BULLETIN

OF THE

NATURAL HISTORY SOCIETY

OF

NEW BRUNSWICK.

No. XXII.

VOLUME V. PART II.

PUBLISHED BY THE SOCIETY.

SAINT JOHN, N. B., CANADA:
BARNES & Co., PRINTERS, 84 PRINCE WILLIAM STREET.
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CONTENTS.

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PLATE III.

SEA-SCULPTURE AT HOPEWELL CAPE.

ARTICLE I.

NEW BRUNSWICK CAVES.

By L. W. Bailey, LL. D., F. R. S. C.

(Read December 1st, 1903 *

The literature of New Brunswick, scientific or otherwise, contains but few references to caves as occurring within its borders, a circumstance from which the inference might naturally be drawn that they do not exist. Nor is the geological structure of the country very favorable to their development; for while considerable areas are occupied by limestones, the material in which caverns in other parts of the world are most extensively developed, and the Province possesses an extended coast line open to the undermining action of the sea, the limestones lack that horizontality which is almost as important as their chemical nature in the determination of extensive underground water-courses, while a considerable portion of the coast is composed of metamorphic rocks, which are not only highly tilted, but of such a nature as to be but little affected by the attacks made upon them. As a matter of fact, therefore, the Province does not contain any caves or caverns at all comparable with those met with in some other countries. Yet we are not wholly without subterranean cavities, and some of these are by no means devoid of interest. It is the purpose of this paper to bring together, as is being done by Dr. Ganong in relation to other physiographic features of the Province, such authentic facts relating to this subject as the writer has been able to obtain.

Sea Caves.

Two sides of New Brunswick front the sea, one, the southern, fronting the Bay of Fundy, being about 250 miles in length, while

* Read previously before the Fredericton Natural History Society.

the other, commonly known as the North Shore, facing the Gulf of St. Lawrence, is in the form of a crescentic curve, which is somewhat longer. On the north the border is also a water one, that of the Bay Chaleur and Restigouche river, but is of minor importance in the present connection. The total coast line is about 600 miles in length.

On the southern coast the shore is bold, the water deep, and the action of waves, tides and currents powerful. But as a rule the rocks forming this coast are either compact and crystalline, giving to these agencies but little chance to act, or they are composed of schists dipping at high angles towards the sea and forming steeply sloping walls, from which the waves are turned back with little excavating effect. Hence, though the coast line is somewhat broken, and in places picturesque, it seldom shows much undermining, or the formation of any recesses, which can fairly be designated as caverns. An exception to this general statement is, however, to be found along certain portions of the shore, where the old pre-Cambrian schists have still resting upon them, or sloping off from them, strata of more recent age. This is to some extent true along the shores of Lepreau Basin and about Point Lepreau, and again in the vicinity of Quaco, especially about Melvin's beach, both localities being in rocks of the Lower Carboniferous system; but the most remarkable illustrations by far are those which occur in connection with the rocks of the same formation about the head of the Bay of Fundy, at Hopewell Cape. Here a series of coarse conglomerates, dipping landward at a high angle, and broken by numerous faults, skirt the shore for half a mile or more, in a series of bluffs one hundred feet or more in height, and owing partly to their exposed position, just where the accumulated energies of the bay have their maximum of power, and partly to their own nature (the loosened pebbles of the rock adding enormously to the eroding action of the water), have been carved and undermined to a degree not often equalled. Certainly no point on the Atlantic seaboard of America can show more curious or more impressive exhibitions of sea-sculpture than are to be found here. The accompanying

PLATE IV.

NATURAL ARCH IN SANDSTONE AT MIRAMICHI.

illustration will convey some idea of their character, though not exhibiting special features of caves. (See frontispiece). Of these, some are evidently the result of simple undermining; others are apparently due to the displacement and fall of large sections of rock now found piled against the more solid face-wall, but with considerable irregular empty spaces between; while in still other instances it is possible to work one's way for several hundred yards through passages shut in by rock on either side, and dark, except where at times some open space, a hundred feet or more above one's head, admits a feeble light to guide the steps. At high water and during storms the waves must be driven with great force through some of these passages, and it is probable that "spouting horns" are sometimes found, though none of these have as yet been reported.

Another tract in which sea-sculpture has produced somewhat similar results, though upon a scale of much less grandeur, is that of Miramichi Bay. Here the rocks are the grey sandstones and grits of the coal formation, and their attitude is horizontal, conditions which have elsewhere shown themselves to be favorable to cave-production; and it is no uncommon thing along the coast to find localities exhibiting overhung recesses, some of which are quite noteworthy. At times also here, as on the Bay of Fundy shore, the partial falling in of roofs of cavities, or it may be the battering action of the waves on either side of narrow promontories, has determined the formation of arches or natural bridges. One of these, occurring on Miramichi Bay, some fifteen miles from Chatham, is shown in an accompanying plate.

River Caves.

Under this designation may be included the cave-like excavations found in such proximity to surface streams as to indicate that they, in part at least, owe their origin to the action of the latter. Here, again, the most numerous and marked examples of such wear are to be found in connection with the coarse sandstones and grits of the coal formation. Thus on the Miramichi river, between Chatham and Bushville, are several places in which the bordering vertical banks of rock have been carved out into cave-like forms; but the most remarkable instances of such excavation, apparently, are some to be found upon the northwest branch of this stream. Of one of these the late M. H. Perley gave the following account in a letter to the N. B. *Gleaner,* October 4, 1845. and for a copy of which I am indebted to Prof. Ganong. He says:

"While at the Indian Reserve, near the Big Hole on the North West, I lived in a very curious and romantic cave, which has been known to the Indians for centuries, but of which I never heard until I was shown into it. The Micmacs call the place "*Condeau-weegan*"—the "Stone Wigwam." Its only entrance is from the water, under a lofty overhanging cliff. The floor of the cave is (by measurement) ten feet above the level of the water, the height of the uppermost overhanging ledge is seventeen feet above the floor of the cave; and the width of the entrance seventy feet. Above the side of the cave a clear and very cold spring bubbles up continually, and an aperture in the roof (whether natural or artificial, I cannot say,) permits the smoke to escape freely. The rocks at this place are all sandstones of coarse grit, thickly studded with angular pebbles of milky and rose-colored quartz, and the exceeding abundance of these crystals give the place the appearance of an artificial grotto. The river rushes swiftly past the entrance, standing in which some very fine trout were caught. The Indians spear many salmon at this place, and they have hollowed out a basin at the spring, in which they place the salmon. The coldness of the water keeps them fresh for two or three days."

The above account is so circumstantial, including definite measurements, that one hesitates not to accept it in its entirety; but considering the fact that the locality has been for years a well known and favorite fishing ground, it seems strange that there should exist at the present time so much uncertainty regarding it. Thus in connection with some enquiries made by me of the late Col. Robert Call, Sheriff of Northumberland county, the latter says that, although some thirty years ago he "went for fishing very often to the Big Hole, he did not remember of hearing anything about a cave" in that vicinity. He adds, however, that upon enquiry, he learned that there is a cave there, and that in it, it is said, a squaw gave birth to a child in the night of the great fire in October, 1825. Again Mr. George Brown, a resident of Chatham, and the present owner of the land and fishing privileges on the northwesterly side of the Big Hole, while saying to Col. Call that he knew where the cave is, and had been in it, felt confident, though without particular examination, that it was small compared with the description given by Perley, adding that he did not think it to be more than fifteen feet wide and six or seven feet in height, extending inwards quite a distance, and narrowing off to a point. Mr. Brown also says that he knows of another cave at the Square Forks of the Sevogle, about ten miles above the Big Hole, that the fishermen have converted into a smoke house, but this is much smaller than that at the Big Hole. Finally Dr. Nicholson, of Chatham, in a letter to Prof. Ganong, referring to the latter cave, says that it is known there, and that Perley's description is accurate.

Caves Resulting from Subterranean Drainage.

In the case of all the excavations noticed above, the results have been due almost exclusively to mechanical action, the wear of waves, tides, or river currents, and only in rare instances are the holes shut out from the light of day. We may now consider some cases which are truly subterranean, and which owe their origination not wholly, or even principally, to mechanical wear, but largely to the *solvent* power of water.

The materials capable of being acted upon by water in the way of solution to an extent sufficient to produce noticeable cavities are limited to three or four, viz., salt, gypsum, limestone and dolomite.

Where beds of rock-salt occur, their removal, whether the result of natural or artificial agencies, necessarily tends to produce cavities corresponding to the material removed; but though saline springs are found at a number of places in New Brunswick (mainly in the Lower Carboniferous system of Kings county, as near Sussex and Salt Spring Brook), no actual beds of rock-salt are known to exist, and the land in their vicinity gives no indication of the existence of considerable cavities.

In the vicinity of gypsum beds the case is different. Large deposits of the latter occur near Hillsborough, in Albert county, in the parish of Upham, in King's county, and on the Tobique river, in Victoria county; and in each of these cases the district immediately surrounding the deposits is remarkable for the evidences of removal. These are usually in the form of pits or sink holes, though subterranean passages also exist. Near the plaster beds of Hillsborough the ground is honeycombed with these vertical holes, so closely aggregated in places and with such narrow intervening walls as to make passage across both difficult and dangerous.

Mr. C. J. Osman, M. P. P., manager of the Albert Manufacturing Company, informs me that he has seen them fully forty or fifty feet deep, while in places, where they are covered with surface deposits, they are sometimes very large, extending in diameter fully one hundred feet, with a depth of forty to fifty feet. He adds that the plaster lands are covered with such depressions, and they are, without question, the result of the percolation of water through seams and fissures in the rock. These waters are sometimes seen issuing as springs of considerable volume below bluffs of gypsum rock, but as a rule the outlets are on the surface of the lower lying lands at the foot of the plaster hills. Even here Mr. Osman has found evidence of subsidence in what might be taken to be the extreme low level for drainage, and showing that there are still deeper subterranean passages. At what is known as the "Sayre quarry," where a good deal of underground work has been done, Mr. Osman has found evidences of old water-courses, which, as he thinks, must be at least sixty or seventy feet below the original water level of the little lake which is one of the peculiarities of that quarry; the water having been formerly discharged by outlets through the underlying limestone and thence to the bed of the river.

It is in connection with these gypsum deposits that the ice pits and the subterranean lake referred to by Prof. Ganong in Bulletin XXI occur, both of which have been visited by the writer, and in one of which he found several feet of snow in the latter part of July. Of the underground lake, so called, on Demoiselle creek, Mr. Osman has kindly furnished me with the following description:

"The gypsum deposit in which the depression occurs presents a high front, probably 90 or 100 feet high, of anhydrite, containing some seams of hydrous gypsum, to a very limited extent, and at the base of this wall of hard rock the little Demoiselle brook ripples peacefully along. At the back of this wall of anhydrite, more or less hydrous gypsum has been found, but not to any large extent, as immediately to the back of it red marl-like limestone and conglomerate has been exposed after limited operations; but a certain wash has taken place, or perhaps solution of the soft rock, which eventually resulted in finding an outlet for the water collected in the pocket so created through one of the seams of soft gypsum in the anhydrite wall, and eventually emptied into the Demoiselle brook, wearing away as it went more or less of the soft gypsum, and making this underground cavern probably about forty feet in width and about 200 feet in length. Without taking any levels, I think the level of the water running through this cavern is pretty nearly the same as the water in the brook, as at the point where it is deepest it is very still, although there is some current in it. Therefore, I surmise that the present source of this little basin of water is from up the brook, and that it flows in at the upper end and out to the brook again at the lower end.

"As near as I can estimate, it is perhaps fifty or sixty feet from the level of the plaster heads at the back of the hard face and down to the surface of the water in the little lake, and in reaching it the climb from the level of the brook is about the same. The whole roof of the cavern is anhydrite, and very little soft gypsum has apparently been exposed by the action of the water. Heretofore its chief interest has been its picturesque surroundings. These have been more or less destroyed by cutting of trees, and permitting the earth dumps made in quarrying plaster to run down the slope near to the little lake."

The third material favoring removal by the combined mechanical and solvent action of water is limestone or dolomite. It is in rocks of this nature, as in Virginia and Kentucky, that the most extensive and remarkable caverns of the world are to be found. In New Brunswick, limestones and dolomites, intimately associated, form extensive deposits in St. John and Charlotte counties, and have been largely removed from the time of the first settlement of the country, while in other parts of the Province, limestones, usually less pure, are met with alike in the Silurian, Devonian and Lower Carboniferous systems. In each of these, but especially the latter, caves and subterranean passages are to be met with.

Of the caves connected with the Lower Carboniferous limestones, the most remarkable known to me are found about the tributaries of Hammond River, in Kings county. One of these was partially explored by the writer, many years ago, in company with the late Prof. C. F. Hart, but beyond the fact that we penetrated several hundred feet, I am unable now to recall anything definite. Another cave, in similar limestones, was also visited by us near the Coverdale river, in Albert county, and may be specially noticed as containing bones apparently of the deer or moose, the only relics of this kind, so far as known to the writer, thus found in New Brunswick. It may be that in this same formation occurs the cave referred to in the following letter from Dr. B. S. Thorne to Prof. Ganong:

"About one and a half miles from Havelock Corner there is a stream which runs underground for about one mile, and forms 'ice caves.' My son, Dr. Van B. Thorne, a number of years ago, took a line and light and went in about 300 yards, and brought out a large lump of ice in July." He does not state the nature of the rock in which the excavation occurs.

In connection with the subject of caves in the Lower Carboniferous rocks, the mode of occurrence of the manganese deposits in Kings county, especially about Markhamville, is interesting and suggestive. Desiring some reliable data upon the subject, I applied to Col. Alfred Markham, former manager of the Markhamville manganese mines, and from him have learned the following particulars:

(1) "I have found caverns at Markhamville and at Dutch Valley, in King's county. Those explored by me were very irregular in size and shape. They had all more or less water running through them, some of them opening to the surface on the sides of ravines having small entrances and opening out into irregular chambers ten to fifty feet wide and six to twenty feet high, narrowing again into small passages, while some of them showed manganese in small irregular patches imbedded in the rock at sides, top and bottom."

(2) "Other caves were closed by earth from the outside, and were opened by my workmen in driving drifts into them in search of manganese."

(3 "I do not think that the deposits of manganese came by filling caves previously formed, because in most cases the rock surrounding pockets of manganese is impregnated with ore so intimately mixed that they must have been deposited at the same time. Yet, on the other hand, I have taken small nodules of high-class ore (pyrolusite) like taking a nut out of its shell."

(4) "I have not found any evidence to warrant the statement that manganese was deposited from an aqueous solution. I should add that the manganese oxide is not found exclusively in rock formation. I have taken hundreds of tons out of the alluvium, sometimes under more than ten feet of earth."

Regarding temperature in the caves, Col. Markham adds: "In some of the caves which I have examined, I have found ice in the month of July, and one immediately in rear of my house at Markhamville, which is a narrow slit in the rock, into which a boy can crawl fifty feet or more, delivers a small stream of pure ice-cold water all the year round, the volume of which is not much affected by heavy rains. The hill above it rises probably 200 feet in 500 yards."

This is not the place in which to discuss at length the origin of manganese beds, but the observations of Col. Markham seem to point strongly to the conclusion that they are residual deposits, not conveyed to their present site by the action of solvent waters, thus filling up pre-existing caverns, but left in a concentrated condition by the removal, through solution, of the limestone beds originally containing them, a process similar to that by which large beds of ferriferous dolomite have in some parts of the world become replaced by extensive deposits of limonite.

I am not aware of the existence of any noticeable caves or cavities in the limestones of the Silurian system. The fact, however, observed at Grand Falls, that a stream of considerable volume discharges into the gorge from the face of the cliff, only a few yards below the face of the cataract, indicates that, where circumstances are favorable to their production, subterranean channels exist.

In the pre-Cambrian limestones and dolomites of St. John and Charlotte counties, cavities of small size have been frequently laid open in the course of quarrying operations. At other points indications of subterranean cavities are to be found in the hollow sound beneath the tread of the feet, or the fact, illustrated in some of the limestone hills about Brookville, that holes exist in which, if stones be introduced, these may be found, as indicated by the sound, to drop for considerable distance before striking bottom. Prof. Ganong informs me that, as a boy, he was acquainted with a good cave in the rear of Lily Lake, near St. John, the dimensions of which he cannot now recall. But probably the most interesting excavation occurring in these limestones is that of Oliver's cave, so-called on the Sandy Point road, about two miles from

St. John. It is evidently an old underground water course, now left dry by the drainage passing in another direction, and is of considerable size, but as it is fully described elsewhere in this Bulletin, it will not be necessary to further refer to it here.

In concluding this branch of the subject, a mere reference may be made to the pot-holes found in several of our rivers, especially in the vicinity of the falls, and which, though hardly falling under the designation of caves, are of related origin. By far the finest are to be seen in the gorge of the river below the Grand Falls of the St. John, where they are of all sizes, the largest attaining a depth of thirty feet, with a diameter of sixteen feet at the top, widening at the bottom. The latter is usually occupied by rounded pebbles of hard rocks, the whirling of which by the tumultuous waters has been the main agent in their formation. On the Nepisiguit river vertical pot-holes, large enough to conceal a man, are found below the Pabineau falls, where the rock is a hard granite. On the Pollet River, near Elgin, in Albert county, the Gordon Falls have below them numerous pot-holes in Lower Carboniferous conglomerate, and evidences of subterranean currents are very noticeable.

In none of the instances of cave-formation alluded to above has any reference been made to the occurrence of statactites. Nor are these known to occur. But at certain points along the border of the Tobique river, in Victoria county, are somewhat extensive deposits of loosely branching coralloidal or statactitic limestone, of Lower Carboniferous age, while the hollow sound produced by walking over them would indicate the existence of cavities beneath. In the same vicinity are remarkable examples of fossil tree trunks, evidently petrified by the agency of calcareous solutions.

Caves or Cavities of Uncertain Origin.

Under this head I would include a number of instances in which caves or cave-like spaces occur, and which are not obviously due to the agencies heretofore described, and some of which cannot be thus explained.

Among these I may first refer to a series of so-called caves occurring along the course of Corbett's brook, a small tributary of the St. John river just below Fredericton. At the point where they occur the brook occupies a well-marked and narrow valley, both sides of which are somewhat abrupt, while that to the north is for a quarter of a mile, or more, bordered by a series of bluffs, which here and there show steep or nearly vertical masses of rocks. These are the grey sandstones and conglomerates of the coal formation, probably representing its lower member, the millstone grit. They are of course well stratified, and their attitude horizontal, a feature made conspicuous in places by the extent to which certain beds are made to project, sometimes as much as ten or fifteen feet from the general face of the rock wall. In other places large blocks of rock are confusedly piled against the same wall, as though they had been dislodged from the latter by some powerful agency. Thus a variety of cavernous spaces have been produced, now the abode of numerous porcupines, the excreta of which cover their floors. In one instance a cavity of this kind, having a small entrance, is sufficiently large within to accommodate not less than fifteen persons. Others are remarkable for their narrow cleft-like character and for their parallelism with the general face of the bluffs.

It might at first seem probable that the conditions above described would find a ready explanation in the wearing action of water, and would be comparable with those already described as due to this agency along the sea-coast. But apart from the fact that Corbett's brook is altogether too insignificant, at least in its present state, to determine much mechanical wear, it is to be noted that the site of the caves is removed several rods from the present course of the stream, besides being twenty or thirty feet above its level. The direction, also, of many of the rifts and cavities, running in for considerable distances from the face of the rock, and at right angles to the latter, is opposed to the view that running water alone has been concerned in their production. Finally it is to be noticed that at several places in the uplands to the north of the brook, and in some instances several rods distant from the latter, the ground shows narrow vertical rents or rifts, similar in character and direction to those near the brook, from one to two feet in width, and of unknown depth, but certainly twenty feet or more. When seen by the writer, in early June, they were partially filled with snow.

Reviewing these facts, it would seem probable that the projection of rock-roofs and consequent formation of grottoes, or miniature caves, to which reference has been made, may best be explained as the result of rock decay in soft, easily disintegrated strata overlaid by more massive and enduring beds, the agency of disintegration being mainly that of frost. The same explanation would account for the resting of large blocks at various angles against the rock face, they being merely masses which have fallen as their support has been removed. But for the rift-like fissures, some other explanation is required, and none seems so probable as that they are due to differential movements and possibly to earthquake shocks. As to their time of origin, it would seem improbable that they are pre-Glacial, as otherwise they would naturally be completely filled with drift—a view which is strengthened by the overhanging projections above the caves, which, under the weight of a superincumbent heavy weight of ice, would certainly have been broken off.

As connected with this subject, it is interesting to notice the evidences elsewhere observed of differential movements in the rocks of the millstone grit formation, and of extensive underground drainage as associated with the latter. For not only do faults abound, but in connection with boring operations undertaken for the discovery of coal, evidence has repeatedly been found of cavities or fissures of considerable size many feet below the surface. Thus at Newcastle, Queens county, the diamond drill, at a depth between one hundred and two hundred feet, suddenly dropped several feet, and upon withdrawal was followed by a fountain of water, several feet high, which continued to play for many months, and similar phenomena have been observed elsewhere. It has also been stated that in the vicinity of the Penniac stream, a branch of the Nashwaak, in York county, vertical holes in the Carboniferous sandstone exist of such a character as to permit of a man being lowered into them to a depth of fifty feet or more. In the Corbett's brook region, near Fredericton, but at a considerable distance from the caves described above, is a remarkable depression, the origin of which is problematical. It is said to be in the general shape of a square, with vertical rock walls or faces, each about fourteen feet wide and about fourteen feet deep. The bottom of the depression is filled with earth, on which small trees are growing.

