most part confined, lies along the southern side of the Bay Chaleur and estuary of the Restigouche, extending from the Nepisiguit river at Bathurst, westward, to the junction of the Metapedia and Restigouche rivers, and is about eighty miles in length following the Intercolonial railway, and from five to ten miles in width southward from the coast line.

To elucidate my remarks on the glacial phenomena of this region ;I propose, before entering into details, to give a short description of the most prominent physical features of the Bay Chaleur and the country surrounding it, the peculiar conformation of which, assuming it were the same during the glacial epoch as at present, seems to have influenced the ice-sheet which once moved over it, in a marked degree, in producing the exceptional courses of striæ which I am about to describe.

The Bay Chaleur forms part of the northern boundary of the Province, and is about ninety miles in length and fifteen to twenty-five miles in width, stretching longitudinally east and west, and appearing as a broad irregular belt of water, with its sides roughly parallel to each other. Its general trend from the western extremity to its widest part opposite Nepisiguit Bay is about south 60 degrees east; thence to its mouth, which opens into the Gulf of St. Lawrence, its course is nearly north 60 degrees east.* In its physical aspect it may be considered merely an enlarged estuary of the Restigouche, Nepisiguit and other rivers

* All the bearings and courses of striæ given in this paper are referred to the magnetic meridian, the variation of the compass being about 24 degrees west.

flowing into it, and is really nothing more than a shallow valley of erosion, the softer Lower Carboniferous rocks which once probably occupied nearly the entire area of the depression having been, to a large extent, removed by denudation. Its waters are comparatively shallow, the deepest parts being rather nearer the northern coast throughout its whole length. Commencing at the western end, we find the soundings in six different places between that and Point Miscou to be as follows:—At the mouth of the Restigouche, ten fathoms; north of Heron Island, twelve to fourteen fathoms; between Belledune and Black Cape, sixteen to nineteen fathoms; across from Nepisiguit Bay to Bonaventure Point, twenty-six to thirty fathoms; between Grand Anse and Paspebiac, forty to forty-six fathoms; and between Point Miscou and Point Maquereau, which is really the mouth of the Bay, forty-five to fifty fathoms; while beyond its mouth, just south of Bonaventure Island, the depth is about sixty fathoms. It thus appears that there is a gradual descent in the contour lines of its bottom from the mouth of the Restigouche eastward and northeastward into the Gulf, for beyond the Orphan Bank (a small shallow area lying opposite its mouth) the lead goes down, according to the charts, to a depth of seventy-five fathoms or more. It will be seen in the sequel how the slope and configuration of this depression have controlled the course of the ice-sheet whose markings are found on the rocks along its southern shores.

This beautiful expanse of water is without rock or shoal, and has only one solitary isle—Heron Island—lying off the coast of Restigouche County.

The estuary of the Restigouche is a sheltered lake-like sheet of water lying nearly east and west, about twenty-one miles in length, reaching from Dalhousie to Tide Head, six miles above Campbellton, and having an average width of two to three miles. It is enclosed by hills varying in height from 500 to 1000 feet.

The general appearance of the country on either side of the Bay Chaleur is quite different. In the Gaspé peninsula the Shickshock mountains and some minor ridges give to that region an elevated and rugged character, although to the south of these mountains a great portion of the surface resembles a plateau intersected by numerous deep river gorges and ravines. This is especially the case with the district lying between the Metapedia and Cascapedia rivers which is elevated to a height of nearly 1000 feet above sea level and presents a bold escarpment or mountain flank towards the estuary of the Restigouche and the Bay Chaleur. Lower margins, however, fringe the coast at intervals. At Nouvelle and Tracadiegash this plateau juts into the Bay and rises into lofty peaks (Nouvelle Mountain, 1058 feet, Tracadiegash Mountain, 1865 feet high). East of the indendation known as Cascapedia Bay the coast region, although not so high as that just described, nevertheless maintains to a certain extent the aspect of an undulating elevated district, exhibiting steep banks and cliffs in many places, with an ascending surface behind which merges into the hill ranges that form the axis of the peninsula.

A portion of this mountainous region crosses to the south side of the Restigouche at Dalhousie, rising into a series of narrow parallel hill ranges, composed chiefly of trap, which occupy a width of three or four miles on the south side of the estuary, and run nearly east and west or parallel to the river, varying in height from 500 to 1000 feet, with intervening longitudinal valleys. All these valleys, including that of the Restigouche, are evidently of pre-glacial origin. These hill ranges extend, with some interruptions, south-west, increasing in breadth and height to the Upsalquitch (a tributary of the Restigouche on the south side, thirty-five miles distant from Dalhousie), where they merge into the highland area in the north-west of the Province. Near the junction of these two rivers the twin peaks, Squaw's Cap and Slate Mountain may be seen, reaching elevations of more than 2000 feet above the sea. Along the Upsalquitch, which descends to the Restigouche in nearly a north-west course, and is about forty-five miles long, the general level is elevated from 500 to 700 feet, while several portions of the district rise much higher. Prof. Hind, in his "Preliminary Report on the Geology of New Brunswick" (1864), gives the altitudes of several peaks to the east of that river, among them the Blue Mountains, a ridge near the source of Jacquet river, all of which are from 1000 to 1400 feet above the sea. Not far from the head waters of the Upsalquitch are the central highlands of the Province, where several mountains loom up to heights of 2200 feet, and within the limits of which some of our principal rivers have their sources.

Between this Upsalquitch district and the Bay Chaleur lies an area extending from the Dalhousie hills, on the west, to the

Nepisiguit river or great Carboniferous plain, on the east, which exhibits, in general, a uniform or gently undulating aspect, and is without any eminences, except the Blue Mountains already spoken of and one or two lesser ridges. This area has a gradual descent from the sources of the rivers debouching into the Bay (which vary in length from fifteen to forty-five miles) towards the low shores of that sheet of water. The rocks underlying it have evidently undergone great denudation, especially near the coast; for, although much disturbed—the strata in many places being upturned vertically—they nevertheless exhibit a comparatively even surface.

To the south-east of the Bay Chaleur stretches the great Carboniferous area of the Province. It is a flat district, whose surface as far south as the Bay of Fundy does not attain a greater height than 250 to 275 feet and slopes very gently down beneath the waters of the Gulf of St. Lawrence.

Bearing in mind the topographical features of this region, we can now mark their influence on the course of the glacier which once occupied the depression of the Bay Chaleur and overspread the district to the south of it.

GLACIAL STRIÆ.

Three sets of striæ occur in the region embraced in my observations. I will note some of the most accessible localities where they are to be seen. No two of these sets have been noticed in any one area.

The first set of striæ was observed in the Restigouche valley and on the hills to the south of it, as well as eastward along the Bay shore as far as Jacquet river, extending over a district about forty miles in length. The particular localities where exposures occur are as follows:

(1) At Campbellton, on the west side of a trap hill or *roche moutonnée* at the Intercolonial railway snow-shed. This hill stands about fifty feet above the level of the river, and is rounded and polished on the west side, having a crag-and-tail form.

(2) At the school-house in the village a similar mass of rock is striated and polished on the west side, and broken off on the east.

(3) On the road to Parker's lake, three miles south-west of Campbellton, near the summit of one of the parallel ranges of

hills already referred to, scratches were seen on the north side of the crest of the ridge, about 500 feet above sea level, by aneroid. The exposure shows that the abrading mass ground off the corners of the rocks on the west side.

(4) On Lily lake road, about three miles south of Campbellton, on the third range of hills from the Restigouche river, striæ were observed in several places, about 650 feet above the sea. The rock-masses here also exhibit stossing on the west side.

(5) Near the Intercolonial railway at Charlo river the surface of a trap dyke was seen to be eroded and polished on the west side, but no distinct scratches appeared. Its height was about twenty-five feet above the Bay.

In all these localities the course of the striæ is nearly east and west by the compass.

At New Mills, Benjamin river and Black Point, I noticed *roches moutonnées* in the fields and ledges of crystalline rocks along the shore with their surfaces smoothed and rounded, and the west sides stossed, while the east were broken off and abrupt. Grooves, not very distinct, were observed having a course nearly east and west, or between that and south 70° east at various heights from sea level to fifty feet or more above it.

On the east side of Jacquet river I saw very distinct striæ on the site of the Intercolonial railway, in 1873, in the bottom of a clay cutting, on red conglomerate rock, which is now covered by the track. The course was about east and west, and the height of the ledge above sea level twenty-five feet.

The second set of striæ is met with in the tract lying between Belledune river and Petite Roche, the grooves and scratches being well exposed along the Intercolonial railway. Owing to the harder nature of the rocks in this locality, which are chiefly limestones, traps and diorites, they have resisted disintegrating agencies more effectually than elsewhere within this region, and a large extent of rock-surface is laid bare or but very thinly covered with soil; nevertheless the striæ have been preserved with remarkable distinctness. They are to be seen at distances of every two or three hundred yards in the fifteen miles which intervene between the two places above named. The course is almost invariably south 60° east. These striated rocks are all stossed on the west side. The scratches occur at heights of from 75 to 200 and 250 feet above tide level. Crossing them at a small angle, fainter striæ were occasionally noticed, as if caused by ice-sheets sliding more directly down the slope into the Bay depression at a later date.

The third set of striæ occurs in the district intervening between Petite Roche and Bathurst, which is about ten miles in length.

(1) A mile east of Petite Roche station along the Intercolonial railway, scratches appear on slate rocks, with a course of about north 65° east. The ledge is probably sixty feet above sea level, and is rounded on the south-west slope.

(2) At Mill Stream (north side), six miles from Bathurst, grits and shales on the site of the railway are distinctly grooved, the direction of the striæ being north 65° east. The grooves occur on a nearly level surface of rock, but afford evidence that the ice-mass moved north-eastward.

(3) On Knight's farm, three miles north of Bathurst, an interesting group of striated surfaces was discovered about a hundred yards east of where the railway crosses it. The rocks are trap, felsite and conglomerate, and stand up a few feet above the general level in the form of bosses or low rounded hills. Their south-western sides are all ground off and polished. No fine striæ appeared, but I noticed a number of wide parallel grooves or furrows which had nearly a north-east and south-west course. Eight or ten of these rock-masses may be seen here planed and grooved in the manner described, the stossing invariably on the south-western slopes, while their north-eastern faces are rough and have a broken-off appearance. It was from an examination of these furrowed rock-surfaces that I was first led to the conclusion that the direction of the ice-flow in the district where the third set of striæ occurs must have been from south-west to north-east.

On rocks a few hundred yards to the north of these, however, I saw what might be taken as indications of glacial erosion on the north-western slopes of one or two exposures. No striæ or grooves were observed, but merely a rounding of the faces; and it was difficult to say whether this was the effect of atmospheric agencies or of ice. If these markings are due to the latter cause, they would indicate that a glacier must have moved over this region in a south-easterly direction at an earlier date than the one whose striæ I have noted.

The elevation of the surface in this vicinity is about 100 feet above the sea.

(4) At Peter's river, on the road to Mill Settlement, striæ appear on slates with a north-east and south-west trend.

(5) Fine clear-cut striæ are seen on granite ledges at Bathurst, in two or more places on the west side of the harbor or basin, the direction being nearly north-east and south-west. The ledges lie below high-water mark, and their glaciation indicates that the movement of the eroding agent was north-eastward.

Whether any one of these three sets of striæ was of an earlier date than the others is a question which it was difficult to determine, as they are closely similar in most respects. But the north-east and south-west scratches in two localities, namely, at Bathurst and Mill Stream, seem to be somewhat finer and lighter than those observed elsewhere.

"TILL" OF BOULDER-CLAY AND ERRATICS.

The "till" or boulder-clay is exposed only in a few localities in the district under examination. Either it is very thinly distributed and lies concealed beneath the later deposits, or it is entirely wanting in a great portion of the region to which my remarks relate, in consequence probably of the extensive denudation which it has undergone. It is met with in the Restigouche valley, however; also on the coast of the Bay at Nash's Creek, and along the Nepisiguit river, near Bathurst. An interesting group of surface deposits, one member of which may, perhaps, be till, was disclosed by a series of borings, six in number, made for foundations to the Intercolonial railway bridge which crosses the Restigouche near the mouth of the Metapedia. Through the kindness of Mr. L. G. Bell, C. E., I obtained a diagrammatic section of these borings just after the work had been finished in 1873, which shows, in descending order, the following formations as described by him:

Sandy soil (at one boring on left bank).....	8	feet.
Strong coarse gravel (probably fluviatile)...	12 to 15	"
Stiff sandy blue clay ("till"?)............	60	"
Sand in some places, black clay in others, resting on the rock..................	5	"
Total thickness...............	88	

These deposits occupy a valley 400 to 600 yards wide, on either side of which hills rise to the height of 500 feet or more above the river. The depth of the water in the Restigouche when the borings were made, was ten feet, and the height of its surface above the level of high tide in the Bay Chaleur, eighteen feet. Hence fully seventy-five feet in thickness of this mass of drift, including the whole depth of the "stiff sandy blue clay" and its underlying sands and clays lies below the level of the sea.