In the fissured or cavernous-like character presented by the millstone grit formation of New Brunswick, this recalls that of the same formation in portions of Kentucky, Virginia and Tenessee, where similar holes abound in the escarpments of stream valleys, and are known as "rock-houses." There is no evidence of their having been employed in New Brunswick for human occupation, unless it be in the case of the big cave on the Northwest Miramichi already described.

I have been informed that in a deposit of apparently recent origin on the northern side of Swan Creek lake, in Sunbury county, there occur several curious holes. The bluff is about forty feet high, and is composed of a hard clay, filled with a great variety of pebbles. The holes run in horizontally at least eight or ten feet, the openings being about two feet wide. In front of these openings is a narrow ledge, or path. It is said that these holes are the homes of raccoons, and, by their appearance, they being quite round and smooth, it looks as if they had been actually hollowed out by these animals.

To the above notes may be added the following, kindly furnished by Prof. Ganong, and which may at least suggest points for further exploration:

From Mr. W. E. S. Flewelling, Waterford, Kings Co.

"A noted ice cave near the village of Waterford, where ice keeps all summer. Eight deep holes or bottomless pits two or three miles from village."

From the Postmaster at Lynnfield, Charlotte Co., N. B.

" Goat Brook is an underground stream for some distance."

From George Draper, Postmaster, Campbell Settlement, York Co.

" There is a place in Waterville that is very good limestone, and in one place there is a hole that if one throws a stone into it, they can hear it rattle down as if it went from one to two hundred feet." [The limestones of Waterville are Silurian limestones, containing remains of encrinites. The writer has examined them several times, but heard nothing of the hole referred to.]

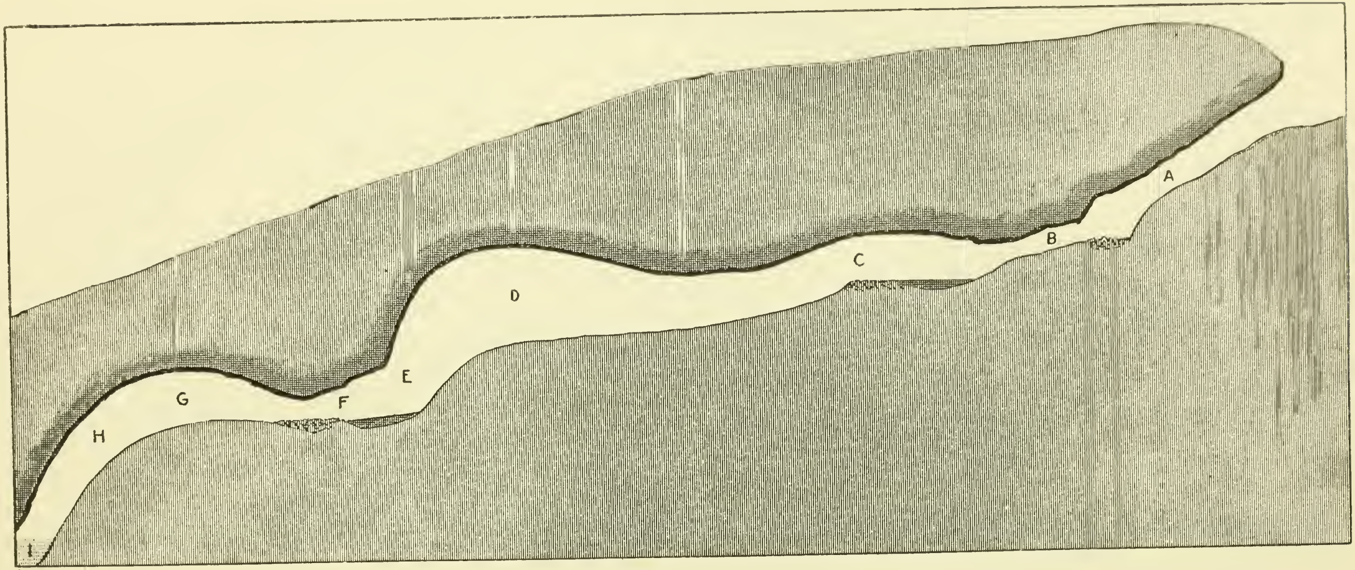
From Mr. W. R. McMillan, Jacquet River, Gloucester Co.

" There is supposed to be an underground lake or deep stream in Archibald Settlement. A number of years ago a man was digging a well, and at the depth of about eighteen feet the bottom fell out, leaving him standing on a ledge of rock. He tried a pole around, and could not reach any sides or bottom to the water. Two or three years ago, when boring for water on higher ground, about 300 yards away, a pond of water was struck at what was supposed to be the same level as the other."

From Mrs. Noble Beatty, of French Village, Kings Co.

" On the top of a mountain facing French Village there is a cave, locally known as ' Adam's Oven.' It can be entered by an opening on its side, and egress may be made by a somewhat similar opening in the top. About three miles from here, on Charles Darling's property, there is a very similar cave. It has a square entrance. The cave itself is very long, and has certainly been formed by nature."

PLATE V.



SECTION OF OLIVER'S CAVE.

Scale about 28 feet to an inch.

(A) Entrance slope.
(B) Passage to antechamber.
(C) Antechamber of main cave.
(D) Main chamber of cave.
(E) Small chamber at lower level.
(F) Low passage.
(G) Inner chamber.
(H) Slope to well.
(I) Well at end of cave, filled with water.

From the Postmaster at Lynnfield, Charlotte Co., N. B.

"Goat Brook is an underground stream for some distance."

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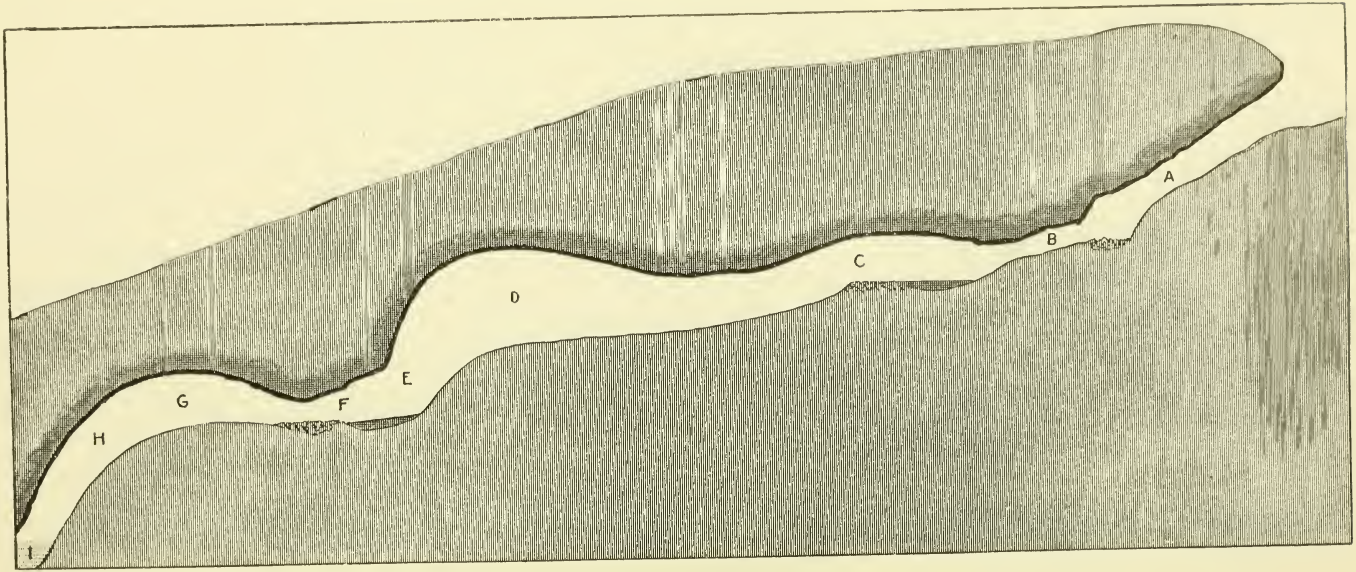

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ARTICLE II.

NOTE ON OLIVER'S CAVE.

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

Somewhere in the " sixties " the finding of a cave on Howe's (now called Sandy Point) road was announced in St. John, the discovery having been made by a man named Oliver, living in the parish of Portland (now incorporated with St. John).

At that time the Natural History Society of New Brunswick was but recently formed, and two of its zealous young members, Messrs. I. Allen Jack and Robert Matthew, undertook to explore the cave. The former of these gentlemen is now dead, and the latter, still a life member of the Society, is in Cuba. Robert Matthew, or the two, collectively, wrote an article on the cave, which was deposited with the Society (but which cannot now be found). With this article he filed a section of the cave, a reduced copy of which is furnished with this note.

In later years the entrance of this cave has been blocked up, but as the writer of this note made a visit to it soon after its discovery in company with its first explorers, he is able to describe the section, and say something about the features of the cave.

DESCRIPTION OF THE CAVE.

The entrance is in the form of a low arch, which may be noticed in the side of a low limestone ridge, that separates a shallow valley leading up to Dark lake, from the valley of Simond's brook, a small stream that discharges into the St. John river at Indiantown. This brook crosses the Sandy Point road a short distance below the site of the cave.

Descending into the cave from the entrance is a slope (A) large enough for a man to pass easily, and at the foot of the slope is a landing with a floor composed of fragments of rock that have fallen from the sides of the slope. Beyond this is a low passage (B) that gives access to an ante-chamber of the main cavern. This ante-chamber (C) has a flat floor, partly of loam and partly of rock-fragments, which have fallen from the roof of the cave.

The main chamber of the cave (D) is about sixty feet long and ten feet or more in height at the highest part. The floor of this chamber is not level, but slopes to the eastward and southward. This is the most interesting part of the cave, not only because of its size, but because of the bats which, when the cave was discovered, hung in large numbers suspended by their claws from the roof.* Another peculiarity of this chamber was the slender filaments of the roots of trees that hung from the crevices of the roof, and which were attributed to the trees which then grew in a thick wood on the limestone hill above the cave. The section prepared by Mr. Robert Matthew gives a thickness of from fifteen to twenty feet of limestone above this part of the cave, but I do not know whether the outline of the surface shown in the plan is from actual survey, or only approximated. In this chamber and elsewhere in this cave, we found stalactites and stalagmites, but these were not remarkable for their size or beauty. However, a number were collected and placed in the museum of the Society.

Beyond the main chamber is a short descent to a small chamber (E) at a lower level; the roof is hardly separated from the main chamber, and the floor is flat and covered with loam or clay. From this depressed level there extends a low and difficult passage (F), much obstructed by fragments of limestone that have fallen from the roof. Crawling through here one comes to a small inner chamber (G) that terminates in a sloping passage (H), somewhat similar to the entrance passage, but smaller and shorter.

*The species is *Vespertilio subulatus*, the Little Brown Bat.

The lower end of this sloping passage is filled with water (I), which bars any further progress in the cave. This sloping well of water was sounded with a pole, but no bottom was found. The water in the well was found to stand at the level of the alluvial deposit which fills the valley of Simond's brook at this point, and in the alluvium opposite the site of the cave is a weak spring, supposed to mark the discharge of the cave drainage.

Though there are several small passages leading out from the sides of the cave, none of these were large enough for exploration, and they seem to mark points where contributory streams may have entered the cave.

A partial examination was made of the loam which occurs at two points on the floor of the cave, for remains of man or of animal occupancy. Nothing was discovered to show that aboriginal man had ever used this cave for residence or sepulture. Nor does it seem to have been much resorted to by beasts of prey; some bones of a lamb were found, whose presence in the cave may have been due to this cause; and the thigh bone of a porcupine (*Hystrix dorsata*) was also met with. Had a skeleton of this animal been found, it would not have been surprising, as this creature is in the habit of resorting to caves and clefts of the rocks.

Origin of the Cave.

The origin of this cave goes back to an early period of Geological history, since the topography of the neighborhood has been greatly changed since the cave was formed. The cave is evidently an old water passage, worn by a strong current. That it is an old water-course is specially shown by the tunnel and well at its lower end. But now, except for this well, the cave is quite dry, and no water from a distant source flows through it.

A shallow valley coming westward from the direction of Dark lake (a small pond a few hundred yards away) runs by the mouth of the cave, but this valley is also dry, and it is necessary to postulate a barrier in this valley west of the cave's mouth, to turn into the cave any stream which might have come down this valley in former times.

That the cave is pre-Glacial in its origin is very evident since the outlet is now choked with Glacial deposits; how much older, it would be difficult to say; but at least this may be said, that the topography of the district where the cave is situated, has been greatly changed since the cave was formed.

Winter Curtain of the Cave.

Occasionally in mid-winter a striking spectacle may be seen at the mouth of the cave. The warm air flowing out of the cave condenses its moisture on the roof in a deposit of hoar-frost, that in still weather hangs pendent like a curtain from the roof at the entrance. To see this canopy in all its beauty, one needs to go inside the sloping descent into the cave and look out through the entrance on a bright sunny afternoon; the western sun then lights up this curtain so that it becomes a mass of brilliant silver spangles, which, as the sun goes down, become varied with rainbow tints. Thus cold weather, still air and a western sun, give an added winter beauty to Oliver's cave.

The following are the lengths of different parts of the cave:*

(A)	Slope at the entrance,	32	feet
	Landing at the bottom of the slope,	8	"
(B)	Passage to antechamber,	16	"
(C)	Antechamber of the main cavern (flat loam floor),	24	"
(D)	Main chamber of the cave,	60	"
(E)	Small chamber at a lower level with loam floor,	16	"
(F)	Low passage to inner chamber,	12	"
(G)	Inner chamber of cave,	24	"
(H)	Slope to the well at end of cave,	20	"
(I)	Well sloping southward, depth unknown,		
	Measured length of cave,	212	"

* These measurements are based on the plan of the cave made by Mr. Robert Matthew, which was on a scale of 8 feet to an inch.

ARTICLE III.

UPON ABORIGINAL PICTOGRAPHS REPORTED FROM NEW BRUNSWICK.

By W. F. Ganong.

Read October 6, 1903.

So far as I have been able to ascertain, there have been reported from New Brunswick only four aboriginal pictographs,* real or supposed, as follows:

(1) The pictures upon wood indicating a portage-path and a dangerous fall, described by Gesner in his *New Brunswick*, page 112. These have, of course, disappeared, and no others of the kind are known.

(2) The well-known carved stone medallion found near St. George in 1863, and now in the museum of this Society. Its origin is doubtful, and the probability is that it is not of Indian workmanship.**

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* Excluding carvings, such as that described by Dr. G. F. Matthew in the *Smithsonian Report*, for 1881, p. 672-673, with cut.

** A bibliography of this interesting relic is as follows:—

Anon. Indian Sculpture found near Lake Utopia, Charlotte County New Brunswick. *London Illustrated News*, Vol. 45, July 16, 1864, page 78, 79, with a cut of the stone. The information is given largely on the authority of Mr. C C Ward, of St. John and the stone is said to have been discovered in November, 1863.

Jack, I. Allen. A sculptured stone found in St. George, New Brunswick. *Smithsonian Report* for 1881, pp. 665-671, map and cut. This article is reprinted with slight alterations, and a good photograph of the stone, in *Acadiensis, II. 267-275*. It is also given in synopsis in the *Canadian Indian, I. 1891, 265-267*.

Adams, A. Leith. *Field and Forest Rambles, 1873*. An account of the stone is on page 34, and a cut on page 1.

Other cuts of this stone are given in *Scribner's Monthly*, Vol. 15, 465, 1878; and (the same) in Mayer, A. M. (editor), *Sport with Gun and Rod* (Century Co. 1883) 181. A photograph of a cast of the stone is in the *Report of the U. S. National Museum*, 1896, 485.

(3) A large marked boulder found on an old aboriginal camp-site at Passamaquoddy, and now in the museum of the University of New Brunswick. It was discovered and presented to the museum by myself, under the impression that it was a genuine Indian relic, and an account of it, with illustrations, was published by me in the *University Monthly* for March, 1885. But I am now perfectly convinced that the markings are of glacial origin, for they are precisely of the character shown by many glacial boulders.

(4) A carved sandstone boulder on the Oromocto river reported by Mr. C. W. Beckwith, as recorded in the *Transactions of the Royal Society of Canada,* V, 1889, section ii, 228. It was described as situated about a mile above the mouth of Lyons stream, and as having cut upon its surface "a plan or map, apparently answering to the forks of the Oromocto River, with curious figures; some that appeared to indicate men and arrows pointing in different directions. . . . . There were no letters, and it did not appear to have been made by a civilized being, but looked to me like some old Indian landmark." He adds details as to its location and appearance. In July last, while descending the Oromocto in company with Dr. Hay, we made careful search for this stone, examining every large boulder along the river from near Otter Brook to Lyons Stream. In about the position described by Mr. Beckwith we found a boulder, or, rather, a portion of semi-detached ledge, answering in some respects to his description, but it bore no markings. About one-third of a mile lower down, however, we found another boulder answering even more closely to his description, except that it was some distance out from the bank, and upon this were markings of the character described by him. They were, however, so faint that we missed them upon a first search, and only found them on the almost microscopic search of a second visit. The markings, however, are true glacial or ice scratches, readily resolvable by fancy into arrows and other figures. One of the lines, no doubt that taken by Mr. Beckwith for the Oromocto, is somewhat sinuous, rather

PLATE VI.

PICTOGRAPH (?) FROM FRENCH LAKE.

an unusual feature in glacial scratches, but there can be no doubt as to the entirely natural origin of them all.

Curiously enough, it was upon this same journey that we discovered certain rock-markings which may represent a genuine aboriginal pictograph. While endeavoring to locate the site of the old French settlement on French lake (of Oromocto), we were told of two smooth boulders near by bearing figures carved by Indians. One of them has been built into the chimney of the neighboring mill, and cannot be seen; but the other was pointed out to us upon the shore of the lake, and we made a careful examination and photographs of it. It lies on the south beach of the lake, about 200 yards to the eastward of the ruins of Hilliard's mill, and somewhat above the summer water-level. It is of fine-grained sandstone, with a smooth, slightly rounded, surface, some two by three feet in area. Cut into this surface are three distinct figures, which I went over carefully with chalk, and then photographed, with results shown by the accompanying figure. At first glance we were inclined to reject the local theory that these were Indian carvings, or indeed had any artificial origin at all; but the more we studied them the more possible did it seem that they may be of Indian origin. If so, they would appear to represent Indian totem or tribal signs, carved, perhaps, by Indian youths in moments of leisure, just as our young people carve their names upon prominent places, where the rock is soft enough to allow it. Upon the whole, however, I am inclined to doubt their artificial origin. Despite the remarkable resemblance of one of the figures to a human form, and of another to a stretched beaver skin,* I think it possible, or even probable, they are but a natural freak in the weathering of the rock. If a carving, the work must have been done with a very hard-pointed instrument struck by a heavy mallet, for the figures

* In this connection, it is interesting to note the following passage in Levinge's *Echoes from the Backwoods*, (London, 1846) I. 103. "The *totem* of the Milicete is the beaver, and a member of the tribe who wished to designate himself would first sketch the figure of the beaver, and then place beneath it his own peculiar *totem* or crest, such as the hawk, or pigeon, the mink, eel or salmon."

are composed of deep pittings, and are not smoothly rubbed in. Again, although these are the only areas of the pittings of any size upon the stone, there are some scattered pittings of the same character, which is to be expected if they are natural, but not if they are artificial. I commend the stone to the study of those learned in such matters. It would not be difficult to secure its transport to a museum.

ARTICLE IV.

NOTES ON THE NATURAL HISTORY AND PHYSIOGRAPHY OF NEW BRUNSWICK.

By W. F. Ganong.

70.—On the Physiographic History of the Upsalquitch River.

Read December 2, 1902; re-written March, 1904.

In August, 1902, in company with Mr. M. I. Furbish, I descended the Upsalquitch River from its head in Upsalquitch Lake to its mouth, and made some observation npon its physiography, as recorded below.