Stratified clays holding marine fossils appear to overlie the series just described on the north side behind the "Club House," attaining a height of fifty-five feet above the river, and these, in turn, are overlain by fine sand and gravel to a thickness of fifteen to twenty feet; but nothing like true till appears here.

I am without information as to whether boulders or fossil shells were found in the "stiff sandy blue clay" of this group of deposits when the borings were made, and its origin and relation to the later beds are therefore uncertain. If we suppose it to be stratified clay (Leda clay) then we would have to admit that a marine deposit upwards of 100 feet in thickness was formed here, thirty miles above the river's mouth, where the Restigouche is not more than 500 to 600 yards wide. This would occur too at a time when the hills on both sides would be some hundreds of feet above the sea; for even at the period of greatest subsidence in the Post-Pliocene epoch they must have reared their summits high above the waters which occupied the valley. I can therefore hardly imagine a bed of this kind, of such a depth, being deposited here under these conditions, more especially as the stratified marine clays of other localities in the Bay Chaleur region, so far as observed, are comparatively thin. Further, this "blue clay" and underlying deposits evidently occupy a rock-basin or trough in this part of the Restigouche valley; for borings made across the river's bed at Campbellton, thirteen miles further down, revealed the fact that the rock-surface there is not more than twenty-five to thirty feet below tide level. From these and other considerations, I lean to the opinion that the deposit referred to, or at least a portion of it (for, perhaps its characteristics and exact position were not noted very accurately) may be "till," and that it is probably the *ground-moraine* of the ice-sheet filling a hollow at the junction of the Metapedia and Restigouche rivers, and resting on the pre-glacial river sands and mud. Additional details regarding these beds will be given, however, when I come to treat of the later surface deposits of the district.

The "till" is found in the river's bank, east of Campbellton village, having a thickness of thirty feet above tide level, and is overlain by stratified fossiliferous clay. At Nash's Creek it likewise appears in a bank on the Bay shore, attaining a height of sixty feet or more where the Intercolonial railway intersects it. In both of these localities it consists of a stiff clay containing a good many boulders, a few of which are scratched. The largest proportion of them have evidently been transported from the west. For example, at Campbellton, considerable quantities of boulders of a peculiar sort of felsite were distributed in the "till," which had been brought from rocks from half a mile to one and a half miles distant to the west. At Nash's Creek boulders of a certain kind of red conglomerate and of trap were met with, which seemed to have been carried distances of from three to six miles in the same direction.

The till at the Nepisiguit river occurs on its left bank and is best seen in a cutting of the Intercolonial railway which is about seventy-five feet above the sea. Dr. Honeyman, who visited this spot, refers to it in one of his papers, entitled: "A month among the geological formations of New Brunswick." Here its color and composition are much different from those of the Restigouche clays, being of a reddish tint, which is derived from the subjacent Lower Carboniferous sandstones, and it is more arenaceous and not so compact.

The "till," as observed at Campbellton and Nash's Creek, seems to have been thrown down in the lee of low hills, occurring at the former place to the east of the elevation immediately behind the village. At Nash's Creek it lies on the coast behind a low swell of limestone and other rocks to the west.

Evidences of the general eastward movement of the ice-sheet are also abundant, from the transport of loose boulders or erratics strewn on the surface in many places within this region. In the majority of cases these appear to be derived from rocks *in situ* a few miles to the west of where they are found. At Petite Roche and Nigadoo river I saw numerous large blocks of limestone and greenstone (diorite) which had their parent beds at Elm Tree river, three or four miles distant. The drift, including boulders, at Little Belledune also appears to have been carried in a similar direction from a patch of Lower Carboniferous sandstones, the red-colored debris overlying the limestones and other rocks to the east of these. Between Nigadoo and Bathurst, however, the district is strewn with the fragments of rocks, the largest proportion of which occur *in situ* in the vicinity.

Erratics are met with occasionally here and there in this region whose presence I am unable to account for without bringing in the agency of floating ice. One of these may be seen in a gorge four miles south-east of Campbellton, through which flows a stream following the Tobique road. It is a grey conglomerate about eight feet in diameter, closely similar to rocks which occupy the valley of the Restigouche to the east. It lies sixty or seventy feet above sea level, and must have been transported thither by floating ice which moved up stream. At Knight's farm, near Bathurst, already mentioned, a few erratics are met with also resembling rocks in Restigouche County; and like instances of the transport of large blocks occur at other localities, indicating that other carrying agents were in operation besides the glacier whose striæ have been observed. It is probable that these latter have been borne to their present sites by icebergs after the ice-sheet had disappeared; and their deposition may have been contemporaneous with that of the stratified marine clay (Leda clay) of the region. The subsequent denudation which the Post-Pliocene deposits underwent has left them exposed on the surface.

From a study of all the facts obtained up to the present date in reference to the drift striæ and till of this region I have come to the conclusion that the mass or masses of ice which moved over it and scored the rocks in the manner described must have been of considerable magnitude. The first set of striæ, if produced by one body of ice, as seems probable, shows that the sheet has been at least six or seven miles wide near Campbellton, filling the valley of the Restigouche to a depth of several hundred feet and mantling the hills to the south of it. East of the Dalhousie hills its width would increase, and must have been very much greater. It probably stretched over the greater part of the Eel river and Charlo river district, which lies immediately south of these hills. At Heron Island it could not have been less than fifteen to twenty miles in width, occupying the whole depression of the Bay here and covering a portion of the district to the south, increasing in extent laterally and probably lessening in thickness towards the east.

The second set, that is, the striæ occurring between Belledune and Petite Roche, afford indubitable evidence, from their regularity of direction, the close parallelism of the scratches and their position on an even sloping surface, that the portion of the ice-sheet which produced them was one solid mass, and could not have been less than seven or eight miles wide, coveting the area in question. The main body of ice of which it formed a part must have exceeded twenty-five miles in width here, and was probably not less than 300 to 350 feet deep in the middle of the Bay Chaleur depression. The glacier in this part of its course has evidently followed the general trend of that depression, moving about south 60 degrees east. The portion of the ice-sheet which covered the Belledune and Petite Roche districts, therefore, has probably been only the lateral part near the southern border of the general mass, and may not have been more than fifty to one hundred feet thick, perhaps less, thinning out on the ascending surface of land.

The striæ of the third set, although varying in direction from north 45 degrees east to north 65 degrees east have most probably been produced also by the southernmost portion of the main ice-sheet overspreading the district in which they occur. This part of the glacier would likewise be controlled in its movement by the general mass, which from Nepisiguit Bay would trend away nearly in a north-easterly course towards the mouth of the Bay Chaleur. The close parallelism existing between the courses of the striæ in this set with the general direction of that portion of the Bay to the north-east of Bathurst, which is about north 60 degrees east, together with the fact that the glaciated rock-masses are all stossed on their south-western faces, point to this conclusion. Smaller local glaciers may have occupied the slopes of land, as well as the valleys of the larger rivers near Bathurst, however, after the main sheet had taken its departure.

Summing up the data regarding the glaciation of the whole area under review, and noting the correspondence of the striæ in all three sets with the general direction of the Bay Chaleur, and especially with the trends of its northern coast, near which its waters are deepest, I think it may reasonably be inferred that the phenomena of striation and deposition of the till and other drift material are due to one and the same ice-sheet occupying the valley of the Restigouche and the Bay Chaleur depression and extending some distance laterally over the region to the south. This sheet, moving eastward from the highlands of the Restigouche and Metapedia, would follow the sinuosities of these depressions and influence or control those portions of its mass which overlay the sloping land along its southern margin, thus causing the somewhat anomalous courses of striæ which I have described.

Admitting, then, that the contour of the Bay Chaleur and contiguous country was the same or nearly so in the Post-Pliocene epoch as at the present day, and that the region was covered with a glacier sufficiently large to produce the effects I have indicated, we might next enquire what the approximate extent and thickness of such an ice-sheet were. A glacial mass such as I have supposed covered the area in question must have had its source in the elevated region in the north-west of New Brunswick, and probably also in the Shickshock Mountains near the head waters of the Metapedia. In its eastward descent it would follow the courses of that river and of the Restigouche, which unite thirty miles above the mouth of the latter. From their junction eastward to the Bay its movements would be controlled by the Restigouche valley. Its length, therefore, would not be less than 125 to 150 miles, and may have been much greater; its width after leaving the Restigouche hills would be twenty-five to fifty miles or more; and its thickness in the Restigouche valley not less than 1000 feet; between the Dalhousie hills and Heron Island 500 to 600 feet, and Between Bathurst and Bonaventure probably 300 to 350 feet. In these statements I have given what I consider the lowest estimate of its dimensions, but it is almost certain that they exceeded this very considerably.

This extensive *mer de glace* was evidently an independent body, guided in its flow by the configuration of the surface of the region; and as it advanced eastward its different parts converged or were deflected towards the lowest area, namely, that which now forms the mouth of the Bay Chaleur.

Further, I infer that the glacier was a local one, and not part of a continental ice-sheet, for the following reasons:

1. From its easterly and north-easterly course, as shown by the striæ in the Restigouche valley and at Bathurst, thus diverging from the normal movements of glaciers as evidenced by their markings on the eastern coast of America.

2. From the close parallelism between the courses of the striæ and the trends and sinuosities of the Restigouche estuary and Bay Chaleur, showing that the ice-sheet must have been one of no very great thickness and with an independent movement, to be thus controlled by the contour of the region; and

3. From the fact that such portions of it as overlay the district to the south of the Bay moved down the sloping surface into the depressed area towards the north-east, and near Bathurst followed the courses of the larger rivers debouching into the Bay, instead of pursuing a course to the south-east over the low lying Carboniferous plain. If the Bay Chaleur glacier had formed part of a continental ice-mass, the difference in level between these two areas was not so great as to prevent it from continuing on in a south-easterly course.

SAND AND GRAVEL RIDGES OR KAMES.

(Syrtensian deposits of Matthew.)

I shall now attempt a brief description of a group of sand and gravel beds which occurs near the coast of the Bay Chaleur in Restigouche County, and which, according to the latest theories regarding their formation, seem properly to come under the head of glacial phenomena. The origin and distribution of similar deposits in other places have been ascribed to the agency of marine currents, but in the locality to which I refer it does not seem possible, for various reasons, thus to account for them. This will become apparent as their position and structure come to be examined. In some of their features these Restigouche sands and gravels bear a resemblance to the "till" of the neighborhood, but in other respects, especially in the nature of their materials and mode of occurrence, they afford evidence of being the result of the action of strong, irregular, intermittent currents, which have flowed from the highland area to the west. It also appears probable that they were deposited at the time the ice-sheet which covered the region was melting and breaking up, and owe their formation to the vast floods which swept large quantities of debris from the Restigouche hills to the plain below during that period.

In the district referred to only one of these ridges or kames has yet been traced out and studied to any extent. It lies between Charlo river and Nash's Creek, being about eleven miles in length, and exhibiting the appearance of a winding, irregular ridge or series of mounds whose general direction is nearly parallel to the coast-line and not very far different from that of the glacial striæ in the same locality. It has a width of from two hundred yards to a quarter of a mile or upwards, and does not rise to a greater height above the level of the district than twenty-five feet, nor more than eighty feet above sea-level, sloping away on both sides, the one facing the Bay being generally the steepest. Where it is widest it encloses hollows; one of these hollows or pits near New Mills is about fifty yards in diameter, and twenty feet or more in depth, although partially filled with later deposits. This kame is intersected by streams and rivers in several places and by the coast-line at Dickie's Cove near Black Point, forming bluffs on each side of that small indentation. Cuttings along the Intercolonial railway have likewise been made through it at various points, showing that the materials of which it is composed are usually sand, gravel and pebbles, more or less stratified, in which are distributed a few boulders from six inches to two and three feet in diameter, nearly all water-worn and well-rounded. These boulders are scattered irregularly through the mass, and many of them resemble, in mineral character, rocks in the hilly district bordering on the Restigouche, consisting chiefly of trap, diorite, felsite, limestone and slate. Several, of a red silicious felsite, were observed closely similar to rocks of that kind occurring in the hills near the railway tunnel at Flatlands, about thirty-five miles distant. Near the bottom portion of the kame at Black Point, however, I saw boulders which seemed to have their parent bed within a distance of three miles to the west. Occasionally erratics of four and five feet dimensions are met with in its upper parts, but they are not common. Irregular strata of fine sand, and sometimes clay, alternate with others of coarser material or are intercalated in them. Instances likewise occur of curved bedding and cross sections generally exhibit a sort of arched stratification. The coarser portions reveal scarcely any traces of stratification, and, as already stated, resemble in some measure the "till," except that the stones are more water-worn and without striæ.

The dimensions of this kame must have been much greater immediately after its formation than now. The streams which intersect it have carried away large quantities of its mass; and its seaward face has been modified to a considerable extent by the action of the waves when it formed a beach, or was in the tideway at the close of the deposition of the stratified marine sands (Saxicava sands). This last deposit, together with the fossiliferous clays next underlying it, both of which are seen resting on the slopes of the kame, especially on its southward side and along the banks of the rivers where they intersect it, have also changed its outward form in no small degree. The best section of these beds is exposed at Black Point near Dickie's Inn. In the railway cutting at this place the three members of the modified drift occur in superposition. Here and at the shore their thickness in descending order is seen to be as follows:—

Stratified sand (Saxicava) passing into surface gravel	10 feet "
Stratified marine clay holding fossils (Leda)	5 to 10 "
Sand and gravel beds or kame	50 feet or more.