First we note the development of our knowledge of the river. On the maps of the French Period only its mouth is shown; its upper waters appear as crude sketches on maps by DesBarres (1780), Bouchette (1815), and others, down to 1820 (or 1821), in which year it was surveyed from its mouth to near the lake by Deputy Surveyor McDonald, whose plan is the original of all later maps to the present. The lake and a few miles of the river were sketched by Berton in 1837, and this sketch was pieced to McDonald's plan to give the representation of the entire river upon the maps of Saunders, 1842, Wilkinson, 1859, and others, which, however, place the lake too far east. This was corrected by the County Line survey of 1872, which gave another sketch of the lake, but the latter was only surveyed for the first time in 1902, as recorded in Note 65. Turning to scientific knowledge of the river, there is little to note. In 1839, Wightman, determining elevations with mercurial barometers for use of the Boundary Commission, descended the river to opposite the head of Jacquet River, to which he portaged, returning apparently by the Tetagouche, but unfortunately few of the localities measured by him can be identified. In 1864 Hind descended the river, making the notes upon its geology recorded in his well-known Report of 1865. It was next studied by Ells in 1879, whose observations, in the Report of the Geological Survey for 1879-1880, gave us our present knowledge of the geology of that region. It was ascended by Mr. Chalmers in 1884, for the study of the surface geology of the region, and his observations are in the Report of the Geological Survey for 1885. In 1900 a collection of mammals was made at Grog Brook Lake by Thaddeus Surber for the Field Columbian Museum of Chicago, as described in Publication 54, 1901, of the museum. Our knowledge of the elevations along the river is given in Note 62. Its economic history is very brief. It is a rich lumbering river, and much lumbering has been done upon it for more than a century, but it is settled only for some ten miles above its mouth. Sportsmen have visited it frequently, but the only published account of a trip along it that I have found is the very brief one by Dashwood (Chiploquorgan, 40), who ascended it in 1863, and portaged from the west branch to Tobique. The same route was followed by Mr. W. H. Venning on one of his trips, as he relates in Forest and Stream, January 10th, 1903.

The Upsalquitch River* heads in the charming Upsalquitch Lake, which I have described in Note 65. In that and an earlier note (No. 33) I have expressed the belief that Upsalquitch Lake represents only a recent (perhaps post-glacial) head of this river, and that its morphological head, that which it had originally, was in the Main South Branch of Nepisiguit. This implies that the Nepisiguit River from Silver Brook downwards, and from somewhere near Mount Denys upward, originally formed branches of this ancient river, which we may call the *Upsalquitch-*

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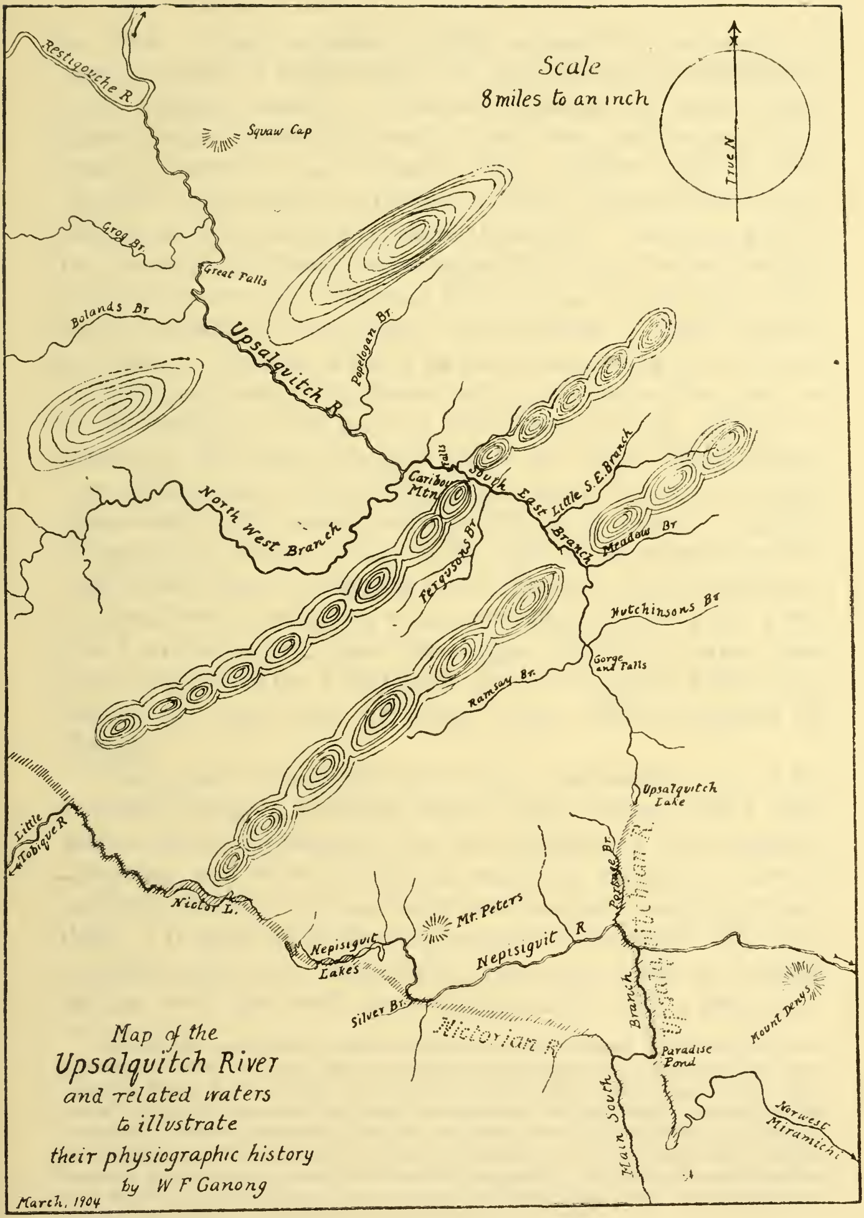
* Corrupted from the Micmac *Absetquetch*, said to mean *a small river* (viz., in contrast with the Restigouche, much as we commonly use Little River). It first appeared on Van Velden's map as *Upsatquitch*, which was copied upon Purdy's map of 1814 in its present form, apparently by a simple misprint of the *l* for a *t*. But this form persisted upon all maps, apparently without exception, to the present, and has determined the present literary (school, tourist, and other map-using public) pronunciation. Locally, however, by Indians, lumbermen and others, the *l* is rarely, if ever, heard, the river being called *Apstegouche*, *Absequish*, etc. The names of the various branches are mostly for the various lumbermen who first operated upon them, except Popelogan, which is said by the Indians not to be Micmac, and which was perhaps given by some early American lumbermen for one of the places of that name in Maine, or southern New Brunswick.


Scale
8 miles to an inch
True N
Restigouche R.
Squaw Cap
Grog Br.
Great Falls
Bolands Br
Upsalquitch R.
Popelogan Br.
Falls
Caribou Mtn
South East Branch
Little S.E. Branch
North West Branch
Fergusons Br
Meadow Br
Hutchinsons Br
Gorge and Falls
Ramsay Br.
Upsalquitch Lake
Little Tobique R
Nictor L.
Nepisiguit Lakes
Mt. Peters
Nepisiguit R
Portage Br.
Silver Br.
Victorian R
Branch
Main South
Paradise Pond
Mount Denys
Norwest Miramichi
Map of the
Upsalquitch River
and related waters
to illustrate
their physiographic history
by W F Ganong
March, 1904

ian River. This conclusion is fully sustained by the studies of 1903, described in a later note (No. 77), but with a modification there indicated, namely, it was not originally the entire South Branch which formed the head of this river, but the part of it from its mouth to near Paradise Pond, together with the continuation of that valley southward, the latter part being now occupied by the head of the Northwest Miramichi. The upper part of the present South Branch seems originally to have formed the head of a distinct river, the Nictorian River (Note 77), though it early became united with the present South Branch. These relations are shown by the shaded bands on the accompanying map. There are still two points to be determined in this connection; first, as to the location of the head of the easterly branch, which was possibly in the narrow-walled valley a little above Mount Denys, (or perhaps nearer Indian Falls), and second, the period at which these waters were turned down the Nepisiguit, whether in glacial or pre-glacial times. So low is the drift barrier separating Portage Brook from Upsalquitch Lake (Portage Brook could now be turned into Upsalquitch by an excavation of only a few feet), that I am inclined to think these upper Nepisiguit waters must have flowed into the Upsalquitch up to the glacial period, and that it was some form of glacial action which produced the change.*

The present Upsalquitch is the only considerable river of the Province having a northerly flow, a phenomenon with a well-known glacial explanation (viz., the tendency of the southward advancing, and of the northward retreating, ice-sheet to dam up northerly flowing rivers and send their waters in southerly directions). It issues from the deep valley of Upsalquitch Lake over a typical drift dam. Immediately, the valley opens out greatly, and the river, here very small, wanders about with a gentle cur-

*The change could not have been simply due to the damming of the Portage Brook-Upsalquitch Valley by glacial drift, for this would necessitate a post-glacial outlet to the eastward, which does not exist. The change appears rather to have been of an "inter-glacial" character, such as is being found to account for the peculiarities of valleys in New York State. Another possibility is that the advancing ice-sheet coming from the north, at the opening of the Glacial period, blocked and dammed the Portage Brook valley, sending the upper waters over the lowest outlet, which happened to be at the eastward, and that those waters kept that direction as a sub-glacial and inter-glacial river, thus cutting out a valley much larger and riper than a post-glacial valley could be.

rent over drift in a flat country, at times almost smothered in alders, for some six miles. Then, for some two miles it is more rapid, its bed is rougher, with some ledges, until, eight miles from the lake, it plunges into a typical, post-glacial gorge two miles in length, in which the water, by a series of falls and rocky rapids, drops some 150 feet.* In the gorge are two sets of beautiful falls, one near the head of the gorge, of some three or four irregular pitches, in all about forty feet, and another, a quarter of a mile lower down, also of some three or four pitches, an upper nearly vertical of twenty feet, and a lower, also vertical, of ten feet. The walls are here very steep and close together, and with their summit of forest present a wild and beautiful aspect. Altogether the gorge and falls deserve to rank among the finer of the Province, although, owing to the small size of the river, they are surpassed in magnitude by several others. The preglacial channel appears to have been on the west bank, perhaps into the present Ramsay Brook.

The river issues from this gorge just above Ramsay Brook, but not as above into open country. On the contrary, it runs over a very rough bed in a deep, winding, narrow valley, cut 300 or 400 feet into a plateau country, to a mile or more below Meadow Brook, where the valley, at the place marked as Devonian on the Geological map, abruptly opens out. This part of the valley just described is much like parts of the Nepisiguit, the Little Southwest and the Northwest Miramichi, though somewhat less extreme in its characters, and without doubt the same explanation, whatever it may be, applies to the origin of them all.

After issuing from the deep valley a mile below Meadow Brook, the river, now rapidly increasing in size, winds about with a smoother current through a wider valley, and develops a considerable flood-plain, including many fine, though small, intervales. The hills, evidently the cut edge of a plateau, are back from the river and more rounded and less lofty than above, and

* Hind (Geological Report, 1865, 129) refers to the gorge and falls, and makes the river fall 420 feet, while Ells (Geological Report, 1879-80, 3 D) makes it 130 feet. I did not measure it, but think it must be greater than Ells makes it, because I made the lake 864 and Ramsay Brook 527 feet respectively above the sea, while the drop from the lake to the gorge is not very great.

this character continues to the Falls, two miles above the Forks. Here the river drops over a symmetrical stair-like fall of some four or five steps, navigable with some difficulty for a canoe. Just to the westward of the Falls rises Caribou Mountain, a prominent bare mountain, some 750 feet above the river, and 1,100 feet above the sea, from which a grand view of all the surrounding country can be obtained. On ascending it, one finds that it is but part of a marked and lengthened range running almost exactly southwest (true) with many abrupt rounded summits, presenting all the aspects of a typical intrusive ridge. Moreover, the same range can be traced to the northeast across the river, where it is equally lofty, though less abrupt.* Now this mountain is composed of felsite, and it is a part of it which here forms the fall in the river. In this prominent range, accordingly, we appear to have a great ridge or immense dyke of intrusive felsite, forming so marked a feature of the topography of this region, and a band showing this formation should be inserted upon the Geological map.

This range in its far westward extension is the same abrupt range of rounded summits, I believe, as can be seen from the top of Sagamook, off some eight or ten miles a little to the west of North (true), and it may even continue somewhat beyond, and form a part of the watershed between the Little Tobique and the Northwest Branch of Upsalquitch. From Caribou Mountain there can also be seen off to the southward, some four or five miles away, another parallel and similar range of hills, evidently the so-called pre-Cambrian band marked on the Geological map; this range extends northeastward into some very lofty hills, and southwestward into a general mass of elevated country, with some marked peaks, continuous, I believe, with the range ending in Mount Gordon or Nictor Lake, and perhaps extending beyond along the Geologists' Range. Between these two ranges, the country marked on the map as Silurian is much below their level and somewhat flat. Furthermore, off to the northward, some five or six miles away, rises a lofty smooth-topped ridge, which

*Ells (Geological Report, 1879-80, D, 37) refers to this mountain, but he did not ascend it, and he considered the felsite area as detached and of small extent.

falls away on the westward before reaching the river, and this, although much more regular in outline than the Caribou Mountain range, is, I think, probably also another parallel felsite range.* It appears to cross the river half way between Popelogan and Boland's Brooks, and to form in its southward extension the divide between the West Branch and Boland's Brook, and the course of the West Branch is apparently determined by erosion of the softer rocks between these two parallel ridges. Felsite dikes cross the river at several points lower down the Upsalquitch at places marked on the Geological map, and again at three different points not marked on the map, below the Great Falls. All of these dikes have a general northeast and southwest direction, indicating an extensive series of these parallel bands of felsite, and erosion between them has probably determined the dirction of the branches of the river. From the top of the mountain one can follow the valley of the Upsalquitch far to the northward, where it appears as a broad, shallow trough (narrowing where crossed by the felsite dikes), into the centre of which the river is cutting a deeper channel. It is plain that the Upsalquitch river must be very old, not only because of the breadth of this trough-like valley, but also because of the way it cuts across the felsite ridges; it must have been formed before the country was carved down

* There is a lofty round-summited intrusive looking ridge, which is very probably of this same character, running northeast from Mount Peters, which may be continuous with Naturalists group near Upsalquitch Lake in that direction, and with Teneriffe, or the Green Range, Winslow, and possibly even with Matthew and Bald Head, to the southwest. The presence of this series of northeast and southwest parallel ridges, with Silurian rocks, in part, at least, between them, is quite in harmony with, if it does not actually substantiate, Professor Bailey's views as to the geology of the Tobique-Nepisiguit region. (See his "Notes on the Highlands of Northern New Brunswick" in this Bulletin, V. 83). The ridges might be of late or post-Silurian intrusive felsite forced up among, and in some case forced over, the Silurian strata. The fact that Silurian rocks occur between the ridges farther north, makes it the more likely that the same is true in the Tobique-Nepisiguit country.

It is possible this system of parallel ranges may be traced a little farther. One may find some evidence for one of them in the line of Missionaries Range, LaTour, Wightman, Feldspar Mountain, and Mount Edward, and perhaps another in Mount Denys, Cartier, Raymond, DesBarres, and perhaps Nalaisk, but it must be admitted that they are not very distinct, and their existence is perhaps doubtful. An attractive feature about this extension of the ranges is the clear explanation it gives of the origin of the Nepisiguit above and below Portage Brook, for it would make these parts strictly homologous with the branches of the Upsalquitch farther north, such as Ramsay Brook and Hutchinson Brook, etc. But this subject needs more study.

between the dikes, viz., when both hard dikes and softer rocks all stood at one level above the present ridges, which is precisely what the peneplain theory requires. Then in course of time the softer Silurian rocks would be carved out between the harder ranges, determining the courses of the larger branches, and leading to the present condition.

Resuming our course down the river, the valley continues of the open-flood-plained type, and the river swift, but smooth, for two miles to the junction with the Northwest Branch. We did not ascend this branch, which looks alluring enough at its mouth, but we have been told by those familiar with it that it is the finest in all respects of the two branches, being easy of navigation for a great distance, and very charming in scenery.* Indeed, from the descriptions, I would infer that there is very much the same difference between it and the much more broken east branch, that there is between the Little Tobique and the Right Hand Branch of Tobique. This resemblance is not accidental, but in a sense genetic, for the west branch of Upsalquitch flows in the same kind of Silurian rocks, and is probably of the same age as the Little Tobique, while the east branch of Upsalquitch and the Right Hand Branch of Tobique flow across bands of older and harder rocks, and are likewise probably of the same age.

Below the Forks the Upsalquitch is a large and very charming river, of grand scenery, swift and abundant clear water affording ideal canoeing, extensive intervales, and all the beauties characteristic of the best of our New Brunswick rivers. As to its size, this surprised us from far up in its course; it is a far larger river than the maps give any idea of, and than its appearance at its entrance into the Restigouche implies. The valley continues broad and open for a few miles, to below Popelogan Stream, and then it appears to narrow somewhat, and low banks appear nearer the stream. This character becomes more marked in descending until the river comes to run in a deepening and

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* An old portage route is said to have existed from this branch to the Nictor [Tobique,] which it apparently reached a few miles below the lake at the big bend. [Dashwood, Chiploquorgan, 41, and Venning in Forest and Stream, Jan. 10, 1903, page 32.] The portage from the lake to Portage Brook is described in Note 65.

rather steep-banked, though still somewhat mature, valley, closely resembling the valley of the main Restigouche. This is, I think, without doubt, due to a fact suggested by the appearance of the valley from Caribou Mountain, namely, the modern river is cutting down below the bottom of its old trough-formed valley. The fact that this river, so closely resembling the Restigouche, is doing this, suggests that the Restigouche itself is in reality a rejuvenated stream at the bottom of a wide trough valley, a subject needing farther study. The river continues of this general character to the Great Falls, below which it opens out again into a broader valley. The Great Falls, an irregular rapid easily run in canoes, is clearly post-glacial with the pre-glacial valley cutting across the bend on the right bank. Below this, three dikes of felsite are passed, high terraces appear, and the uppermost settlements are met with; finally the country opens out, estuary-like, and at length the Upsalquitch, by a narrow mouth, joins the Restigouche.

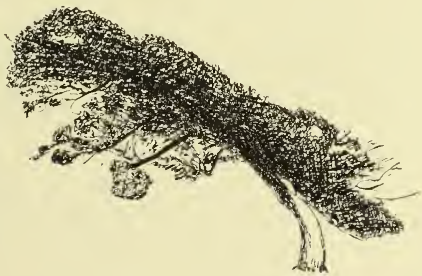
Viewing now the probable physiographic origin of the river as a whole, we have an origin and history, I believe, in general much like that of the Tobique (Note 45). The true head of the river lies south of the Nepisiguit, in the crystalline rocks forming the central watershed, and must have been formed at the same time with the Nictor and Right Hand Branch rivers, on the surface of the oldest of the two peneplains, into which, I believe, New Brunswick was formerly carved. It then followed the general slope of the great peneplain northward along approximately its present course, and probably originally flowed into the St. Lawrence by the course either of the Metapedia, or, more probably, by the Patapedia. When the country was elevated and stood at the level determining the second peneplain (the boundary between the two lying a little north of the lake) it kept its course, but carved its way down into the plain, (the Restigouche forming at this time and turning it into Bay Chaleur), reaching the harder felsite ridges and cutting into them, and carving out the softer rocks between; this continued until the soft rocks were carved to near the present general level of the Silurian plateau, and the rivers ran in broad, shallow troughs. Then came the elevation which permitted the rejuvenation of the streams and their cutting below the trough of the older valleys, which process is still in progress. Finally came the glacial period, which beheaded the Upsalquitch, and turned it out of its course in places, as we find it at present.

71.—On Some Peculiar Tree Forms Found in New Brunswick.

Read April 7, 1903.

In earlier notes in this series (Nos. 22 and 27), I have called attention to some remarkable tree forms, with their causes, noticed in New Brunswick, and to these the three following may be added. The illustrations are in every case traced carefully from photographs, and hence are approximately accurate.

The first of the three figures represents an apple tree, ten feet high, standing near the shore of Rougie Bay, near Waterside, in Albert County. A low valley extends thence through Shepody, and through this valley the southwest winds, sweeping up the Bay of Fundy, rush with great force for most of the summer. The winds in this region are strong, for very much the same



reason the tides are high, namely, the Bay of Fundy is funnel-shaped, causing a concentration of both water and air currents, with an intensification of both. The tree here figured is not only bent mechanically to leeward, *i. e.*, the northeast, but it is also aborted (by hindrance to growth and death of branches through excessive transpiration) on the windward side, and it is to a combination of these causes that such tree-forms are due. This is the most extreme example of wind-effects that I have myself seen, nor have I found any better described in the literature of the subject.

The second figure represents a spruce, which I photographed some years ago on White Head Island, Grand Manan. The bank here is rapidly washing away (no doubt because of a progressive sinking of the coast), and this had evidently deprived the tree of support when very young. It has accordingly sunk down, at the same time bending geotropically upward, until it now rests against the bottom of the bank, while the main root ascends vertically upward for some six feet (the tree itself being about that height), and then bends over horizontally into the soil at the top of the bank, the present approximate outline of which is shown by the curved line. Whether or not the tree has taken root also in the bank at the base, my notes unfortunately omit to state. This case shows two interesting facts; first, that the washing away of the banks must be at times very rapid, (though apparently intermittently), and second, it shows that woody plants must retain their powers of geotropic bending much later than is commonly supposed, and than the nature of the tissues would lead us to expect.

The third figure represents a form of spruce very common on the elevated open barren plateaus just east of the valley connecting the Nepisiguit and Upsalquitch. All such trees, which grow only to about ten feet in height, show a lower very dense part extending up a foot or two from the ground, a living pyramidal rather close top, and a branchless bare trunk between. This form is due, I think, to the following causes. Growing as these trees do in the crevices of the rocks of windy bare plateaus, they must at times, especially on the bright, warm, windy spring days, be subjected to an intense transpiration when the water supply is very limited, or, in the early spring, still frozen, and hence unavailable. At this time the lower branches are protected from excessive transpiration by the snow covering, and in

part by their proximity to the ground, and hence are preserved. The new branches at the top, while very short and compact, are able to obtain a sufficiency from the stem, but as they grow longer they obtain their supply with more and more difficulty until they finally perish, thus producing the advancing bare area behind the young tip. The result is probably purely a physical result of the attendant conditions, with nothing in it of adaptation.