These kame deposits have not been observed in contact with the "till"; but between New Mills and Black Point they rest on glaciated rock-surfaces.

I have already referred to the theory of the origin of kames, which supposes them to be due to the effect of oceanic currents, sorting out and redistributing the "till" and morainic debris thrown down by glaciers, and have stated that this theory will not suffice to explain the formation of the kame deposits in question. In straits and along the Atlantic border where the coast is exposed to the sweep of the arctic and other currents these agencies have no doubt had powerful influence in modifying the older drift deposits when the land stood at a lower level. But the position of the Bay Chaleur region, with a highland area to the west and south-west, forbids the supposition that currents from the north-east traversed it. Although we have no data to show what the height of the land was during the formation of these sand and gravel beds; yet in the period subsequent, namely, that of the deposition of the stratified marine clays (Leda clay), which in this district have not been observed at a greater height than 100 to 150 feet above the sea. we find that a subsidence of 400 to 450 feet below the present level would be sufficient to account for the presence of its marine fauna, that is, allowing the bathymetrical range of the species found fossil here was the same as that of similar species existing in the Gulf of St. Lawrence at the present day. Hence, it is quite probable this region was not further submerged during the Post-Pliocene epoch. A sinking of the land to the depth of 450 to 500 feet, however, would not admit of currents flowing up the Restigouche valley, nor over the area in the north-west of the Province; nor does it seem possible that local marine currents which might have circulated within the Bay during Post Pliocene times could have sufficient strength or velocity to produce these ridges.

For these reasons, as also from the fact that no fossil remains have yet been found in these beds, the theory of marine currents does not appear to be applicable to the solution of the problems presented by the kame deposits in this region.

But, apart from these considerations, no evidence has been obtained in the course of my investigations to show that currents having any power or velocity traversed any part of the area under examination in a south-westerly direction, if we except the transport of a few of the larger erratics which may have been carried about by floating ice. On the contrary, all the data hitherto collected point to the fact of currents moving in an opsite course. The stossing of the hills and exposed rock-masses on their western sides; the direction in which the boulders met with in the sand and gravel series seem to have been transported; the position of the "till" in the lee of elevations; the denuded condition of the region generally as regards surface deposits; the crag and-tail phenomena exhibited in the case of isolated ridges and peaks, notably at Sugar Loaf Mountain near Campbellton, which has its west end worn bare and steep down to the level of the valley, while at its eastern end a "tail" stretches away several hundred yards, the crest of which stands 300 or 400 feet above tide level—all go to demonstrate that the great denuding and transporting agents proceeded from the west.

On an examination, therefore, of all the facts at hand relating to the position, the materials and the mode of occurrence of the kame described, it appears to me that the theory which explains the origin of similar groups of deposits from the action of glacial rivers or floods during the dissolution of the ice-sheet will account for the phenomena in question more readily than any other. It is a mooted question yet, however, whether these glacial rivers flowed in channels under the ice, or on its surface, although several geologists of note have quite recently adopted the hypothesis of their being super-glacial. They are supposed by these geologists to have formed channels on the surface of the ice-sheet, carrying *detritus* from higher levels and depositing it at their mouths in a partially stratified condition as the glacier melted and withdrew. Rivers analogous to these are said to have been observed on existing glaciers in the arctic regions during the summer months.

But whatever explanation be finally accepted, it is at least probable, with regard to the Restigouche sands and gravels, that their deposition took place when the ice-sheet which occupied the Bay Chaleur depression was breaking up and retreating to the hills. The river torrents which would then pour down the Restigouche valley and from the adjacent snow-and-ice-clad summits must have been enormous. Moreover, the physical conformation of this valley and adjacent district favors the supposition that a portion of the flood which emerged from it would find an opening to the level country below by the Eel river pass, a gap or break in the Dalhousie hills, through which the Intercolonial railway now runs. A glacial river or flood following such a course would be very likely to deposit its burden of sand, gravel and stones where we now find the kame referred to. The winding, irregular formation of this kame is proof that the materials of which it is composed were not moved and arranged by regular, steady currents, but rather were brought to their present position by rapidly-flowing waters, such as we might suppose would sweep down from the hills among the dissolving remnants of the ice-sheet. The enclosed hollows favor the same view. The large boulders in its upper portions have probably been carried thither by icebergs at a subsequent period, when the whole kame was beneath the waters of the Bay.

If we admit that this kame is the result of the transport of detrital material by a super-glacial river, then at the time of this flood the Restigouche valley and estuary must have been occupied by a dissolving ice-sheet probably 200 or 300 feet thick. From the configuration of the estuary, which resembles a lake-basin with an outlet opening towards the south-east, this body of ice would, when its surface fell below the level of the enclosing hills, be unable to move out of this depression, and would, consequently, thin down and melt almost wholly in the situation in which it lay, or with but very little eastward motion. Eel river pass, now only forty to fifty feet above sea level and filled with stratified marine deposits, would then likewise be occupied with a portion of the same mass of ice extending eastward probably as far as Heron Island. On the surface of this ice-sheet would be thrown the debris brought down from the hills, as well as the earth and stones exposed in the thawing of the glacier itself. This detrital material must have accumulated in large quantities. The strong currents supposed to flow over the ice surface from higher levels every summer would be sufficient to transport this *detritus*, which included coarse gravel pebbles and small boulders, to the terminal ice-front.

There are certain masses of clay, sand and gravel incorporated in this kame, however, without stratification. These have probably been dropped down *en masse* from the melting ice-sheet without undergoing the sorting action of the currents.

What the height of the land was at this period I have had, as already intimated, no means of ascertaining. At the time the Bay Chaleur glacier had attained its maximum thickness and extent the region probably stood somewhat above the present level. For, it it is difficult to imagine the moving ice-sheet clinging so closely to its bed and following the different courses of the Bay Chaleur valley, if the sea then stood at its present height, or was above it relative to the land. As the melting of the glacier is supposed to have taken place during the period of subsidence, the region was therefore slowly sinking beneath the waters of the Bay when the deposition of the sand and gravel beds occurred, and probably was not very far from the level at which it now is.