72.—The Location of the Highest Land in New Brunswick.

Read October 6, 1903.

Every New Brunswicker must have a desire to know where in the Province lies the highest point above sea-level; and the subjest is one also of considerable topographical and physiographic importance. Yet up to the present time it has been impossible for anyone to say where that point is. Such study as has been given to the matter has seemed to show, as recorded in earlier notes of this series (Nos. 5, 19, 25, 34), that Big Bald Mountain, on the South Branch of Nepisiguit and Mount Carleton, three miles south of Nictor Lake, are the two highest mountains of the Province; but it has been uncertain which of the two is the higher, though the evidence seemed to favor the former. Now, however, as the result of measurements made during a recent visit to Big Bald in company with my friend, Professor A. H. Pierce, I am able to definitely settle the question as to their relative heights.

Before presenting the new facts, however, we should note the evidence for the published heights of these two mountains. The height of 2,675 feet recently given for Carleton rests upon aneroid measurements made by myself in 1899 and in 1902 (Notes 25, 34, 62). The height of 2,700 feet commonly assigned to Big Bald, was first attached to it upon the Geological map, published in 1887 (or 1888). Now this map for the Big Bald region is based solely upon the observations of Dr. R. W. Ells, who was there in 1880, but it is a curious fact that in his report he gives the height of the mountain, presumably as the result of a single aneroid measurement, as 2,330 to 2,430 feet in one place (Report 1879-80, 32D), and 2,500 in another (35D), but nowhere as 2,700 feet. In answer to my question, as to the cause of the discrepancy between report and map, Dr. Ells, as earlier noted (Note 5), disclaimed responsibility for the greater height given on the map. Later, however, Dr. Chalmers wrote me that he had made the mountain over 2,700 feet, as a result of the re-calculation of Ells' data (Note 25), whence I conclude that Dr. Chalmers is authority for this height on the map.

Our measurements of Big Bald were made on August 22, 23 and 24, 1903, and consisted of six independent observations made exactly synchronously with the regular barometric readings at Fredericton and Chatham. The instruments were the two excellent aneroids, used with precisely the same precautions as to correction for index error, temperature and weather, as previously described (Note No. 53), and the results were calculated in the same manner from the same tables. One of the readings was rejected because of a thunder storm prevailing at the time, and the other five corrected from the Fredericton base gave 2,373, 2,341, 2,364, 2,331, and 2,345, averaging 2,351 feet above sea level. The five corrected from Chatham gave 2,272, 2,292, 2,250, 2,235, and 2,250, averaging 2,259. The cause of the discrepancy in the results calculated from the two bases will be noted later (Note 76), as will the reasons why greater weight must be given to the Chatham than to the Fredericton results. The height must, therefore, fall in the vicinity of 2,300 feet, and under rather than over that figure. Thus Big Bald is proven to be very much lower than Carleton.

So unexpected and altogether surprising is this result that it will naturally be questioned. It may be argued that my figures are somewhere in error; but not only were they all made with a care commensurate with the interest and importance of the problem, but they are all consistent with one another, and could hardly all be in error in the same degree. Again, it may be assumed that my instruments are out of order; but not only were they carefully compared with the standard mercurial barometers at Fredericton and St. John, both before and after the journey, and the index errors taken into account, but also they are the same instruments used in precisely the same manner as for the determination of the height of Mount Carleton, so that they are at least conclusive as to the relative heights of these two mountains. Further, certain measurements which I made this year of the surface of Nictor Lake gave results in close agreement with those of previous years. Allowing, however, the greatest possible error under the circumstances, it could not bring Big Bald up to 2,400, nor Carleton down to 2,600, so that Carleton still is to be ranked as much the higher.

There is, furthermore, other evidence confirmatory of this height. Big Bald rises from the bed of the South Branch, on its south side, less than 600 feet, according to our direct measurements. Now, we found the South Branch some four miles north of the mountain to be, as a mean of two measurements, just under 1,600 feet in elevation. The current of the river between the two places is very gentle, largely stillwater, and it cannot fall 100 feet. On a liberal estimate, therefore, the height of the mountain would not exceed $1,600+600+100=2,300$ feet. That the mountain does not really rise more than to this height above the river is evident at a glance to anyone accustomed to the measurement of elevations. While very conspicuous from parts of the surrounding region, because of the contrast of its bold, bare summit with the wooded hills in the vicinity, it is, so far as height is concerned, a very disappointing mountain to visit, and it is certainly somewhat surpassed in height by other wooded hills in the vicinity. That it has come to be accepted as the highest in the Province is due, of course, first of all to the error of the Geological map, but this has been aided by a common psychological phenomenon, namely, the tendency in the minds of men to attribute remarkable properties to that which is remote and of difficult access. Big Bald is in the very heart of the New Brunswick highlands, and there is no spot in the Province more difficult to reach; hence it is easy to imagine it is also the highest place.

Mount Carleton is, therefore, the highest land in New Brunswick which has been measured. The Province is now sufficiently well explored to make it seem certain that in none of the less known parts can any mountain exist equalling it in height. The highest point of land in New Brunswick may, therefore, be accepted as the summit of Mount Carleton.

73.—The Physiographic History of the Oromocto River.

Read November 3, 1903.

One of the most remarkable of New Brunswick rivers, both in its own features and in its relations to neighboring waters, is the Oromocto. In July last, in company with Dr. G. U. Hay, I visited the Northwest Oromocto Lake and descended the Oromocto River to its mouth in the St. John. The observations I was able to make, together with certain conclusions drawn from them, are presented below.

The development of our knowledge of the river may be briefly traced. As it formed a part of an important ancient Indian portage route from the St. John to Passamaquoddy and the Penobscot, it was early know and markedon the maps. It is indicated, as *Ramouctou,* crudely on the Franquelin-de Meulles map of 1686, and is given with remarkable accuracy on the still unpublished de Rozier map of 1699, which, with many others later, call it the *Medocta.** Its modern representation begins with a fair sketch on Sproule's map of the southwest part of the Province, of 1786,** in which the lake is probably represented from a sketch by Lieutenant Lambton, who crossed it in his winter trip from Fredericton to St. Andrews in 1785, while the lower part up to the Forks is laid down from surveys made in connection with Loyalist land grants. The Northwest Lake was carefully surveyed in 1831 by O'Connor, whose very detailed map is the original of all down to the present, including that accompanying the present paper, the topography of which is photographically reproduced from an exact tracing of his original manuscript.***

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* An error of which the origin is explained in Trans. Royal Soc, Canada, II, 1896, ii, 250; III, 1897, ii, 372.

** Published in Trans. Royal Soc. Canada, VII, 1901, ii, 412.

*** The Magaguadavic on this map is reduced photographically from the very detailed and accurate map made in 1797 for the International Boundary Commission, of which the original Ms. Field-book is now in possession of Rev. Dr. Raymond, of St. John, to whom I am indebted for its use. The old Indian portage path, now apparently unknown locally, is marked at two ends very accurately on these two maps [O'Connor's and the Survey of 1797,] and its intermediate course may be inferred from the fact that itmust have followed the low place in the ridge a little north of a direct line between the two ends. It is of interest to note that by far the finest camping place on the lake is at White Sand Cove, near the Oromocto end of this portage. For other facts about it, consult Trans. Royal Soc. Canada. V, 1899, ii, 241. A reported Indian carving from this river was found by us not to be genuine, The Northwest River from the Forks to Lyons Stream was surveyed in connection with land grants prior to 1810, but the part from Lyons Stream to the lake has not hitherto been surveyed at all, and I had the pleasure of making a traverse survey of it during our trip, the results of which are given on the accompanying map. The South Branch and Back Creek were surveyed prior to 1800 in connection with land grants, and the south Oromocto Lake and stream were sketched somewhat later.

The river was settled from its mouth to the Forks by Loyalists in 1784-86; by their descendants up the South Branch to Back Creek, and up the Northwest towards Lyons Stream prior to 1810; the western shore of the Northwest Lake was settled by an expansion from Harvey settlement after 1837, and later immigrants after 1840 have settled between Back Creek and the South Branch, and a few settlers live near the South Lake. The remainder of the river, including the east and south sides of the Northwest Lake and the river to Lyons Stream, and most of the South Lake, with the South Branch from near Back Creek, are still unsettled forest. Much lumbering was formerly done on the lakes and river, especially in the years from 1830 to 1865, but it has now ceased.

Turning now to scientific knowledge, we find that the geology of the basin, which is of carboniferous conglomerates and sandstones, and comparatively simple, was first observed, and was known in general to Gesner, who mentions it briefly in two of his Reports. The geology of the vicinity of the Northwest Lake was

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Consult an article "Upon Aboriginal Pictographs Reported from New Brunswick" in this Bulletin.

The local pronunciation of the name of the river is *Erramucta*, which must be an old form, since it is found practically thus, *Erramouctau*, on Allen's map of 1786 (Trans. Royal Soc. Canada, VII, 1901, ii, 264). Of other names, *Kelly* and *Bedford* [Tracey] are said to be for early lumbermen, as doubtless others are also. The names on the maps are those commonly in use by those who know the river, while certain of O'Connor's names not now in common use I have put in brackets. *Indian Point* is explained by a local legend, to the effect that an Indian having stolen a girl on the St. John was fleeing by the portage route to Penobscot when he was overtaken and shot by her relatives on this point; but another tradition derives it simply from an Indian camping place in the cove near by.

For very much local information about the lake and river I am greatly indebted to Mr. Thos McFarland, of South Tweedside, as well as to Mr. C. L. Tracy, of Tracy Station, and to Mr. William Clark, of Flume Ridge. I have obtained from them much more information than I have used in this article, but which will appear later in another connection.

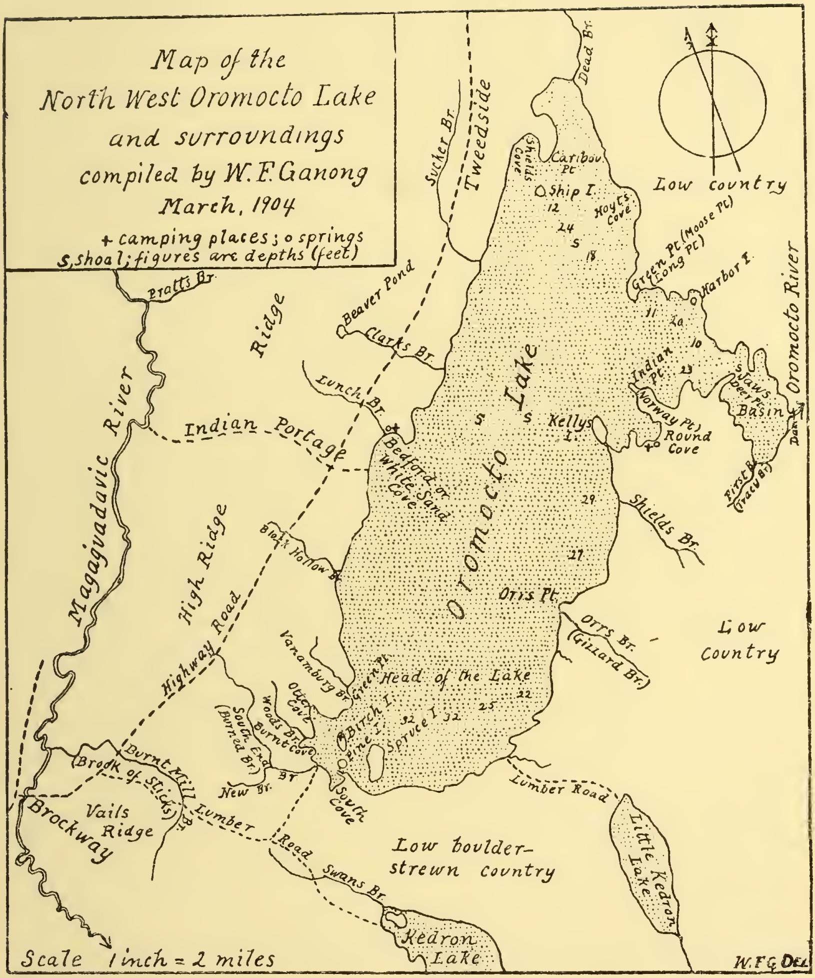
first studied with some care and described by Charles Robb in 1868. (Report of the Geological Survey for 1866-69). Studies of other parts of the basin have been made by Bailey, Matthew and Ells. (Reports of the Geological Survey of Canada, 1870-71, 1872-73, and 1878-79 D). The surface geology of the lake has been described from a visit in 1883 by Chalmers (Report of the Geological Survey of Canada, GG, 1882-84) who gives also an appreciative account of the scenery, especially towards the north. No studies of any kind upon the natural history of the basin appear to have been made prior to our trip. I understand from Dr. Hay that his observations of the plants along the river showed only the common plants of New Brunswick, with none especially noteworthy.

Our study of the river shows that it falls naturally into six sections, which I shall consider separately.

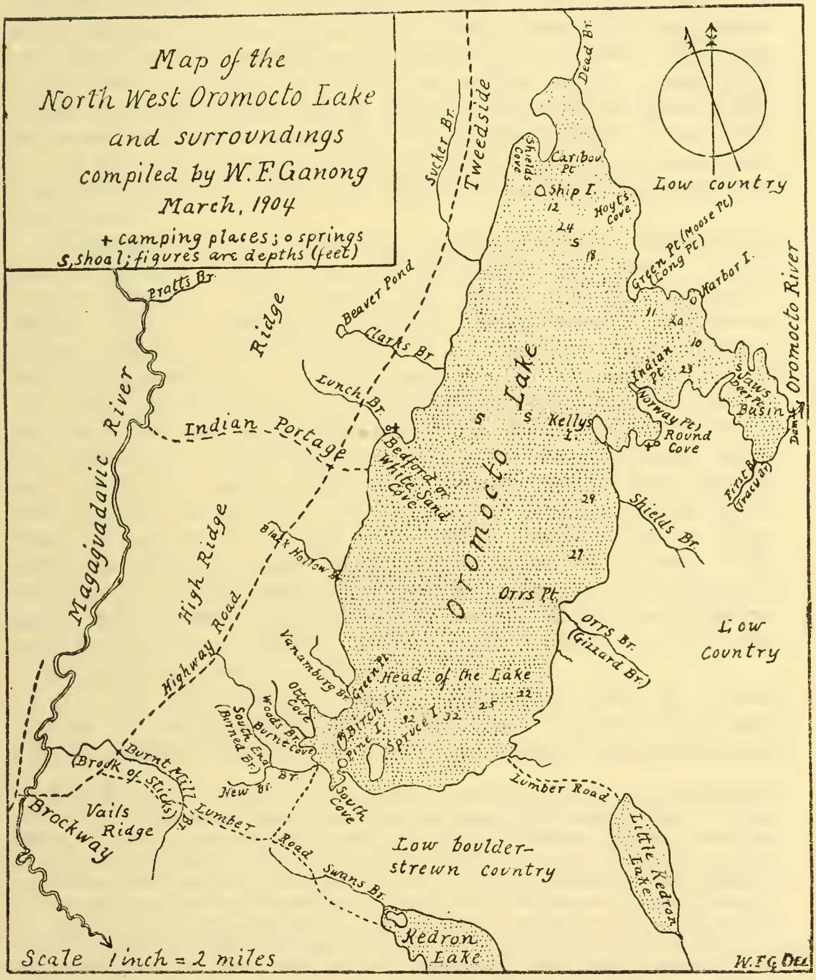
1. *The Northwest Lake.*—The Northwest Oromocto Lake, some eight miles long* and 2½ in extreme breadth, lies in a north-and-south valley with high ridges (some 200 feet over the lake), on the west between it and the Magaguadavic, and a low country to the east and south. It empties from the eastern side. Its shores are nearly everywhere rocky, for the most part of middling-sized boulders, often pushed up into marked ice-dykes, sometimes pavement-like, and including many morainic points of small boulders, extending often as shoals far out into the lake. In many places, notably at Ship Island, Kelly Island** and the northeast coast, the shores are conglomerate ledges, often worn by the water into caves. Elsewhere, especially at White Sand Cove and on the southeast shores, are some fine sand beaches. The three islands at the southern end of the lake are of glacial drift and their axes have, with the moranic points, the usual northwest and southeast direction. The depths of the lake are extremely irregular, and in many places it is very shoal, both near the shores and also upon certain island-like shoals, apparently ledges, which come nearly to the surface, especially between Ship Island and Green Point and between Kelly's Island and the western shore. On the

* Locally it is insisted that this lake is nine miles long, but O'Connor's map, made with much care and checked by mumerous intersections, makes it less than eight miles.

** A fact worth mention about this island is its use locally as a kind of large game trap. Deer and other animals cross to it from the shore by the bar of gravel and sand, indicating their presence by their tracks on the sand; they are then driven from the woods of the island by hunters, to fall before the guns of others stationed at the bar.



Map of the
North West Oromocto Lake
and surroundings
compiled by W. F. Ganong
March, 1904
+ camping places; o springs
s, shoal; figures are depths (feet)
Oromocto Lake
Low country
Oromocto River
Tweedside
Sucker Br.
Dead Br.
Caribou Pt
Shields Cove
Ship I.
Hoyts Cove
Green Pt (Moose Pt) (Long Pt)
Harbor I.
Indian Pt.
Norway Pt.
Round Cove
Kellys I.
Jaws
Deer Pt.
Basin
Dam
First Br. (Tracy Br.)
Shields Br.
Orrs Pt.
Orrs Br. (Gizzard Br.)
Low Country
Head of the Lake
Birch I.
Spruce I.
Pine I.
South Cove
Lumber Road
Little Kedron Lake
Kedron Lake
Low boulder-strewn country
Swans Br.
Lumber Road
Beaver Pond
Clarks Br.
Lunch Br.
Bedford or White Sand Cove
Black Hollow Br.
Varamburg Br.
Otter Cove
Woods Br.
Burnt Cove
South End (Burned Br.)
New Br.
Ridge
Pratts Br.
Magaguadavic River
Indian Portage
High Ridge
Highway Road
Burnt Mill Br.
(Brook of Sticks)
Vails Ridge
Brockway
Scale 1 inch = 2 miles
W. F. G. Del.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Oromocto Lake
Oromocto River
Magaguadavic River
Tweedside
Sucker Br.
Dead Br.
Caribou Pt
Ship I.
Hoyts Cove
Low country
Green Pt (Moose Pt) (Long Pt)
Harbor I.
Indian Pt.
Norway Pt.
Round Cove
Kellys I.
Shields Br.
Orrs Pt.
Orrs Br. (Gizzard Br.)
Low Country
Head of the Lake
Spruce I.
Birch I.
Pine I.
South Cove
Lumber Road
Little Kedron Lake
Kedron Lake
Swans Br.
Low boulder-strewn country
Vails Ridge
Brockway
Burnt Mill Br.
Brook of Sticks
Highway Road
High Ridge
Ridge
Indian Portage
Pratts Br.
Beaver Pond
Clarks Br.
Lunch Br.
Bedford or White Sand Cove
Vanamburg Br.
New Br.
Scale 1 inch = 2 miles
W. F. G. Del.

shoals west of Kelly's Island, the boulders have been pushed, apparently by ice action, into a curious kind of atoll, (evidently homologus with the ice-dikes of the shores) such as I have not elsewhere noticed. The moderate depths found by us near the shores are marked on the map; O'Connor states on his map, however, that the "fine open bay" formed by the southern expansion of the lake was found by him to be 72 feet deep by soundings, which is in conformity with the rule for these glacial lakes which are usually deepest towards their southeastern ends. The elevation of the lake above sea-level is in the vicinity of 400 feet,* and it undoubtedly is, as locally stated, higher than the Magaguadavic to the west.

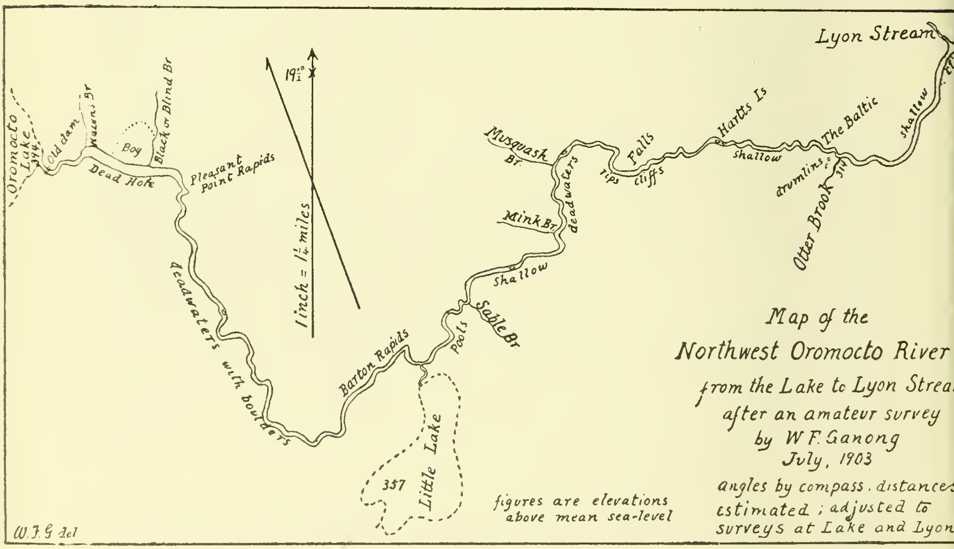
Turning now to the interesting question as to the origin of this lake, which lies directly across the direction of the river to which it now belongs, I think there is no doubt that Mr. Chalmers' opinion that in pre-glacial times its valley emptied southward through the low drift-filled valley to the Kedron and thence into the Magaguadavic, is perfectly correct. It lies therefore in an old valley parallel with the Magaguadavic, and emptying southward and does not belong morphologically to the Oromocto at all. Mr. Chalmers also calls attention to an apparent pre-glacial valley between the lake and Cranberry lake basin, which I also noticed. But it appears to me this valley is rather a continuation of Deadwater Brook, and I believe it can be traced farther,—east of Magaguadavic Ridge to Little Magaguadavic Lake and beyond. This would make a continuous valley parallel to that of the Magaguadavic and separated from it mostly by high ridges, an arrangement perfectly in conformity with the river structure of this region as discussed in a later note,** (No. 75).

2. *The Northwest Oromocto from the Lake to Lyons' Stream.*—Leaving the lake on its easterly side the river flows with a gentle current, making easy canoeing, through long reedy dead-

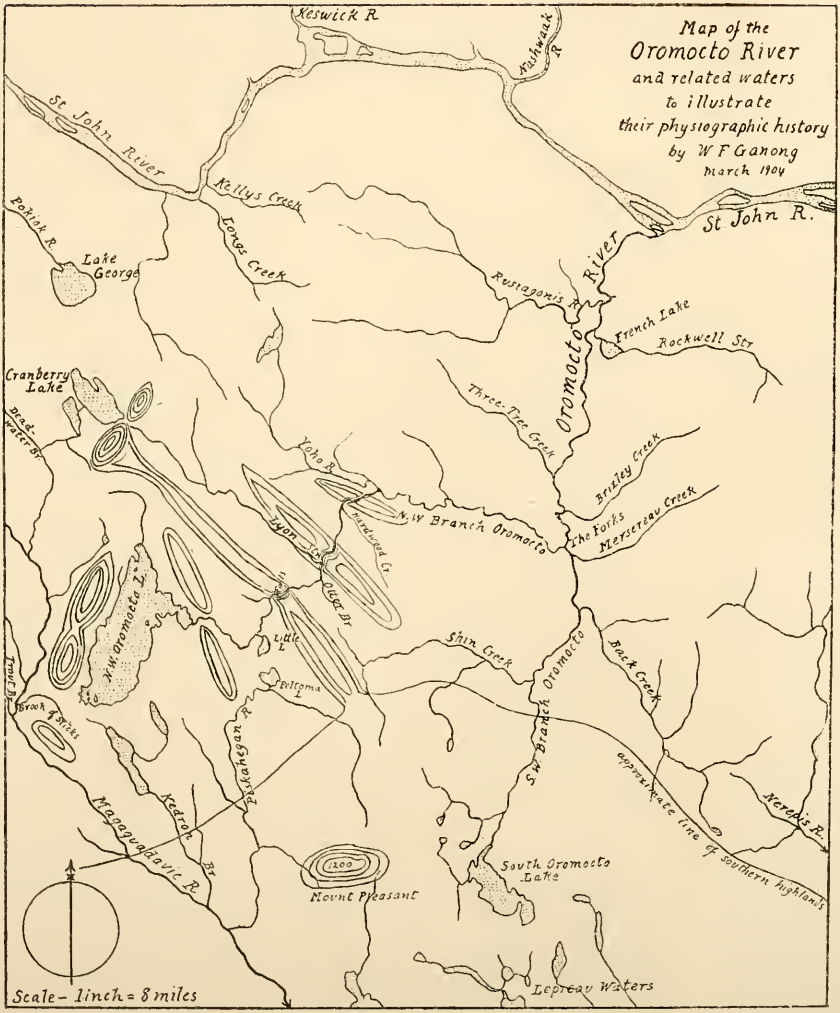
* Robb, Report, 179, gives it as 370 feet, without mentioning the source of the information. This was perhaps from a preliminary survey for the Western Extension Railway which was made a few years earlier, and passed close to this lake. Chalmers, Report, 18, gives it as 417 feet, of course from aneroid measurements. I made it, as the mean of ten very careful measurements with aneroid, synchronous with and checked from the barometic station at St. John (for lists of readings from which I am indebted to the Director, Mr. D. L. Hutchinson), as 394 feet. It will doubtless prove, when exactly levelled, not to exceed 400 feet. Indeed it ls difficult for me to see where it manages to make that much drop between the lake and the Forks, the latter lying practically at sea level. Other heights measured by us along the river gave these results: Little Lake, 357; Mouth of Otter Brook, 314: Mouth of Lyon Stream, 282.

**It seems to me very likely that the Magaguadavic itself had a pre-glacial, or some yet earlier, course into the Kedron by way of the low ground of Brook of Sticks and Swans Brook; and it may even have had a very early or original course across the dip in the ridge west of the lake to Little Kedron and Piskahegan. See Note 75.

waters and stillwaters separated by occasional bouldery rips of little fall, in a flat wooded country showing occasionally morainic knolls, down to Little Lake, a very pretty lake, connected with the river by a short stream of little fall. (Compare the map). Below this, for a mile, the river forms a series of long quiet pools, broken by occasional small rips, with a heavy border of over-hanging vegetation; a charming canoe stream. This is followed by shallows and rips, and some deadwaters, down to Musquash Brook, where the river bed becomes rougher and of greater fall; the



banks begin to rise in rocky ledges, and presently, at North Branch Falls, occurs a typical post-glacial low fall, or bad rapid, below which the banks are still higher, rising to cliffs 50 to 80 feet high, and the valley is typically post-glacial. Below Hartt's Island the banks become lower and the valley opens out, while the river flows swiftly and roughly through an open country with much drop over a bed partly of boulders and partly of flat ledge rock, between banks mostly low but rising at times into morainic hills; and this continues to Otter Brook. Just above this brook, on the same side of the Oromocto, in open burnt country, are two of the most per-


Map of the
Oromocto River
and related waters
to illustrate
their physiographic history
by W F Ganong
March 1904
Keswick R.
Nashwaak R.
St John River
St John R.
Kellys Creek
Longs Creek
Pokiok R.
Lake George
Rusiagonis R.
Oromocto River
French Lake
Rockwell Str
Cranberry Lake
Dead-water Br.
Three-Tree Creek
Yoho R.
Brizley Creek
Mersereau Creek
Lyon Str
Hardwood Cr.
N.W. Branch Oromocto
The Forks
N.W. Oromocto L.
Otter Br
Little L
Shin Creek
Peltoma L
Back Creek
Trout Br
Brook of Sticks
Piskahegan R
S.W. Branch Oromocto
approximate line of southern highlands
Nerepis R.
Kedron Br
Magaguadavic R.
1200
Mount Pleasant
South Oromocto Lake
Lepreau Waters
Scale - 1 inch = 8 miles

fect drumlins, one of them conical, that I have seen in New Brunswick. Below this the river continues very rough with much fall and many ledges for nearly two miles, where again the banks rise into rocky ledges, and at Lyon Stream the junction of river and stream is in a rocky post-glacial valley, some 30 feet deep. Below this the banks again fall off and the country gradually opens out; the river has much fall and flows for the most part over a flat conglomerate-ledged bottom. Gradually it broadens and develops some intervales and low terraces, but below Hardwood Creek the banks again rise and the valley is once more post-glacial, with banks often of vertical rock some forty or fifty feet high; then these fall off and the river reaches a wide valley in which the Yoho unites with the Oromocto.

Reviewing now this part of the river it seems plain that from the lake to Yoho stream, this valley is all post-glacial, and that it cuts directly across three, and perhaps four, low ridges* and their intermediate shallow valleys, which in pre-glacial times drained from northwest to southeast, probably into the present Piskahegan and Shin Creek. There is probably a low ridge just east of the lake, forming the eastern boundary of the old valley now occupied by the lake, and east of that lies the shallow valley across which the river now wanders. It is very likely that this valley drained through Little and Peltoma lakes into the Piskahegan and Magaguadavic (compare the map) in pre-glacial times. The next ridge to the eastward would be that extending from Roach Settlement, crossing the river at North-Branch Falls and extending between Shin Creek and the Piskahegan. East of that comes another valley in which probably Lyon Stream belongs, the pre-glacial position of which must have been either farther east or farther west, doubtless the latter; and it is likely that this stream, (formerly extending through the gap at Harvey to Cranberry Lake), flowed in pre-glacial times through the present Otter Brook valley into Shin Creek, while earlier than that, there is good reason to believe, it flowed across the southern highlands into the Lepreau (as discussed in Note 75). East of this lies another ridge and then a small unimportant valley occupied only by Hardwood Creek, also doubtless emptying pre-glacially into Shin Creek, and east of that another ridge bounding the Yoho Stream. If we ask now why this part of the river took this direction across the ridges, the answer would seem to be this, that these shallow valleys in the glacial period were filled with drift, and the new stream, turned by a glacial dam from its old course into

* The rocks of these ridges are nearly horizontal, showing they are ridges of erosion and not anticlines.

Kedron, found its lowest outlet to the eastward, where it naturally followed the direction of the general slope of the country, which is here to the northeast. It has since cut to the rock bottoms of the two eastern valleys, as well as through their intervening ridges, but not to the bottom of the western valley, where it still runs over the drift.*

3. *The Northwest River from the Yoho to the Forks.*—At its junction with the Yoho the character of the Oromocto changes completely. The valley is broad, open, mature; the river, still shoal and swift, though less so than above, winds extensively among wide intervales and fine terraces (all well-settled) over a drift bottom showing ledges only rarely and on one side. This character continues but with lessening drop to Tracy, where there is a small post-glacial fall at a bend of the river (the old valley being to the south) and beyond with still gentler current to Fredericton Junction, where the river turns abruptly to the northward, forming a series of post-glacial falls and rapids. The pre-glacial valley is doubtless here on the right bank, though I did not trace it. Below this the river runs into intervales and winds about among them to the Forks.

It is perfectly plain that this part of the river occupies an ancient, mature and extensive valley, the post-glacial falls at Tracy and Fredericton Junction representing only local deviations from the general course. Moreover this character extends continuously up the valley of the Yoho as far as can be seen from their junction; and since, as the maps show, the Yoho is the direct continuation in direction of this part of the valley I think there is no doubt that, morphologically, this part of the river and the Yoho occupy the same ancient valley, of which the Oromocto above the Yoho is simply a post-glacial branch.

4. *South Oromocto Lake and the South Branch.*—This part of the river I have not visited and know nothing of. Noting the direction of the lake, however, its relation to Mahood's Lake, to the small lakes northwest of it and to the head of Shin Creek, I think it is extremely probable that all of these occupy one very ancient valley, which in former times ran across the southern highlands, giving a continuous river from the Lepreau to Cranberry Lake by Lyon Stream. (See the map and that with Note 75). This connection, however, is probably long pre-glacial, and Shin Creek probably took the drainage of Lyon Stream in immediately pre-glacial times. I have seen the junction of the South Branch with Back Creek, and it enters the latter by a rather narrow valley

* Of course it is possible that there is a pre-glacial valley in this same general direction, but this seems wholly unlikely.

at an abrupt angle, showing it to be morphologically a branch of the broad ancient valley of Back Creek, and not the main stream.

5. *Back Creek and the lower part of the South Branch.*—The South Branch from the Forks to Back Creek, and Back Creek itself wind about in a continuous single, broad, mature, intervaled and terraced, obviously ancient, valley. This valley narrows towards its head, but merges gradually, without a break, into the valley of the Nerepis, which continues its direction without deviation to its junction with the St. John and beyond that through the Short Reach, Grand Bay, and South Bay. There can be no doubt, I believe, that this Back Creek—Nerepis Valley, is morphologically a single one. The question now at once arises as to its original direction of flow. This is easily answered, and in two ways. First, certain streams near the head of Back Creek have a re-entrant or southward direction,* (compare the map), and second, the general river directions of this entire region necessitate a southerly direction. This raises the question as to the original head of the valley, and here again I think the answer is fairly clear. This same valley extends up the northwest Oromocto, (cutting across the Forks near the low hills on the south) and up the Yoho River to its head. But it did not end here, for it extended, I believe, through a gap in the hills to the flat country at the source of Gardner's Creek, through Lake George and the Pokiok, and into the St. John, and this ancient and important valley we may well call from its modern remnant *The Nerepisian Valley,* the further extension and relations of which to other neighboring rivers will be found discussed in a later note (No. 75).

6. *The Main Oromocto from Forks to Mouth.*—This part of the river has at present a very uniform character. It is a deadwater creek, winding in a very broad valley through extensive intervales. In only one place, namely, just above French Lake, does it come in contact with rock-formed upland.** In conse-

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* There is, however, another explanation for these re-entrant streams, namely, that in immediately pre glacial times the Nerepis headed farther west, and these were branches of it, and not of Back Creek, a point still to be investigated. For some distance north of the present divide between the two rivers, the Back Creek flows over a ledge-rock bottom, as may well be seen from the railway train. This implies that its course here is post-glacial; but this is not necessarily the case, for either a pre-glacial channel may exist on one side or the other of the present channel, or this may represent the pre-glacial summit of the rocky divide between Back Creek and Nerepis.

** This, the only case in which the river actually now touches the rocky upland, is on the right bank. In general, this river seems to keep nearer to the upland on the right than on the left, a supposition confirmed by the representation of the intervale upon the surface geology map. This tendency to keep to the right is very likely due to the well-known tendency of rivers in the northern hemisphere to erode their right faster than their left banks, due to the effect upon the moving water exerted by the earth's rotation quence one can make out little of the geographical relations of the river from the stream itself, but an inspection of the general maps brings out some important facts. First, the streams flowing into the upper part of this section, namely, Three-Tree Creek, Mersereau Creek, Brizley Creek, are all markedly re-entrant in their main courses, indicating that at one time this part of the river flowed south, and suggesting that it was at one time a small branch of the Nerepisian River. Second, it has a large branch, the Rusagonis, entering at right angles, parallel with the St. John and in a line with Kelly's Creek and the Upper Reach of the St. John, while its direction is continued across the Oromocto by French Lake and Rockwell Stream. Though I have not been able to study this problem I think it very probable, for reasons which will be given in a later note (No. 75), that the Rusagonis and Rockwell streams persist in an ancient valley, of which the Upper Reach and part of Nacawic are parts, and which joined the present St. John at Little River in Hampstead. In this case the present Lower Oromocto was at first a small branch of the St. John, which in very early times extended back capturing the Rusagonis, and later, cutting through the divide, the remnant of which is the ridge south of French Lake, captured the branch of the Nerepisian River, and thus the main part of the river, turning it northward into its present course. The condition which allowed this extensive alteration was no doubt, as later more fully discussed, the ease of erosion in the soft sand-stones of this region, combined, perhaps, with some synclinal folding or other favoring local conditions.

The conclusions drawn from the facts here stated are of course largely tentative. I regard them as in the highest degree probable, but much study is still needed before they can be either fully confirmed or definitely disproved.

74.—Notes on the Physiographic Origin of the Keswick River.

Read November 3, 1903.

For some years past I have been making such observations upon the physiographic character of the Keswick valley as may be accomplished from railway trains. The method is not ideal, but the trains in that valley do not move at a rate to render such study quite impossible, especially when several trips are made to supplement one another in conjunction with the use of the best maps.

Some interesting possibilities are thus suggested, which are as follows.

The Keswick valley enters the St. John valley as a direct continuation of the latter, the two together forming a single broad, flood-plained, terrace-bordered, gentle-sloped, matured valley, while the Upper St. John enters this combined valley at an abrupt angle, in a much narrower steeper-walled and obviously newer valley. This suggests that morphologically the Keswick and the St. John valley below it are one, and that the Keswick is the morphological head of the St. John below it. Ascending, the Keswick valley retains much of its width and all of its ancient and matured appearance, the present stream, winding about amidst intervales and terraces, being obviously much smaller than that which formed it. At Jones Fork comes in a broad branch from the north; at Zealand one comes from the west; at Stone Ridge is another from the north; and another also from the north appears to come in at Upper Keswick. All the way up, the river maintains its matured appearance, though narrowing somewhat, and seemingly narrowed much more than it really is by the remarkable great terraces. At Upper Keswick the railway climbs by very steep grades (265 feet within three miles by the railway levels) out of this valley over a water-shed into the valley of the Nacawic. But as the railroad ascends, one can see finely displayed the ripe old valley of the Keswick continuing off to the northwest. Beyond this point I have not seen it, but in an earlier note (No. 50) I have suggested the probability that the north and south parts of both the Nashwaak and the Miramichi, both of which lie in a direct line north from its present source, formerly flowed through this valley, and certainly its great size strongly sustains this conclusion. I believe that these three rivers lie in a single ancient valley, with large and important branches, forming the original head of all the St. John below it, and this we may call from its modern remnant, *The Keswian Valley*. It is probable that in its lower part it had another branch, for the course of the Mactaquac on our maps strongly suggests that it formerly flowed by a small brook into the present Keswick near its mouth. Tracing now the Mactaquac valley upward, as represented on the maps, we find it lying in a line with a branch of the Nacawic and of the Becaguimec (compare map with the next note), and even with the Presquile beyond the St. John, and it is possible that all of these lie in a single ancient valley. Certainly the curious course of the Becaguimec, which at present folds back so remarkably on itself, is in harmony with some such explanation as this, even though the present explanation may not be precisely correct in detail. If now we trace this Keswian river downward, it must have followed the present St. John valley to Jemseg, and possibly followed it to the Long Reach. There is, however, another possibility, suggested by the parallelism of this system of rivers (discussed in the next note), namely, that it originally continued from Jemseg across to Lewis Cove on the Washademoak, thence by Southwest Brook and Spraggs Brook to the Belleisle, thence across to Paticake Brook, Hammond River, Porter Brook and Quaco River to the sea at Quaco. If it really had this course, it would have been turned in very early times into its present course by the easterly erosion of branches from the lower Nerepisian and Rusiagonian valleys, as described in the preceding and in the following notes.*

75.—The Origin of the Fundian System of Rivers.

Read November 3, 1903.

The rivers of New Brunswick belong to three great natural systems,—one sloping southeastward into the Bay of Fundy, another sloping northeastward into the Gulf of St. Lawrence, and the third sloping northward and eastward into Bay Chaleur. Upon the first of these, which we may designate *the Fundian* system, I wish here to record some observations, looking to an explanation of the origin of its remarkable features.**

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*Dr. Chalmers, in his latest Geological Report, has suggested that the St. John may once have flowed through the Nacawic and Keswick, but his explanation of the possible method differs much from that here given.

**There are many references to peculiar features, and their explanation, in the rivers of this system in the writings of the geologists who have investigated New Brunswick geology, notably those of Bailey, Matthew, Ells and Chalmers. But no attempt has hitherto been made, so far as I know, to explain the features of these rivers collectively. All physiographic study must rest upon topographical and geological data, and such studies as those here attempted are only made possible by the previous labors of these geologists who have made accurately known in its outlines and in many of its details, the structural geology of New Brunswick.

There are two very striking facts about this system, of which the explanation is not obvious. First, the courses of the rivers are in large part independent of the geological formations, for many of them, especially the westernmost, run directly across the formations, hard and soft alike. Second, the principal river of this system, the St. John, has a curious zig-zag form, with some of its parts in the prevailing southeasterly course, but others at right angles to it, and its course as a whole forms almost a semicircle around rivers west of it. All of these phenomena, I think, can now be explained, and the key to their interpretation is found in the probable physiographic history of the Oromocto, supplemented by that of the Keswick, outlined in the two preceding notes.

The general lack of correspondence between river-courses and the underlying formations can have, it would appear, but one meaning. The river valleys must be much older than the present exposure of those formations, and must have originated on a general uniform southeasterly slope which could have been formed in either one of two ways. First, this entire country was covered by level homogeneous deposits, such as the Carboniferous sandstones form in the eastern part of the Province at the present day; these became elevated from the sea with a southeasterly slope on which the rivers formed and gradually eroded their valleys down into the underlying deposits. Second, all of the formations were planed off uniformly, either by sea or river action, to a great peneplain, which, on its elevation, sloped southeast, thus establishing the parallel southeasterly valleys. Which of these two explanations is correct is not, from our present point of view, important. The great crucial point is this, that by one or the other (or possibly by some other) method, the rivers of this region were given, after all the formations were deposited, a general southeasterly course, and this they have largely retained down to the present day. Where they have deviated from the arrangement, as they have very often, it is because of the influence of the underlying formations, as will be shown later in this paper.

So far as I have been able to work out the original valleys of this system, they are as given below. The descriptions can be followed in general upon the accompanying small-scaled map, but they will be much plainer if read in comparison with the maps of the Geological Survey, which show also the courses of the formations.