Some facts obtained in the course of my examination of this district would lead me to infer that the oscillations of level which the Bay Chaleur region underwent in the Post-Pliocene epoch have not been so great as appear to have taken place in the St. Lawrence valley. Among them, I may mention the position of the stratified marine clays and sands (Leda clay and Saxicava sand), which, as already stated, have not been observed at greater heights than 100 to 150 feet; and the preservation of the ice-markings on exposed rocks and ledges above that level in places where we might expect them to have been obliterated, had the sea covered them and subjected the rocky slopes to the action of the waves and coast ice. But further observation on this point is required.

RECENT ANALYSES OF CANADIAN MINERALS AND RIVER WATERS.

From a recent Report by Mr. CHRISTIAN HOFFMANN, F. Inst. Chem. to the Director of the Geological Survey.

CYANITE.

From the North Thompson River, British Columbia—Collected by Alfred R. C. Selwyn, Esq.

The mineral was imbedded in a granular quartz which, in addition, contained a few scales of a silvery-white mica. It, for the most part, occurred in in the form of radiated columnar aggregates, the colour of which was in parts pure blue, passing into greenish-grey; occasionally, but rarely, almost colourless—the other portions were of a uniform light bluish-grey colour. Lustre vitreous. Subtransparent. Specific gravity, 3.6005.

The material selected for analysis was found, after drying at 100° C., to have the following composition:

Silica	36.288
Alumina	62.254
Ferric oxide	0.552
Lime	1.064
Magnesia	0.355
	100.513

Previous to the finding of this specimen, cyanite was not known to occur in Canada.

LAZULITE.

Found three-quarters of a mile east of the mouth of the Churchill River,—District of Keewatin. Collected by Dr. R. Bell.

Occurs massive in veins, having a maximum width of seven millimetres, traversing a greyish-white, in parts milk-white, subtranslucent quartz. Colour fine deep azure-blue. Lustre vitreous. Fracture uneven. Brittle. Streak white. Subtranslucent. Hardness very nearly but not quite 5.5. Specific gravity—3.0445. Before the blow-pipe colours the flame pale bluish-green; swells up, whitens and falls to pieces, but does not fuse.

The material upon which the analysis was conducted, although selected with great care, and apparently pure, was nevertheless found to contain 3.808 per cent. silica; in calculating the results this has been excluded; the composition of the mineral dried at 100° C., then being as follows:

Phosphoric acid	46.388
Alumina	29.140
Ferrous oxide	2.091
Magnesia	13.838
Lime	2.829
Water	6.468
	100.754

This is the first time that this interesting mineral has been met with in Canada.

WATERS OF THE ASSINIBOINE ANE RED RIVERS.

Geological character of the areas drained by these rivers.—The following information in connection with the subject has, at my request, been kindly furnished me by Dr. G. M. Dawson.

"The Red River, flowing from south to north, runs probably for its whole length over deposits of late date. These are, either the fine silty materials laid down in the bed of the southward extension of Lake Winnipeg, which previously occupied the valley; or clays and sandy clays due to the glacial period. Long and important streams, however, join the Red River, both from the east and west, and the character of the river water is doubtless due to the nature of the country occupied by the springs and sources of these, rather than to the composition of the bed of the main stream, with which the waters, passing rapidly and in large volume, cannot come very often or intimately in contact. Probably more than half of the water of this river is derived from the Rat, Roseau and Red Lake Rivers and other streams flowing from the wooded and marshy country in the east, and this it may be supposed does not differ much from that found in the rivers flowing from the woodland country in eastern Canada. This country is also covered with drift deposits of glacial and post-glacial age, and the streams seldom or never flow over solid rock. The tributaries from the west including the Shayenne, the Pembina and numerous smaller rivers, are from a region which may be regarded as almost altogether open prairie, and is subject to a rainfall considerably less in amount than that in the east. These streams flow in part over glacial and post-glacial deposits, but in part also over the underlying Cretaceous rocks, of which the shales and clays of the Fort Pierre group cover the most extensive area. Springs, the water of which come in contact with the Cretaceous rocks also, doubtless feed the tributaries. The Cretaceous shales contain a considerable proportion of disseminated pyrites, which latter when exposed to atmospheric influences undergoes decomposition, ultimately giving rise, in the presence of the calcium carbonate contained in the rocks, to the formation of gypsum, with which mineral—generally in the crystalline form of selenite—many of the beds are in consequence charged. There are also on this side of the Red River, several springs impregnated with common salt; these resemble those of the Manitoba Lake district, and are probably like them derived from the underlying Devonian rocks. Springs of this character are known on the Salt River, south of the Pembina, and it was previously attempted to utilize these as a source of supply of salt. Similar springs are said also to occur on the Scratching River.

The country drained by the Assiniboine resembles in most points that described as giving rise to the other western tributaries of Red River. By some of the eastern branches of the upper part the Assiniboine, from Riding and Duck Mountains, a certain amount of woodland drainage is derived; but by far the greater part of its tributaries bring to it the drainage of prairie lands with a compartively small rainfall, and in which the saline matter, would therefore be supposed to exist in a more concentrated form. Though a compartively small portion of the total length of the streams can flow in actual contact with the underlying Cretaceous rocks, there is a reason to believe that in the praire region west of the valley of the Red River, a great part of the drainage of the country passes below the drift deposits along the surface of the underlying rocks, and this being brought very intimately in contact with these rocks would be likely to be influenced by their composition.

These samples of the waters were collected by Mr. A. S. Cochrane,—at the instance of Dr. R. Bell—on the 26th of October, 1876: that of the Assiniboine was taken from the centre of the river, about a quarter of a mile above its junction with the Red River; whilst the water of the latter was taken from the centre of the stream, about a quarter of a mile above where the former flows into it.

The water of the Assiniboine, after filtration, had a faint yellowish tinge. The suspended matter, which had a brownish-grey colour, left on ignition a light reddish-brown coloured residue, this on examination was found to consist of argillaceous matter.

The water of the Red River, after filtration, had a pale yellowish tinge. The suspended matter was of a light brownish-yellow colour, on ignition it left a residue, which, as in the previous case, consisted of argillaceous matter.

The nature and amount of the organic matter contained in these waters was not ascertained,—the quantity of the water at disposal being altogether inadequate for the purpose,—apart from which, it is highly probable, that, during the interval of collection and analysis, the organic matter had, to some extent at least, undergone decomposition, the amount of carbonic acid therefore, although estimated, has not been given.