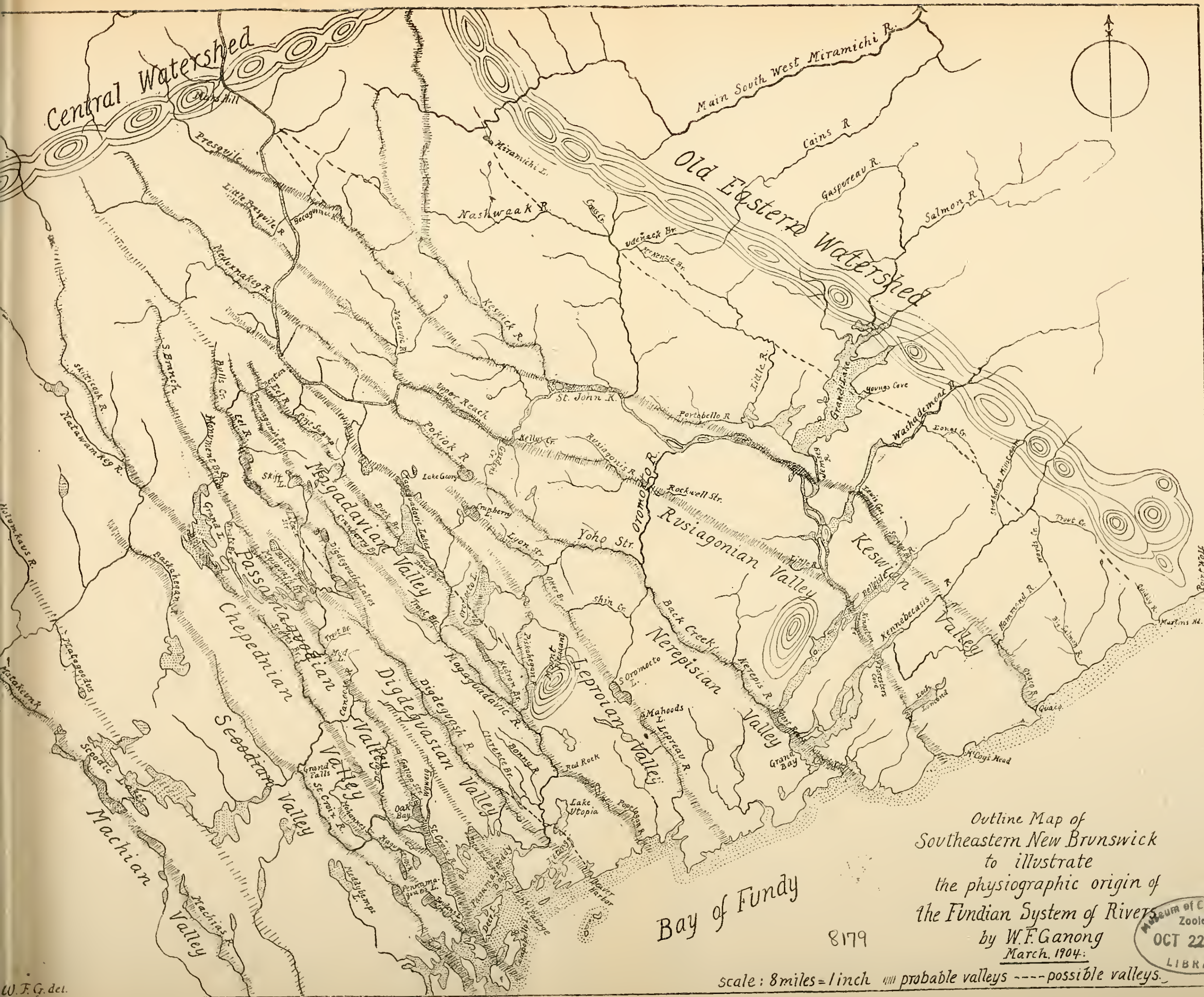
1. *The Machian Valley.*—To the westward of the New Brunswick series lie lines of valleys strongly suggestive of a continuation of the system. The westernmost of these heads in the East Branch of Penobscot (outside the limits of the accompanying map, but very plain on Wilkinson's map), follows the Penobscot a short distance to the re-entrant Matakeunk, which it follows through the westernmost Scoodic lakes to the Machias.

Possibly another occurs east of this, heading in the Molumkaus, crossing through Matagoodus, Scoodic Lakes and East Machias.

2. *The Scoodian Valley.*—This is the least distinct of the valleys of the region, but it appears to be traceable from the Baskahegan along the streams to the Grand Falls of St. Croix, thence following the present river (the ancient Scoodic) to near Meddybemps Lake, whence it probably runs through the Penamaquam Valley into Cobscook. But my evidence as to this valley is almost wholly cartographical, and I can offer little more than a suggestion. A minor valley seems to be east of this, including Mohannes Stream, Magurrewock and Boyden's Lakes.

3. *The Chepednian Valley.*—This appears to head in Matawamkeag River, or Skitticook Branch, (if not farther north in Aroostook waters), and extending through Grand Lake and its Great South Bay, Lambert Lake, Scott's Brook, the Chiputneticook (St. Croix) to Canoose, runs thence across to Denys River, and by this to the St. Croix below St. Stephen, which it follows to near the Narrows, when it passes behind the Devil's Head to reach the lower St. Croix near Red Beach.

4. *The Passamaquodian Valley.*—This valley appears to head in the south branch of Meduxnekeag (and perhaps farther north), extends thence to Lower Monument Brook, thence across the head of Pirate Brook to Musquash Brook, thence directly through to the St. Croix, which it leaves at Mud Lake, whence it extends across the heads of Canoose and Denys streams, Gallop Stream, and thus into Oak Bay and the Lower St. Croix (both of which it formed); it continues through Passamaquoddy near the Maine shore, passes between Deer Island and Moose Island, and crosses Campobello to empty through Herring Cove. A large river having this general course explains perfectly the origin of the remarkable Oak Bay-St. Croix estuary, which otherwise stands much in need of interpretation.



Outline Map of
Southeastern New Brunswick
to illustrate
the physiographic origin of
the Fundian System of Rivers
by W. F. Ganong
March. 1904.

There is perhaps a minor valley east of this, including possibly some of the west branch Digdeguash and Upper Waweig, which emptied through Bocabec Bay and Letite Passage, forming the latter.

5. *The Digdeguasian Valley.*—This appears to arise as far north as Bull's Creek (perhaps even in branches of Mednuxnakeag), includes the Upper Eel River, the three Eel River lakes, La Coote Lake, the Digdeguash lakes (or possibly as on the dotted line of the map), thence to the Digdeguash itself, whose course it follows with perhaps a branch from Bolton Brook to near its present mouth, where it may have emptied by Letite Passage, or it may have crossed in part by the small streams shown on the maps, to Letang, forming the deep entrance to that harbor.

6. *The Magadavian Valley.*—The lower course of this river is fairly clear, but two possible branches may be traced at its head with two others lower down. One branch may have originated north of Eel River, in Pokomoonshine Brook, following Eel River to Pocowagamis Brook, Skiff Lake, Grassy Lake and Upper Cranberry Brook to Upper Trout Brook and the Magaguadavic. A second branch seems to have included Eel River below Benton* (and possibly the brook through Spearville and even Bull's Creek above Debec) through Pine Swamp Brook to Sheogomoc waters, (following the railroad at Canterbury), through second Sheogomoc Lake, Big Duck Lake, Duck Brook across Magaguadavic Lake and along the present Magaguadavic (or a stream west of it to Davis Brook) and by the present Magaguadavic to near Brook of Sticks, where it may have crossed through the low ground into Kedron, and by Kedron Brook to the Magaguadavic. (Compare Note 73, and its map of Oromocto Lake) Or it may even have crossed through the small gap in the ridge west of Oromocto Lake, across the lake to Kedron waters, as shown by the dotted line on the map. The third branch probably originated in Charlie Lake (and perhaps farther north in a part of the St. John and Bull's Creek), thence running to first Sheogomoc Lake, thence to Little Magaguadavic Lake, thence through the gap between Blaney and Magaguadavic Ridges, through Deadwater Brook into the head of Oromocto Lake, through that lake into Kedron and thence into the Magaguadavic. A fourth, and very minor, branch perhaps originated northeast of Oromocto Lake, flowed southeast through Little Lake and Peltoma thence into Piskehegan and the Magaguadavic. The deviation of the two latter branches to the

*It seems possible that Eel River had a former, perhaps immediately pre-glacial, outlet from Benton eastward along the general course of the present highway and the old Indian portage.

westward is of course caused by the great granite mass of Mount Pleasant, rising 1200 feet, which as this deviation of the rivers would show, stood out as a monadnock from the plain on which the rivers formed. The lower Magaguadavic below Piskahegan appears to run in its ancient valley to Red Rock, whence it pretty certainly continues through Red Rock, Sparks and Clear lakes to Forked Lake (between the two latter lakes there is a remarkable valley that I have myself seen), thence into Popelogan and Popelogan Harbor. The Magaguadavic below Red Rock appears to belong to Bonny River and Clarence Brook.*

7. *The Leproian Valley.*—As mentioned in Note 73 it appears possible that a valley originated in the Cranberry Lake basin, flowed through the gap at Harvey into Lyon Stream, thence by Otter Brook, the head of Shin Creek and its south branch, to South Oromocto Lake, Mahood's Lake and into the Lepreau, which probably emptied on the coast at or near Little Dipper Harbor, or else at Musquash. This country is now so elevated, the lake surfaces lying nearly 600 feet above sea-level, that this river must been turned from its course at a comparatively early time, and Shin Creek would appear to be the modern successor of the early stream which took this direction.

8. *The Nerepisian Valley.*—As described in Note 73 I have traced this ancient valley on the ground through much of its course. Its source is uncertain, but most probably, I think, is in the Meduxnekeag, whence it crossed in a line through the heads of several small streams to the Pokiok, (although it may have followed the present upper St. John). From the Pokiok it extends southward across the head of Gardens Stream to the Yoho, the Oromocto, Back Creek, the Nerepis, the Short Reach, Grand Bay, and to the sea in or near St. John harbor. At this early period the upper St. John, above the central watershed, either did not exist or else flowed to Bay Chaleur, a subject later to be considered.**

9. *The Rusagonian Valley.*—As suggested in Note 73, this appears to represent another of the parallel valleys. It headed in some branch of Nacawic, and very likely in the Little Presquile beyond the St. John, (the Little Presquile would seem, from the

* Or possibly the Didgeguash flowed through Digdeguash Lake, and by its lower end to the Magaguadavic, the Canal, Lake Utopia, head of Letang and Beaver Harbor, as shown by dotted line on the map.

** All physiographic evidence, of which I have collected much, later to be presented, tends to show that this present central watershed separating the Tobique from the Miramichi is also the ancient one. This is in marked contrast with the eastern water-shed, which has shifted from its ancient position and moved farther to the eastward.

maps, to have had an earlier outlet, in the line of its general direction, through a little brook now flowing southeast into the St. John); and followed the Upper Reach, Kelly's Creek, the Rusagonis, and Rockwell Stream. Beyond this I have found no direct evidence of its course, but the general parallelism with other rivers would lead us to expect that it crossed to near Little River in Hampstead and followed the St. John to the Belleisle (originating this part of the St. John). It ran thence through Kingston Creek, Forester's Cove, and a line of brooks to Loch Lomond, Black River and the sea west of McCoy's Head. Such a course explains perfectly several otherwise puzzling geographical features, such as the course of the St. John from Long Island to the Belleisle, and Kingston Creek. The deviation from parallelism at Little River is of course explained by the presence of the great Bald (or Champlain) mountain mass, which would thus be shown to have stood up like Mount Pleasant, as a monadnock from the general plain on which the rivers were forming.

10. *The Keswian Valley.*—As described in the preceding note, this river probably headed in the Miramichi, flowed through the Upper Nashwaak (with a branch from the source of the Miramichi and a part of Becaguimec, and possibly from the upper St. John), the present Keswick and the St. John to Fredericton receiving an important branch from the Nacawic, Upper Becaguimec (and perhaps the Presquile); thence its course was probably along the present Portobello under the intervale to Major's Island and the present river to Jemseg.* From this point it seems possible that we can trace it also across country to the sea through Lewis' Cove, Spragg's Brook, Paticake Brook, part of Hammond River, and Quaco River, to the sea in Quaco Bay.

It is possible that even another of these parallel valleys existed east of the Keswian along the course of the dotted line on the map. If so, it arose in the Nashwaak above the Udenack (perhaps even in Miramichi Lake and north of the Miramichi), passed through Udenack and McKenzie Brook (or as on the map) across the head of Little River, over Grand Lake to Young's Cove, over Washademoak to Long's Creek, thence to a branch of Studholm Mill Stream, to Sussex Vale, and by Trout Creek and Quiddy

*Below Fredericton there begins an extensive intervale basin which soon opens to include Portobello, French Lake and Maquapit; and it is noteworthy that the St. John for the most part keeps close to the upland on the southwest. It is possible that this is a result of the tendency in rivers of the northern hemisphere to erode their right banks, a consequence of the influence of the earth's rotation on the moving water. Something of the same kind appears to be true of the Lower Oromocto, (Note 73.)

River, or else by Wards Creek and Big Salmon River to the sea. Such a river should be named from its only important existant part the *Nashwian River*. But I have no evidence for it other than cartographical.

Somewhere east of this river, and parallel with it, must have come the ancient water-shed between this Fundian System and the St. Lawrence System. This water-shed I believe we can still trace in its remnants, constituting the elevated land near Point Wolfe, extending thence to the lofty hills of Sussex and across the Washademoak to Marrs Settlement hill, across the head of Grand Lake, Emigrant Settlement hill, between Salmon Creek and Newcastle Creek, thence to the water-shed between the Taxes and the Nashwaak, and beyond to cross the Miramichi, as shown on the map. There is evidence to show, which will later be presented, that originally all waters west of this line were branches of the Keswian (or Nashwian) while all east of it flowed into the St. Lawrence.*

One important fact about all of these rivers remains to be mentioned, namely, it is possible that at the time of their formation the Bay of Fundy was rock-filled, and these rivers flowed across Nova Scotia into the sea (just as those of the St. Lawrence system flowed over Prince Edward Island, and those of our northern system flowed across the Restigouche valley into the St. Lawrence), thus originating the valleys which cross that Province from northwest to southeast. It may even prove possible to identify the corresponding valleys in the two Provinces (thus determining, for instance, which valley formed Annapolis Gut, which emptied through Mahone Bay, etc.), although on the Fundy slope the Nova Scotia rivers are much modified.

Such appears to me to have been the original arrangement of river valleys in this region. I have no doubt that further research will modify the conclusions in many details, but the general principles I believe are correct and will stand.

We must consider now the causes of the profound modifications of the original arrangement which have given us the very different conditions of the present. According to our theory,

*As I have pointed out in an earlier note, No. 49, footnote.

these valleys originated on a southeasterly sloping surface as it arose from the sea. Had the underlying rocks been uniform in texture and hardness, those rivers would doubtless have kept those courses to the present day. But the rocks were not of equal hardness, but on the contrary consisted of bands of harder and softer rocks running for the most part directly across the courses of these rivers. In the process of erosion these softer bands were cut down rapidly, forming large right-angled branches to the older valleys. Ultimately these branches were able to cut back into neighboring valleys and frequently to capture their head waters. It is in this erosion by branches of the main valleys along the softer rocks crossing from valley to valley that we have the explanation of the changes which have altered the original arrangement to the conditions that we find at the present day, for all of the river courses of this system seem to lie either in the ancient northwest and southeast valleys across the rock bands, or in northeast and southwest valleys following the general direction of the softer rocks.

Turning to these cross valleys, we note that by far the most important of them is the Oromocto, which lies near the middle of the broadest of the bands of the soft Carboniferous sandstones. Starting as a small branch of the Keswian River (which itself, running across a greater extent of soft rocks that any of the rivers to the westward, cut its channel more rapidly than they, thus becoming a sort of trunk river), it cut backward into the Rusagonian valley, capturing its upper part. It is precisely because this valley was the first thus to be captured that it is now the least distinct of them all (especially east of its captor). The Oromocto then extended farther back capturing a branch of the Nerepisian valley. Similarly, but somewhat later, a branch of the Nerepisian, eroding backward (along the present Shin Creek), captured the Upper Leproian, but the final capture of two branches of the Magadavian was only effected (as Note 73 shows) by aid of the glacial period. Meanwhile, and very early in this series of changes, certain bands of soft rocks occupying the present Belleisle-Long Reach and Kennebecasis valleys (their presence there being due to earlier geological causes worked out by our geologists) were gradually cut out by backwardly extending branches from the lower Nerepisian, which thus very early captured the lower Rusagonian, and soon after the lower Keswian (whence the lower courses of these rivers have had time to be much altered by minor later changes), while a branch of the lower Rusagonian early extended back and captured the Keswian, forming the present St. John from the foot of Long Island to Jemseg. It was no doubt a similar erosion which formed the great Hammond River-Loch Lomond-Little River valley, and another of analogous character which formed the northeasterly part of the Nerepis River.

In the meantime, also, a branch parallel with the Oromocto was eroded back from the Keswian near the mouth of the present Keswick, to capture the Rusagonian at Kelly's Creek.* It is true this part of the river does not now run in the softer Carboniferous rocks, but remnants of those rocks exist, showing that it formerly did so. The erosion of this band did not stop here, however, but extended along upper Gardens Creek. It was very probably a similar erosion starting in bands of soft rocks now removed which formed the northeast branch of Nacawic and the St. John thence to Pokiok, thus capturing upper Nerepisian waters. Something of the same kind would explain the northeast and southwest parts of Eel River (and even the course of the main Matawamkeg beyond). During this time also the great branches of the Keswian were eroding eastward, originating the Washademoak, Grand Lake, Little River and the Nashwaak, a regular radiating series, capturing in early times for the great Keswian the old Nashwian, if that really existed. We can trace also similar effects on the other rivers. Thus it was probably a similar erosion which formed the Magaguadavic northeast of Trout Brook, turning one branch of this valley into another. Such an erosion northeast from the Chepednian valley also probably formed the St. Croix from Mud Lake to Scott's Brook (and Trout Brook beyond), thus early capturing the upper Passama-

*Professor Bailey gives evidence to show that this part of the river occupies a channel dating back to pre-Carboniferous times, which makes its explanation all the simpler. (On the Physical and Geological History of the St. John River, New Brunswick. Trans. Royal Soc. Canada, I, 1883, iv, 283).

quodian. Another similar erosion from the Scoodian at Grand Falls formed the St Croix east to the Canoose (and that river), capturing the Chepednian, while to the westward it formed the Scoodic Lake valley. Changes of a similar general character seemed to have turned the lower Scoodian and the lower Chepednian into the lower Passamaquodian, while others turned the Magadavian into the valley of Bonny River and formed the lower Lake Utopia and lower Magaguadavic, the Latang and its extension between Deer Island and Campobello, Lepreau harbor with its extension northwest of the Wolves and between Campoello and Grand Manan. Of course these erosions may have been and doubtless were, aided by other causes, such as earth movements (synclinal), fault lines, etc., and some of the minor ones may even be of glacial origin only, but all of these influences are really more or less connected, and lateral erosion seems to have been without doubt the leading factor.

The zig-zag form of the present St. John (and of the St. Croix, though much less in degree,) is thus in great part explained. Its semi-circular course around the other rivers (shared in much lesser degree and in the opposite direction by the St. Croix) is due in a broad way to a combination of the tendencies of the waters to continue on their direct courses with the tendency to more rapid erosion in the softer rocks, which together carry the rivers around the margin, as it were, of the hardest and hence more elevated region occupied by the enclosed rivers, Thus gradually was a condition approximating that of the present brought about. The final details were added *first,* by the glacial period, which produced many minor modifications (including perhaps the turning of some streams to the southward), and *second,* by an extensive subsidence which has carried the lower courses of these valleys beneath the sea. The course of events here related is largely independent of any theories of peneplains, etc., but the facts in general are in harmony with the theory of the two peneplains, earlier discussed (Note No. 49), of which New Brunswick appears to be made up. There is here opened up a most attractive field of investigation in the working out of the subject in detail.

76.—On New Aneroid Measurements in New Brunswick in 1903.

Read December 1, 1903

During July, August and September, 1903, I made a number of aneroid measurements of the heights of places in the Province, mostly hitherto unmeasured, with the results below. The instruments and methods were identical with those earlier employed. as recorded in Notes Nos. 53 and 62. I may repeat the opinion earlier expressed, that the results thus obtained are as accurate as can possibly be secured with aneroid barometers under New Brunswick conditions. A few measurements made on the Oromocto are recorded in my note on that river (No. 73) ; I shall here consider only those made in the Tobique-Nepisiguit region.