The analyses of these waters were conducted by Mr. Frank D. Adams, and the following are the results obtained by him, expressed in grains per imperial gallon:

	ASSINIBOINE.	RED RIVER.
Potassa	0.499	0.549
Soda	5.324	5.028
Lime	6.783	6.912
Magnesia	4.588	5.142
Alumina and ferric oxide(1)	0.084	0.092
Silica	1.571	2.208
Sulphuric acid	4.906	7.093
Carbonic acid	?	?
Chlorine	1.988	3.390
Organic matter	?	?
Oxygen equivalent to the chlorine	0.448	0.765
Total dissolved solid matter, dried at 100° C.	41.09	44.63

Suspended matter—	ASSINIBOINE.	RED RIVER.
Organic	0.692	0.342
Mineral	4.508	3.509
Total	5.200	3.851
Hardness (2)—		
Temporary	13.90	16.03
Permanent	6.70	7.87
Total	20.60	23.90
Specific gravity	1000.64	1000.52

The foregoing acids and bases are most probably combined in the water as follows:

(Carbonates calculated ás mono-carbonates and all the salts estimated as anhydrous.)

Chloride of sodium	3.277	5.589
Sulphate of potassa	0.923	1.015
" of soda	8.216	4.727
" of lime	—	6.739
Carbonate of lime	12.112	7.388
" magnesia	9.635	10.798

1.—Although here given as ferric oxide, the iron was doubtless present in the water as a ferrous salt.—2. Direct method, Wanklyn and Chapman.

In the case of the Assiniboine water there was an excess of soda, above that required for the sulphuric acid, amounting to 0.114 grain (equals 0.084 sodium)—this might be present as carbonate: it would require 0.129 chlorine or 0.147 sulphuric acid in excess of the amounts found of these respective constituents. It has been calculated as, and added to the, sulphate of soda.

PROCEEDINGS OF THE NATURAL HISTORY SOCIETY.

The fifth regular meeting of the session 1880–1881, was held on the evening of Monday, March 28th. Principal Dawson occupied the chair.

The Sommerville Lecture Committee presented their report, which stated that the lectures had been a great success and more largely attended than in the past years.

The Chairman read the following interim report of the committee of council on the proposed meeting of the American Association for the Advancement of Science in Montreal in 1882:—

The Committee having met on Monday, March the 14th, requested Dr. T. Sterry Hunt to prepare a circular to be printed and sent to scientific men abroad, inviting them to attend the meeting: copies of this circular to be furnished to members of the Society and others willing to send them to their scientific friends.

It was further agreed to recommend that the President of the Society, Dr. Hunt, Mr. Selwyn and Dr. Osler, with any other members of the Society who may attend the Cincinnati meeting of the Association, be requested to act as a delegation to promote the acceptance of the invitation tendered last August to the Association to meet in this city, and that the delegates be instructed to request that the meeting be held in the last week of August, 1882.

It was also agreed that so soon as the acceptance of an invitation is secured, lists shall be prepared of names of gentlemen to be invited, and that in the meantime the committee would make suggestions of names, and also of those who should be solicited to subscribe to a guarantee fund towards the expenses of the meeting, and to become members of the local committee.

It was understood that in the event of the acceptance of the invitation, the McGill University should be requested to allow the use of its hall and class rooms for the meetings and the lectures.

Dr. J. Baker Edwards read a paper entitled "Notes on dangerous Well-waters." Referring to the water supply of Lennoxville College, he said that a well being wholesome at one season was no reason for it always being so; it would make a material difference in the quality whether the well was two or eighteen feet deep; that the condition of a well which was regularly being filled by ample water rushes was totally different from that which would obtain during a winter frost. Therefore the sample of water he obtained from the well in August last might be totally different from that obtained from the same well by Prof. Croft of Toronto, in the depth of winter, and their difference was a difference of opinion only, not a difference of fact. His verdict was that the water was perfectly wholesome, that of Prof. Croft, that it was critical if not dangerous. Had the circumstances been the same it was possible no difference of opinion would have appeared. He than gave a detailed account of his analysis in August, 1880, and a description of the process employed, justifying his analysis on that date, and his opinion that the water was free from organic impurities, and especially sewage contamination. Speaking of disease arising from bad water, he said that the malaria affecting country districts seldom arose from the filtered water of wells, but rather from open meadows, marshes and inconstant streams. To a large extent the safety of a water supply depended on its recent filtration rather than on its source. He gave an account of the different kinds of well water and of the condition necessary to make the water wholesome.

MISCELLANEOUS.

Meteorological Results for the Year 1880.

McGill College Observatory, Montreal, Canada. C. H. McLeod, Superintendent. Height above sea level, 187 feet.

Month.	Thermometer.				* Barometer.				† Mean Pressure of Vapour.	‡ Mean relative humidity.
	Mean	Max.	Min.	Range.	Mean.	§ Max	Min.	Range.		
January	22.445	43.8	- 9.5	53.3	30.11781	30.864	29.487	1.377	.1048	77.6
February	19.888	51.2	-17.5	68.7	30.00822	30.540	29.340	1.200	.0974	73.9
March	22.086	49.6	-11.2	60.8	30.05803	30.695	29.228	1.467	.0896	69.2
April	34.539	63.4	10.2	53.2	29.85688	30.298	29.285	1.013	.1720	69.0
May	58.603	85.2	22.9	62.3	29.94195	30.360	29.537	0.823	.3349	63.8
June	66.598	86.1	48.8	37.3	29.92147	30.275	29.487	0.748	.4363	67.1
July	69.282	86.2	52.7	33.5	29.88216	30.086	29.482	0.604	.4787	67.4
August	66.949	86.2	41.8	41.4	29.98902	30.369	29.556	0.813	.4459	68.2
September	60.312	85.0	40.3	44.7	29.95100	30.265	29.561	0.704	.4017	74.[illegible]
October	45.745	77.1	24.3	52.8	30.03562	30.400	29.374	1.026	.2490	78.0
November	29.059	59.0	2.2	56.8	30.15725	30.664	29.353	1.311	.1442	79.5
December	15.700	40.6	- 8.6	49.2	29.98282	30.579	29.488	1.091	.0809	82.2
Means for 1880	43.018	67.78	16.62	51.17	29.99354	.....	.....	1.015	.2529	72.52
Means for 6 years ending with '80.	42.471	.....	.....	....	29.96253	......	.....	....	.2562	74.30

Month.	Wind.		Sky clouded per cent.	Rain and snow melted.
	Mean direction.	Mean velocity in miles ⅌ hour.		
January	S.	13.61	63.6	3.03
February	S. W.	15.09	61.5	3.74
March	N.	11.70	48.0	2.55
April	W. S. W.	14.78	65.2	4.03
May	W. S. W.	12.45	60.8	2.97
June	S. W. by W.	8.73	54.6	3.27
July	S. W. by W.	8.69	53.5	5.35
August	W. S. W.	9.11	47.0	1.44
September	W. S. W.	9.15	67.8	2.83
October	S. W. by W.	11.00	66.5	4.75
November	S. W.	12.05	68.0	4.82
December	W. S. W.	11.26	75.2	2.11
Means for 1880	S. W. by W.	11.502	60.31	3.407
Means for 6 years, ending with 1880	W. by S.	11.077	62.02	3.301

* Barometer reduced to 32° Fah. and to sea level.
† In inches of mercury.
‡ Relative saturation 100.
The monthly means are derived from observations taken every fourth hour, beginning with 3.13 a.m.