In Note No. 62, I called attention to the fact that all heights checked from the Chatham base averaged lower than when checked from the Fredericton base, and that the figures show an average difference between the two stations of about thirty-two feet, which ought not to exist. As I had found reason to consider the Fredericton station as without sensible error, I attributed the discrepancy to some peculiarity in the methods or instruments of the Chatham station. I find the same difference this year, though larger in amount, reaching thirty-eight feet, but I have also discovered the explanation in part. A comparison of certain figures shown me by Mr. D. L. Hutchinson with the daily weather maps, suggested that there was a real difference in the average prevailing barometric pressure, independent of elevation, of the two stations, and this is confirmed by the pressure maps published in the latest Report of the Chief of the United States Weather Bureau, which show that the average barometric sea-level pressure through the year is less at Chatham than at Fredericton. The average difference, however, in August, according to the latter map, is not over .0125 of an inch, which answers to about ten feet, leaving a discrepancy of about twenty-five feet to be accounted for in some other way, a subject which deserves investigation. The practical question now arises as to the value to be given the readings of the two stations respectively, in determining the altitudes. Since all of the more important measurements were made on the South Branch Nepisiguit, which is north of Chatham, and since the lines of equal pressure in August run east and west, it would seem to be fair to give full value to those of Chatham, and ignore those of Fredericton; but since it seems clear that there is still a discrepancy not accounted for by the average pressure-difference of the two stations, and since I have cause to think, for reasons given in Note 62, that the Fredericton station is free from this discrepancy, I think it will be fair to give to the control from the Chatham station twice the value of that from Fredericton, and this has accordingly been done in all the following measurements. All figures in italic are heights above mean sea level, and all of the various places in the vicinity of the South Branch are shown on the map accompanying Note 77.

Mount Bailey (Nictor Lake). Adopted height of the lake 850; northwest peak 600 feet above lake, hence *1450*; south peak, 1125 feet over the lake, hence *1975*; east peak, 920 feet over lake, and hence *1770* feet above the sea.

Paradise Pond. (See Note 77 and map). Mean of nine good measurements checked from Fredericton 1251, from Chatham 1221; hence by the above rule the height is about *1230*.

Chief's Mountain. 960 feet over Paradise Pond; hence 2190 feet above the sea. Two measurements checked from Fredericton gave 2236 feet, and from Chatham 2181; these would give, by the rule above, 2199. Averaging this with the direct measurement of 2190, we may accept *2195*.

Scudon Mountain. 830 feet over Paradise Pond, and hence *2060*.

Acquin Mountain. 70 feet under Chief's, and hence *2125*.

Hannay Mountain. 909 feet over Paradise Pond; and hence *2139*.

Fisher Mountain. 895 feet over Paradise Pond; hence *2125*.

Raymond Mountain. 985 feet over Paradise Pond; hence 2215. One measurement compared with Fredericton gave 2184, with Chatham 2181; hence 2182. Averaging this with the direct measurement we have *2198*.

First Forks river surface. One measurement from Fredericton, 1396, from Chatham, 1347; hence by the rule *1363*.

Elizabeth Mountain. 790 feet above the First Forks, and hence 2153 feet. One measurement checked from Fredericton, 2174; from Chatham, 2140; hence by the rule, 2151. Averaging this with the direct measurement, *2152*.

Bald, or Kagoot Mountain (near source of South Branch; fully discussed in Note 72). Mean of five good measurements checked from Fredericton, 2351 feet; from Chatham, 2259;* hence by the rule, *2290*.

Middle Mountain. 120 feet lower; hence *2170*.

Caribou Mountain. 220 feet lower than Big Bald; hence *2070*.

South Branch Nepisiguit, immediately south of Big Bald. 585 feet below Big Bald; hence *1705*.

South Branch Nepisiguit, just south of the Notch. Two measurements checked from Fredericton, 1640; from Chatham, 1575; hence by the rule *1597*. The deadwater just west of Big Bald is probably about *1675*.

Source of the Northwest Miramichi. (See Note 77). One measurement checked from Fredericton gave 1351; from Chatham, 1331; hence by the rule *1338*.

Northwest Miramichi just south of Mount Cartier. Two measurements checked from Fredericton, 1164 feet; from Chatham, 1167 (sic); hence *1165*.

Mount Cartier, or Little Bald. 960 feet over the Northwest south of it; hence 2125 feet. Two measurements checked from Chatham, 2226; from Fredericton, 2174 (sic); hence by the rule, 2212. Averaging this with the direct measurement, *2168*. This mountain, however, is apparently higher than Chief's and any others in the vicinity, and I am inclined to think there is some error in my measurements and that it really is considerably over 2200 feet.**

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*The great difference between these figures suggests some error in my figuring, but comparison of the readings of Fredericton and Chatham at those times shows that the difference really exists in the readings of the two stations.

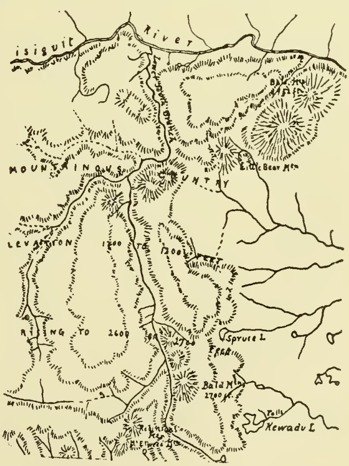
**Nothing, however, can possibly be more deceptive than the apparent heights of mountains viewed from others at a distance, for the eye invariably judges the height according to the distance it rises above its neighbors. Hence a mountain really not very high may seem ot great elevation when isolated among lower hills; and this is the case with Little Bald or Cartier. Again, a mountain really of great height, if rising little above its neighbors, may be thought not to be so; this is the case with Carleton, highest in the Province. There is one thing which makes me think Cartier may really be little or no higher than Chiefs, despite its much greater apparent height, namely, in a photograph of it from Chiefs it stands up very little above the horizon beyond. As the land to the eastward is certainly of lower elevation, this implies that Cartier cannot greatly surpass Chiefs in height.

77.—On the Physiography of the South Branch Nepisiguit.

Read December 1, 1903.

One of the least known of all the wilderness parts of New Brunswick is that drained by the South Branch Nepisiguit. This is because that stream is practically not navigable for canoes from its mouth, while it is extremely difficult of access from any other direction. In August last (1903), in company with my friend, Professor A. H. Pierce, I traversed this stream from its mouth to beyond Bald Mountain near its source. The observations, and some surveys then made, are recorded upon the accompanying map and in the notes below.

The development of knowledge of the river may be briefly traced. It appears first upon the remarkable Franquelin-de Meulles map of 1686, with the name *Attououik*.* It then vanishes from all records, until its mouth is located upon Peters' Plan of the Nepisiguit of 1832, and in 1837 it was surveyed for some fifteen miles by Berton, whose plan, with the addition of a few incorrectly located mountains, was first used on a printed map by Wilkinson in 1859. This was followed by Loggie in 1884, with the addition of Bald and some neighboring mountains, taken from an incorrect plan of 1882 by Freeze, who approached it from the south while surveying timber lines. A great improvement over this map was made in the Geological Survey map of 1887 (or 1888), which embodied the observations of Ells, who was in this region in 1880, and despite its fanciful and erroneous hashure topography, this map has remained the best down to the present.

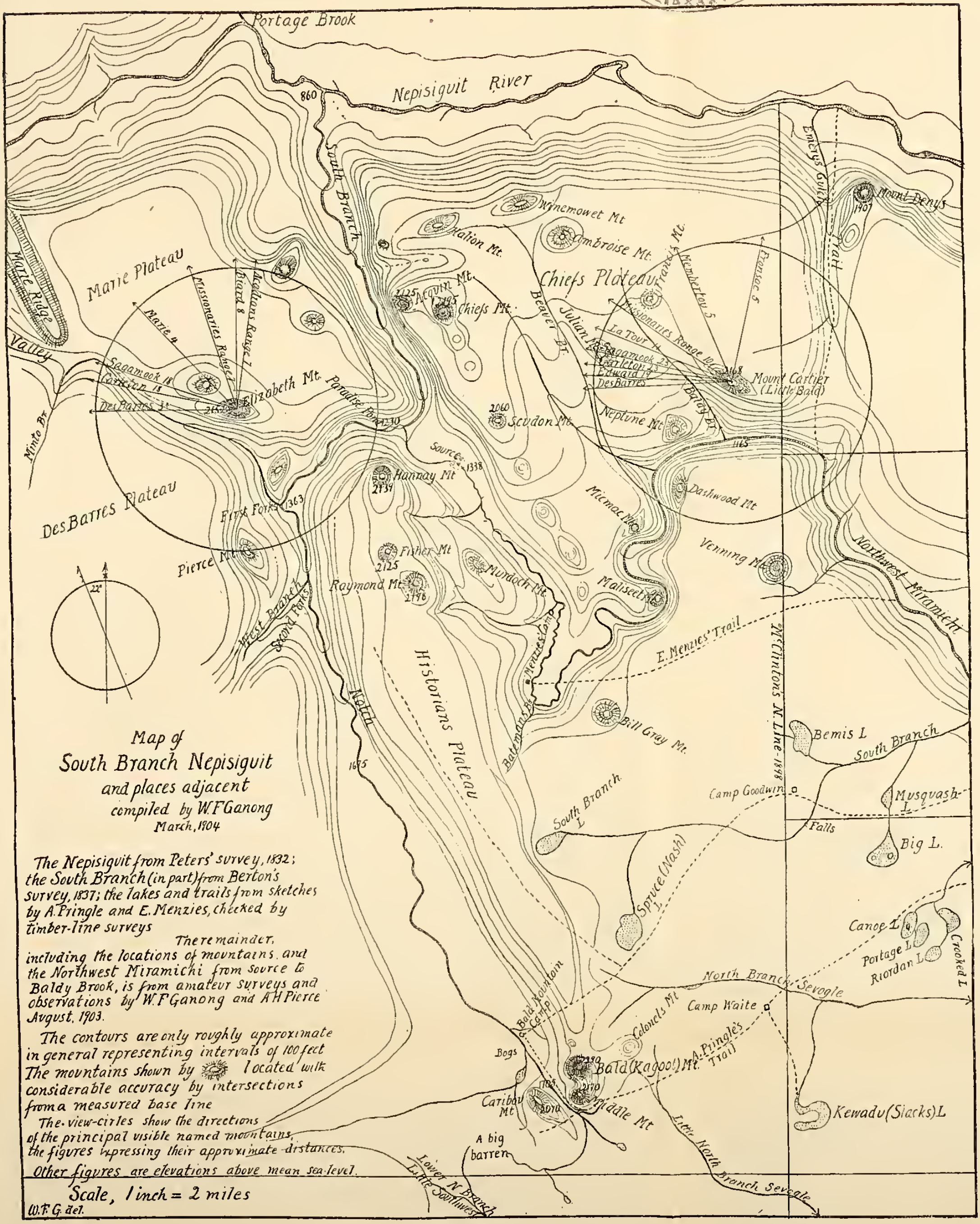


* This map is in Trans. Royal Soc. Canada, III, 1897, ii, 364. On this map the Little South Branch appears as *Kagout*, or *Kagoot*. But as the Micmacs of to-day call the Main or Lower South Branch *Kagikqu*, or as Rev. Father Pacifique writes me *Gagigo;* as Rand would write it, *Kagikkw;* and the Little South Branch, *Paatkunok*, as Father Pacifique gives it *Patganog; Paatkunok*, as Rand would write it, I infer that deMeulles has accidentally transposed these names. Since the Micmac name of this river ought to be preserved, and since the very numerous Bald Mountains of the Province ought to be given at least alternative names, I propose that the Micmac name of the South Branch, in its ancient and simple form used by deMeulles, *Kagoot*, be applied to this mountain.

It is reproduced, though somewhat crudely, in the accompanying cut, which is one-half the size of the original, and which covers the same area as our larger new map illustrating this note. A later sketch of the river in Whitehead's sportsman's map, 1902, adds some lakes at the heads of its western branches.

References to the basin in scientific or other literature appear to be extremely few. The earliest I have found is the mention in Dashwood's "Chiploquorgan," (1871), of a hunting journey he made on foot in 1863 from the mouth of this branch to the head of the Sevogle, apparently along the stream, and he appears to have ascended Bald Mountain and to have gone thence to Kewadu Lake. The next record of a visit is by Ells, in his Geological Report, 1879-80, who gives an account of the geology, and some description of the topography of the region. His report does not made it clear by what route he traversed the country, but he has been so kind as to write me that he went on foot with a hunter from Forty-two Mile Brook via the Northwest Miramichi and Kewadu Lake to Bald Mountain, and thence along the South Branch to its mouth, whence he returned to the head of the Norwest, and thence by Little Bald (Cartier) to Nepisiguit. The only published references to the region since that time appear to consist in a mention in the *University Monthly* for November, 1898, of a visit of some surveyors to Bald Mountain, and an account of the killing of a big caribou on Bald (our Kagoot) Mountain by James Turnbull, in *Recreation* for March, 1899. A number of sportsmen have visited the Bald Mountain district, guided by Mr. A. Pringle, who has a hunting camp at the foot of this mountain (the only human work in the South Branch basin), and a trail thence, as shown on the accompanying map, to the Northwest Miramichi. I can learn of no one who has ascended the lower course of the South Branch by canoe, and it is probable that our canoe trip up its lower ten miles last August was one of the first ascents of it made by white men, and doubtless it was the first by amateurs without guides.* Very little

* We dragged our canoe and load up for some ten miles (a mile or two above the Second Forks) and went the remainder of the distance on foot; afterwards we carried over from near Paradise Pond into the source of the Northwest, and descended that river to Newcastle.


Map of
South Branch Nepisiguit
and places adjacent
compiled by W. F. Ganong
March, 1904
The Nepisiguit from Peters' survey, 1832; the South Branch (in part) from Berton's survey, 1837; the lakes and trails from sketches by A. Pringle and E. Menzies, checked by timber-line surveys. The remainder, including the locations of mountains, and the Northwest Miramichi from source to Baldy Brook, is from amateur surveys and observations by W. F. Ganong and A. H. Pierce August, 1903.
The contours are only roughly approximate in general representing intervals of 100 feet. The mountains shown by located with considerable accuracy by intersections from a measured base line.
The view-cirles show the directions of the principal visible named mountains, the figures expressing their approximate distances.
Other figures are elevations above mean sea-level.
Scale, 1 inch = 2 miles
W. F. G. del.
Portage Brook
Nepisiguit River
860
South Branch
Marie Plateau
Marie Ridge
Valley
Minto Br.
Elizabeth Mt.
Paradise Fork
Des Barres Plateau
First Forks
1363
Pierce Mt.
West Branch
Second Forks
Notch
1675
Historians Plateau
Hannay Mt
2139
Fisher Mt
2125
Raymond Mt
2198
Murdoch Mt
Menzies Camp
Batemans Br.
Scudon Mt
2060
Sources
1338
Acquin Mt.
Chiefs Mt.
Halion Mt.
Winemowet Mt
Ambroise Mt.
Chiefs Plateau
Beaver Br.
Julian Mt.
Mount Cartier (Little Bald)
Neptune Mt.
Baldy Br.
Dashwood Mt
Micmac Mt.
Venning Mt
Maliseet Mt.
Mount Denys
1407
Emerys Gulch
Trail
Northwest Miramichi
E. Menzies' Trail
McClintons N. Line 1898
Bemis L
South Branch
Musquash L
Big L.
Falls
Camp Goodwin
South Branch L
Bill Gray Mt.
Spruce (Nash) L
Canoe L
Portage L
Riordan L
Crooked L
North Branch Sevogle
Camp Waite
Bald Mountain Camp
Colonels Mt
A. Pringle's Trail
Bogs
Bald (Kagoo!) Mt.
Caribou Mt
Middle Mt
A big barren
Little North Branch Sevogle
Kewadu (Slacks) L
Lower N. Branch Little Southwest

lumbering on the river has been done, though some twelve years ago some lumber was driven down it by Lovell Bros., of Bathurst.

The South Branch Nepisiguit is remarkable for three things: its curiously gradual transition from a deadwater near its source to the roughest river of the Province near its mouth; its remarkable hills; and its surprising relations to other rivers. These we shall consider in order.

The river rises in three heads on the northern margin of the great central watershed, one branch coming from the west, another from the south, and another from the east. These streams unite in a great open basin west of Bald Mountain and wander for some two miles through deadwaters and small ponds in bogs and alder swamps. Flowing northward the river then begins to fall, at first gently, and then more swiftly, forming one of the most charming of New Brunswick streams, winding over gravel between wooded banks, much as does the Little Tobique or Upper Nepisiguit. Farther north the basin narrows rapidly by the approach of the forested hills, until the river runs in a narrow winding notch between steep forested hills, with an increasingly swift current over cobbles and small boulders. Issuing from the Notch it flows more swiftly* over boulders between lofty naked hills, and it receives two streams from the westward, after which it makes a big bend to the eastward. It now becomes so swift and broken by rapids and falls among boulders that for the next two miles it is navigable for canoes only with very great difficulty. Near the end of this easterly stretch lies a large pool or pond (Paradise Pond), with charming surroundings, the only quiet waters on the whole lower river, and in this pond are trout of so

*The accompanying map, unfortunately, does not show this winding character of the valley through the Notch, and it fails also to show the similar winding of the rocky valley below Paradise Pond This is because I depended upon Berton's plan for the river to south of the Notch, and I did not discover until too late to make surveys that the map is seriously inaccurate in both of these parts, representing as it does the general course of the stream as straight when it is very winding. I have preferred to follow his plan on this map rather than to attempt to put in the winding from memory.

Ells' description of the stream above the Forks is not strictly correct, or at least is misleading. He says (Report 2): "From the frequency of its falls and rapids, it lower part for about six miles is difficult for canoes, but above this point no such obstacles exist;" again, (34) "above which [the forks, 7 miles from the mouth] the stream for some fourteen miles winds through a low and swampy hollow between high mountain ranges." As a matter of fact the canoeing is difficult for some miles above the Forks, though steadily improving as one ascends, and it only becomes really easy south of the Notch.

wondrous size, beauty, number and voracity that a man doth danger his name for truth if he but tell the fact concerning them. Below Paradise Pond the river again swings to the north, and cuts its narrow valley still deeper (about a thousand feet), between the great bare rocky hills, and from this point to its mouth it is little better than a bouldery torrent, almost unnavigable for canoes, and the swiftest river in New Brunswick. In places the valley becomes so narrow, and its walls so steep, that great masses of granite have fallen into the stream, making falls and rapids of the roughest character, necessitating many portages by the voyager. Finally it enters the valley of the Nepisiguit, which it joins quietly in a great basin. The scenery of this part of the river has been well described by Ells, though with some exaggeration as to the vertical bluffs: "immense mountains, whose white weathering bald sides, often terminating in vertical bluffs of several hundreds of feet, flanked by huge heaps of debris, present prominent features of the landscape. The scenery is among the grandest in the province. Huge hills extend as far as the eye can reach. These are often burnt completely bare, and the mountain rock is entirely denuded of soil; at others small clumps of green woods break the sterile aspect of the country, and indicate the course of some small stream." (Report 33 D). Whether hills are seen from the valley, or the valley from the hills, the aspect is the grandest and roughest to be seen in New Brunswick. The view along this deep rocky valley from Hannay Mountain towards the Nepisiguit, with the basin of that river in the distance, comes the nearest to a genuine mountain view that I have seen anywhere in this Province. So rough is the river that its roar can be heard far back upon the hills, where it forms the most characteristic sound of the region.

The great descent of the river is made more apparent from the levels taken by us with the aneroid at several points. The sources of the river must lie at about 1.800 feet above the sea, for we found the elevation of the river in the vicinity of Bald (Kagoot) Mountain to be 1,705 feet (Note 75). Just south of the Notch we found it to be 1,597 feet, while at the Forks, near Pierce Mountain, it was 1,363 feet. At Paradise Pond it is 1,230 feet; hence the drop in the two miles from the Forks to Paradise

Pond was sixty-one feet a mile. Now the mouth of the river is about 860 feet above the sea (for I estimate it is about fifteen feet below the mouth of Portage Brook,* two miles above), and hence the drop in the lower five miles is seventy-four feet per mile (in some of the miles much more), a greater drop than any other five miles of river in New Brunswick possesses, exclusive, of course, of the vertical drop of lofty falls.

A very notable fact about the river throughout its course is this, that it invariably runs over drift. Ledges in places form the valley walls, and the river washes against them, but not once in its entire course is the valley bottomed by ledges, and the falls are invariably over and among boulders. Moreover, in most places along the river there are distinct boulder terraces, and these are very well marked even in the narrowest part of the lower valley. These facts show conclusively that no part of this river is post-glacial, but that it all flows throughout its course in a pre-glacial valley.

We consider now the mountains of the South Branch, and first note those about its source. Those from among which the three heads of the river descend are somewhat over 2,000 feet above the sea, of gentle contours, and forested. They form a part of the great central watershed of the Province, a remnant of an ancient peneplain which extends both southwest and northeast, as will presently be described. By far the most conspicuous one among them is Bald (also called Big Bald, our Kagoot), hitherto supposed, but erroneously (as I have shown in a previous note, No. 72) to be the highest in New Brunswick, which owes its prominence not to its height, which is 2,290 feet, and but little greater than that of its neighbors, nor even to its elevation above the basin of the South Branch, for it is only about 600 feet above the river at its base, but to a combination of complete and striking bareness, with partial isolation and a bold outline. The view from its summit is fine, but is neither so extensive nor so striking as that from several other mountains in the Province. To the east and south the country is a great featureless plateau, as it is also, though with a little more irregularity, to the southwest and west. To the northwest in the distance the country is much broken,

*875 feet. Note 62.

for here are seen those irregular hills carved from the original peneplain by the numerous streams about the sources of the Nepisiguit and Tobique. To the north one sees the great open valley of the South Branch narrowing to its notch in the northward, and east of that the great wooded dome (higher than Kagoot) which connects this mountain with Raymond and the neighboring mountains to the northward, all of them together forming a single great plateau. To the northeast are the broken hills of the source of the Northwest, and nearer lie the two lakes, Spruce and Kewadu, apparently in ancient north and south depressions. Immediately to the southward extends an outlier of this mountain (Middle Mountain) also bald, and beyond that, across the stream, is another bald summit (Caribou Mountain) some 220 feet lower than Bald.