The greatest heat was 86.2, on July 10th and August 24th. Greatest cold was 17.5 below zero on February 2nd. Extreme range of temperature for the year 103°.7. Greatest range of thermometer in one day was 46.6 degrees the 30th January. The warmest day was the 4th of September, the mean temperature being 76.85. The coldest day was the 2nd of February, the mean temperature being 4.85 below zero. Highest barometer reading was 30.864 on January 29th. Lowest barometer reading was 29.228 on March 5th, giving a range for the year of 1.636 inches. The lowest relative humidity was 26, on March 26th. Greatest mileage of wind recorded in one hour was 47 on January 10th, when the greatest velocicty was at the rate of 68 miles per hour.

NOTES:—Wheel traffic commenced on the 1st of April and closed on the 18th of November.

The heaviest rainfalls were on June 11th, 20th and on July 20th. The rainfall on July 20th measured 3.45 inches, which is the greatest amount recorded here for one day during the past six years. Of this rainfall 0.47 inches fell in 7 minutes and 1.58 inches in 46 minutes.

The first appreciable snow for autumn fell on the 26th October.

The earthquake noticed at Quebec on the 4th Aprii was not felt here.

The ice in the river moved April 5th.

First arrival in port was on the 21st of April. The first arrival in the St. Lawrence from sea was on April 30th.

RAIN AND SNOW FALL DURING 1880.

MONTH.	Inches of rain.	No. of days on which rain fell.	Inches of snow.	No. of days on which snow fell.	Inches of rain and snow melted.	No. of days on which rain *and* snow fell.	No. of days on which rain *or* snow fell.
January	1.27	12	16.3	11	3.63	2	21
February	1.14	6	26.0	16	3.74	2	20
March	0.01	2	25.1	16	2.55	0	18
April	3.17	18	8.6	10	4.63	5	23
May	2.97	19	0.0	0	2.97	0	19
June	3.27	16	0.0	0	3.27	0	16
July	5.35	17	0.0	0	5.35	0	17
August	1.44	13	0.0	0	1.41	0	13
September	2.83	17	0.0	0	2.83	0	17
October	4.44	17	3.1	5	4.75	3	19
November	3.63	8	12.7	15	4.82	3	20
December	0.29	2	17.6	18	2.11	1	19
Totals	29.84	147	109.4	91	40.89	16	222
Means for six years ending with 1880	27.75	137.5	118.2	85.2	39.61	16.3	206.3

THE COLOR OF FLOWERS—At a recent meeting of the Vaudois Society of Natural Sciences, Professor Schnetzler read an interesting paper on the color of flowers. It has been generally supposed that the various colors observed in plants were due to so many different matters, each color being a different chemical combination without relation to the others. Now Professor Schnetzler shows by experiments that when the coloring matter of a flower has been isolated, by means of spirits of wine, one may, by adding an acid or alkaline substance, obtain all the colors which plants present. Flowers of peony, give, when placed in alcohol, a red-violet liquid. If some salt of sorrel be added, the liquid becomes pure red; while soda changes it, according to the quantity, into violet, blue, or green. In this latter case the green liquid appears red by transmitted light, just as does chlorophyll (the green coloring matter of of leaves). The sepals of peony, which are green with red border, become wholly red when put in salt of sorrel. These changes of color, which can be had at will, may quite well be produced in the plant by the same causes, for in all plants there are always acid or alkaline substances. Further, it is certain that the transformation from green into red, observed in the leaves of many plants in autumn, is due to the action of tannin, which they contain, with chlorophyll. Thus without wishing to affirm it absolutely, Professor Schnetzler supposes *à priori* that there is in plants only one coloring matter —chlorophyll—which being modified by certain agents, furnishes all the tints which flowers and leaves present.

NIAGARA FALLS DRY FOR A DAY.—The Lord Bishop of Niagara recently lectured in Hamilton, Ont. on "Upper Canada as it was fifty years ago. and Ontario as it now is," and in the course of his remarks said: "The falls of Niagara were dry for a whole day. That day was the 31st of March 1848. I did not witness it myself; but I was told of it the next day by my late brother-in-law Thomas C. Street, Esq. Mr. Street's theory was this: That the winds had been blowing down Lake Erie, which is only about 30 feet deep, and rushing a great deal of water from it over the Falls, and suddenly changed and blew this little water (comparatively speaking) up to the western portion of the lake and that at this juncture the ice on Lake Erie, which had been broken up by the high winds, got jammed in the river between Buffalo and the Canada side, and formed a dam which kept back the waters of Lake Erie a whole day." One of the local papers noticing his lordship's lecture spoke of the statement concerning the Falls as "rather fishy." The lecturer then sent to the sceptical editor declarations from several gentleman all corroborating his statement.

The Hon. L. F. Allen of Buffalo declared: "I well recollect it, although I have no precise date as to the month or year in which it occurred. It was so remarkable as to be noticed in Buffalo newspapers. Nor do I recollect whether the subsidence of the river waters was caused by a dam of ice at the outlet of Lake Erie or by a strong east wind, which sometimes, by blowing the water up the lake, makes very low water in the river for many hours.

Two other witnesses made the following statutory declarations; (the laws of Ontario forbid taking oath in such cases).

County of Welland, to wit: I, Henry Bond, of the Village of Chippewa, in the County of Welland, blacksmith, do solemnly declare that I well remember the occurrence of there having been a day during which so little water was running in the Niagara River that but a small stream was flowing over the Falls of Niagara during that day. It happened on or about the 31st day of March, A. D. 1848.

HENRY BOND.

Declared before me, at Chippewa, in the County of Welland, this 17th day of May, A.D. 1880.

J. F. MACKLAN, Notary Public.

County of Welland, to wit: I, James Francis Macklan, of the Village of Chippewa, in the County of Welland, Province of Ontario, notary public and Justice of the Peace, do solemly declare that about the 31st day of March, A. D. 1848, the waters of the Niagara River were so low that comparatively little was flowing over the Falls for a whole day. "The phenomenon of the Falls of Niagara running dry," as was the term used in speaking of the occurrence, caused great excitement in the neighbourhood at the time.

J. F. MACKLAN,
Notary Public and Justice Peace for County of Welland.

CHIPPEWA, May 17, 1880.

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