The summit of Bald Mountain is of granite, which has weathered into several curious boulder-like masses, of which two are very prominent on the summit. Its slopes are covered with a close growth of heath bushes and lichens, mostly very easy to travel over, and intersected everywhere by caribou trails.* Immediately south of the mountain, in the valley of the South Branch, occurs one of the most interesting and attractive associations of vegetation I have seen anywhere in New Brunswick. Very symmetrical, completely cone-shaped black spruces grow scattered in a park-like fashion over a close vari-colored carpet of reindeer moss, dwarf blueberries, mayflowers, and other small heaths, while the park-like aspect is increased by the numerous caribou paths winding here and there among the trees.

Northward of Bald Mountain to beyond the Notch all of the mountains are heavily forested, but about the Second Forks the open burnt country begins and continues to the Nepisiguit. This country, very probably the most extensive open tract in the Province, must have been burnt a long time ago, for all traces of fire, except the bareness, have vanished. The country is very slowly reforesting itself, forming first the usual barren vegetation of lichens and heaths, and upon the turf thus formed there comes in

* On the slopes of these mountains, and also on the open plateaus, occurs an abundance of the Dwarf Birch, *Betula glandulosa*, a plant which appears not to have been reported hitherto from the Province.

the Scrub (or Gray or Banksian) pine (Pinus Banksiana), which is now the most characteristic tree of this open country. Their openness makes these hills very easy to climb and travel over, while they afford suberb views, most charming in themselves and illuminating as to the topography of the region. For the most part, the hills are not isolated, but form summits, more or less distinct, of great plateaus, separated from one another by deep valleys. Of these plateaus, four are distinctly recognizable north of the Notch. First, there is a great wooded plateau (the DesBarres Plateau) west of the Forks, the culminating points of which are the conical Mount DesBarres (named by me in 1898, Note 30), and a gently rising somewhat higher dome south of it. But this group I have not studied, and hence I have not brought it within the limits of the accompanying map. The somewhat isolated Pierce Mountain, west of the First Forks, is an outlying part of it. North of this, however, comes a fine great plateau, *Marie Plateau,* partially wooded, bounded by the South Branch, by the Main Nepisiguit, and by the fine Nictorian valley, to be described below (see the map). The culminating point of this plateau is the great ridge, the northern end of which I have earlier named Mount Marie (Note 30). East of Mount Marie this plateau exhibits some seven distinct peaks, of which one, Mount Elizabeth, (2,152 feet) immediately north of the First Forks, is by far the most important, for it is so elevated and so fortunate in situation that it commands one of the best views in all New Brunswick. From its summit all the important mountains of North Central New Brunswick (as the view-circle on the map but imperfectly indicates), can be seen, and it gives also an admirable view of the topography of this part of the country.

The third great plateau is that named on the map the *Historians Plateau.* It is perfectly continuous with Bald Mountain, and is bounded by the South Branch on the south, west and north, and on the east by the Upsalquitchian valley and the head of the Northwest Miramichi, and by what appears to be a very ancient but shallow valley extending thence southward, and including Spruce Lake.* At its northern end rises the extremely rugged rocky bare summit, Hannay Mountain (2,139 feet); south of it

* Kewadu appears to lie in another shallow parallel valley more to the eastward.

comes another of less prominence, Fisher (2,125 feet), and south of that a well-rounded summit, less conspicuous than Hannay, but really loftier and of wider outlook, Raymond Mountain, (2,198 feet). On the eastern flank of this range, and partially detached, is a lower hill, Murdoch Mountain. Beyond that the plateau appears to rise still higher in several rounded wooded summits, to be named for students of the future, and of which the highest should bear the name Historians Mountain.

The fourth plateau, Chiefs Plateau, is the most striking and important of them all. It is bounded by the South Branch, the Upsalquitchian valley, and the head of the Northwest on the west, by the Nepisiguit on the north, by Emery's Gulch and a line south to the Northwest on the east, and by the Northwest on the south. Two of its summits I had named earlier for Indian Chiefs prominent in early days in the Province, Halion and Winemowet;* hence I propose to name this the *Chiefs Plateau,* and its summits (excepting Mount Cartier, earlier named by me, Note 30), for other chiefs whose names deserve to be held in recollection. Its highest summit, Chiefs Mountain (2,195 feet), (readily recognized by the huge squarish granite boulder on its bare summit), is separated by a small valley from Halion and Winemowet, but to the southward it extends away as a distinct ridge, sloping very gradually in a series of progressively lower and more distinct summits, around the southernmost of which the Northwest swings to the northward. To the eastward the plateau is partially cut by two streams, branches of the Northwest, and shows several partially isolated bare mountains, of which the most important by far is Mount Cartier, which I shall later describe in connection with the Northwest. The Chiefs Plateau** is the barest and most attractive of all the plateaus, and upon its nearly level summit from Chiefs Mountain to Scudon (this latter summit commanding a fine view up the South Branch above Paradise Pond), we measured our base line from which we triangulated the mountains of the vicinity. The granite ledges of this plateau

* I have since discovered that the Seigniors Ridge described by me in an earlier note (Note 30) is simply another view of Winemowet and others south of it.

** I think this fine plateau could most readily be reached by leaving a canoe at the mouth of the South Branch, following the stream on foot to near the foot of Acquin Mountain and climbing the latter to the plateau.

are glaciated to remarkable smoothness (even smoother than typical roches moutonées), and they are so nearly bare of vegetation that the view is unobstructed in every direction, while one may travel over them as conveniently as across cultivated fields or along good roads. It is indeed one of the purest joys of life to stride in full-pulsing health on glorious summer days over such elevated places as this, where the eye may revel in the spacious distances, the spirit may come into sympathetic touch with all benignant nature, and the mind finds satisfaction in the pride of accomplishment as it solves the problems of the construction of this ancient land.

An important question now arises as to the relation of these great plateaus to the great central peneplain or plateau, which I have described in earlier notes as extending from south of the Negoot Lakes (Notes 55, 56, 64) to Patchel Brook, and beyond that to the northeastward of Thunder Mountain. That the plateau in which the South Branch heads is an extension of this same plateau, there is, I think, no doubt. Since the country falls away to the eastward, as the river courses show, it must be that the axis of this old watershed is now represented by the Bald-Mountain-Historians Range, whence it extends across the Upsalquitchian valley to the Chiefs Plateau, after which it extends across the Nepisiguit (this being the only considerable river which anywhere crosses it), and thence away to the northeastward to reach the sea, I believe, in the vicinity of Belledune. In this region it is cut across by three valleys, partially by that of the South Branch south of Bald, by the Upsalquitchian valley and by the Nepisiguit, and here this important watershed is at its narrowest existent part.

We consider finally the remarkable relations which exist between the valley of the South Branch and of other neighboring valleys. In two earlier notes (Nos. 33, 70), I have expressed the belief that the South Branch is the morphological and ancient head of the Upsalquitch, and this view I find fully sustained by these later studies, though the South Branch proves to be more complicated and interesting than I had thought.

The first striking feature of the valley is the remarkable basin of its upper course, which narrows regularly northward, and, as seen from Bald Mountain, seems to slope and empty not northward, but southward. So marked is this appearance that, in 1882, as a plan in the Crown Land Office shows, it seems to have deceived the surveyor Freeze into believing that it did actually flow south, and formed the head of the Northwest Miramichi. This all suggests that morphologically this was a southward flowing valley heading near the Notch, and possibly this may be the case. But I was entirely unable to detect any considerable notch to the southward, through which it may have flowed, though possibly such might exist. It seems to me much more probable that this is a basin of erosion of softer rocks, in which connection it is interesting to note that the granite of Bald Mountain appears to be very soft, for it has weathered remarkably around the bare bosses on the summit.*

The second curious relation of this valley to others consists in the existence of a very remarkable valley extending from the First Forks northwest towards the southern extremity of Mount Marie (and for this distance occupied by Minto Stream), whence it swings somewhat more to the west and extends as a very distinct valley, clearly visible from the summit of Mount Elizabeth, all the way to Sagamook and Bernardin, between which it seems to pass. The presence of this remarkable valley is one of the most striking features in the view from Elizabeth Mountain. I have not myself traced this valley except from the mountain, but I recall two other references to it. In 1863 Professor Bailey, in examining Feldspar Mountain, came upon what he describes as a great chasm to the southward of it. Again in a manuscript map kindly sent me by Mr. J. W. Hoyt, showing his timber-surveys in that region, there is marked just south of and parallel with the Nepisiguit east of Little South Branch a "deep dry ravine." Apparently, then, we are here concerned with a single old valley running from the present head of the South Branch through by way of this valley to the mouth of the Little South Branch, including here, perhaps, a little of the Nepisiguit valley, and thence by the valley between Teneriffe and Cooney, by the Nepisiguit lakes,

* Not only on this mountain, but on Chiefs and Historians Plateaus as well, there are remarkable "pot holes," a foot or two in diameter and up to a foot deep, evidently the result of aerial erosion perhaps aided by fire effects.

the portage valley and Nictor Lake. But, traced so far, it can be traced beyond this in the upper course of the Little Tobique as far as the right-angled bend of that river. This upper South Branch valley represents, I believe, the old head of the Nepisiguit-Lake-portage valley-Nictor Lake valley of which I spoke in earlier notes (Note No. 33, 45), and the entire valley represents the primtive course of a river which arose in the Central Highlands and flowed into Bay Chaleur waters when all the northern Silurian Basin drained that way, if it did not run by an earlier course clear across that Silurian Plateau into the present St. Lawrence river. This valley should be named for the river and lake still occupying a part of its ancient course, *the Nictorian.* We are not without evidence as to the causes which have fragmented this valley as we find it at present, but this subject I expect to treat in a future note.

The third remarkable relation of the South Branch to other valleys is found in the striking valley which lies between the Historians Plateau and the Chiefs Plateau, and which is a perfectly direct continuation of the part of the South Branch valley lying north of Paradise Pond. This valley is as distinct, deep and as old as its northward continuation in which the South Branch now runs. It is, happily for the physiographer (and the canoe portager) mostly open burnt country, so that all its characters may be clearly seen. It is bottomed, and clearly at its northern end dammed, with glacial drift, and less than a mile from the North Branch, and some 100 feet above it, lies a swamp from which one brook runs northward into the South Branch, and another runs southward and forms the present head of the Northwest Miramichi. This latter stream has a gentle slope southward, as will later be described (Note 78). All the evidence seems to show not only that this valley is an old head of the South Branch, but that it emptied into it in immediately pre-glacial times. Its extreme head I was unfortunately not able to trace, but I have little doubt from the appearance of the country from the neighboring hills, that its head is to be found in a southerly continuation of the valley, very probably in the vicinity of Spruce Lake, if not farther southward. The true morphological head of the South Branch, therefore, and hence of the Upsalquitch, was on the east, and not the west, of the Historians range, and it was later, though still very ancient, changes which turned the upper courses of the Nictorian river into this *Upsalquitchian* valley by the short easterly reach between the First Forks and Paradise Pond.

Finally we notice the possible economic future of this region. It is absolutely impossible for agriculture, and almost valueless for timber, for it will require generations to reforest the region (if it can ever be done), and such little lumber as exists is mostly too expensive to bring out. No minerals are known to occur there, and the nature of the formations does not promise wealth of this kind. It is, however, a great game country, especially for caribou, which find on these barrens their congenial home. This suggests its only apparent economic future, which is as a hunting ground, and the only question is how the Province may best realize the greatest advantage therefrom.

Place-Nomenclature.—Following is the origin of names used on the map. Some of them were given previously to this year, as noted earlier in this paper:—*Denys* for Nicolas Denys, early French Governor of all the North Shore; *Cartier* for Jacques Cartier, the explorer; *Winemowet* and *Halion,* for Indian chiefs, early prominent in the province; *Marie,* for Marie (Madame) de la Tour; *DesBarres,* for a prominent early surveyor of our coasts; *Emery's Gulch* is probably for some early hunter or lumberman; *Minto Brook,* of course for the present Governor General of Canada, is from a plan, showing its head, by W. B. Hoyt. Of the new names, *Elizabeth* is for Louise Elizabeth Joibert, born at St. John in 1673, wife of one Governor General of Canada and mother of another; *Kagoot* is the Indian name of the South Branch; *Scudon* is a simplified form of Chkoudun, Indian chief at St. John in 1606; *Ambroise,* for Ambroise St. Aubin, an "august and noble" chief on the St. John in 1777; *Julian,* for a family of Micmacs friendly to the whites; *Francis,* for a chief at Miramichi in 1761; *Acquin,* for Gabe Acquin, a well-known chief and hunter, who died at St. Marys a few years ago; *Neptune,* for Louis Neptune, prominent chief of the Passamaquoddies; *Chiefs,* simply for Indian chiefs and to answer to Acadians and Missionaries Ranges near by; *Micmac* and *Malisect,* for the two Indian tribes of New Brunswick; *Notch* is descriptive; *Hannay, Raymond, Fisher,* and *Murdoch* are the names of the principal historians who have written on New Brunswick; *Pierce* is for my companion of the voyage; and *Paradise Pond* is in memory of a place at our home in Northampton, Mass., and of the happy time we had there; *Dashwood,* for the man who first published an account of this region; *Venning,* for Mr. W. H. Venning of Sussex, a veteran sportsman, who as a young man fished on the Northwest and has seen much service for the province; *Bill Gray,* for Mr. Ells' guide in these parts.

The names of various places supplied to me by Mr. Pringle: *Middle, Caribou, Crooked, Canoe, Portage, Spruce, Big,* are obviously descriptive, while *Riordans, Nash, Slacks, Bemis, Colonels* and the camps *Goodwin* and *Waite,* are for sportsmen who have visited them on hunting expeditions in recent years. The latter names represent a new and not especially welcome element now being introduced into New Brunswick place-nomenclature. Each year the guides push farther into the wilderness in search of new hunting grounds and the sportsman, nearly always an American, who happens to be with them when the first moose or caribou is killed, has his name attached to that lake or hill, and these names will undoubtedly persist. Indeed one or two such names have already been applied by one guide at least to some of the places I have re-named. These names, however, are not yet fixed and are used only by one guide, I believe, and, moreover, as I have since found, some of the places are known to lumbermen by entirely different names. I think it quite proper under these circumstances to re-name them, although, as a rule, I prefer to adopt on my maps the names in local use. *Batemans* is a lumberman's name. *Kewadu* is said to be an Indian name, Micmac for Indian devil.

78.—On the Physiography of the Basin of the Northwest Miramichi.

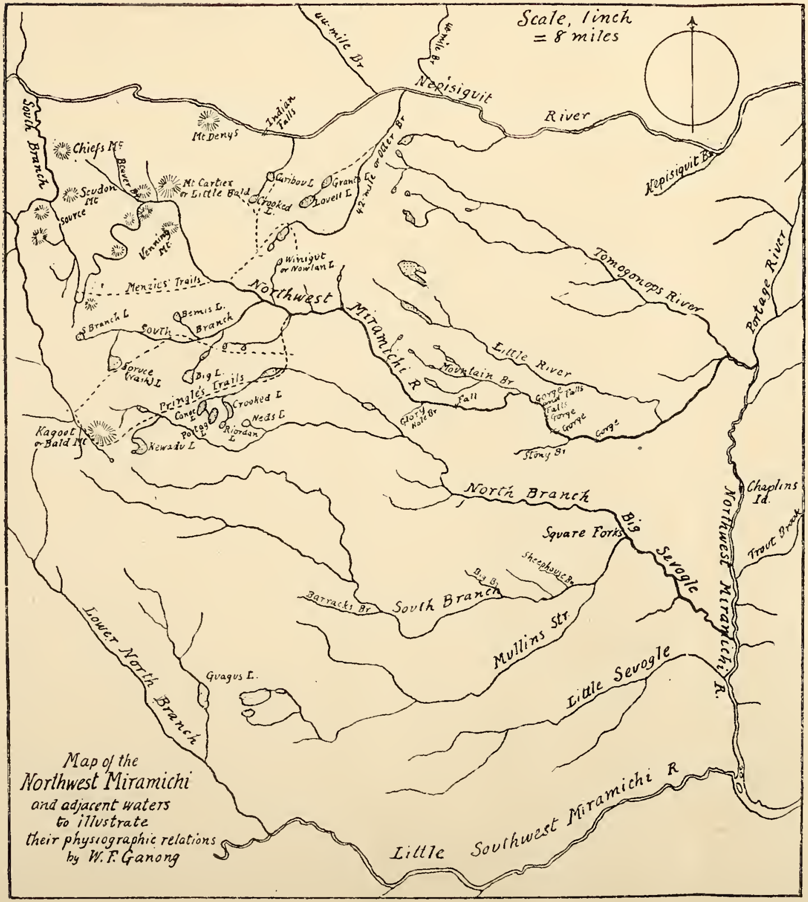
Read January 5, 1904.

One of the least known, though in many ways one of the most interesting, of our rivers is the Northwest Miramichi. In early September last, in company with Professor A. H. Pierce, I descended it in a canoe from its extreme source to its mouth, and made the observations which, with some related matters, here follow.

We first note the development of our knowledge of the river. Its lower course appears imperfectly and without name on French maps by Jumeau in 1685, and by Franquelin-deMeulles in 1686; it is first given the name *Minaqua* (the Micmac *Mool-mun-ak-un,* still used) on a French map of 1754, which name was followed on many other maps, though the river to which it becomes applied on most of them is the Little Southwest, and not the Northwest. On modern maps its lower course below Portage Brook is first shown, from a sketch, on Bonnor, 1820, but it is first laid down from survey on Lockwood's map of 1826. Above Portage River to near the South Branch it was first surveyed (and the country laid off in five-mile timber blocks) by Peters in 1836, and his plan is followed on Saunders' map of 1842, with some extension at the headwaters on Wilkinson of 1859, and with further additions at the headwaters on Loggie of 1884. Loggie's map was followed with but very slight changes by the Geological Survey map of 1888, and this has remained the best down to the present. Parts of its branches, and many of the old timber lines have been resurveyed in recent years by Hanson. No map whatsoever up to the present has correctly represented the position of its source and the curious course of its upper valley, and these appear with approximate correctness for the first time on the map accompanying an earlier note, No. 77.

The lower course of the river was early settled by the descendants of the Loyalist and Scotch settlers of the Miramichi, to whom some later immigrants have been added, and settlement has gradually extended up to the mouth of Portage River, and somewhat above. Above that the river is, except for some five or six fishing and hunting camps, and a few lumber camps, an entire wilderness, abounding in all kinds of big game, while the river itself is one of the finest of salmon streams. Except at its head it flows through forested country, which has yielded great quantities of lumber, and lumbering is still actively carried on every year.

Of literature, scientific or other, relating to the river, there is very little. Hardy's "Forest Life in Acadie," (1869, page 240), refers to the excellent salmon fishing on it, and refers to a portage to the Nepisiguit, doubtless that by Portage River. Dashwood's Chiploquorgan (1871, 60), seems to show that in 1863 he portaged from Kewadu Lake to this river, and descended it in part to Newcastle. The geology of the river was studied by Ells, who in 1880 (Note 77) crossed its headwaters, and the same year studied the lower river below the Winigut Lake Branch. His results are


Scale, 1 inch
= 8 miles
Nepisiguit
River
Nepisiguit Br
Indian Falls
Mt Denys
South Branch
Chiefs Mt
Scudon Mt
Source
Mt Cartier
or Little Bald
Venning Mt
Caribou L
Grant L
Lovell L
Crooked L
42 mile or Otter Br
Winigut
or Nowlan L
Menzies' Trails
Northwest
Miramichi R
Bemis L
S Branch L
South Branch
Spruce Wash L
Big L
Pringle's Trails
Crooked L
Canoe L
Neds L
Portage L
Riordan L
Kewadu L
Kagoot
or Bald Mt
Tomogonops River
Portage River
Little River
Mountain Br
Fall
Glory Hole Br
Gorge
Falls
Gorge
Gorge
Gorge
Stony Br
North Branch
Big Sevogle
Square Forks
Sheephouse Br
Big Br
Barracks Br
South Branch
Mullins Str
Little Sevogle
Northwest Miramichi R.
Chaplins Id.
Trout Brook
Lower North Branch
Guagus L.
Little Southwest Miramichi R
Map of the
Northwest Miramichi
and adjacent waters
to illustrate
their physiographic relations
by W. F. Ganong

recorded in his Report for 1881, and upon the Geological Survey maps. Later, in 1886, the surface geology of the lower river from Tomogonops River downwards was studied by Chalmers, whose comments upon it are contained in his Report for 1888, and upon his surface geology map. Many sportsmen have visited the river in recent years, for salmon, or for moose and caribou, but, aside from scattered notes in sporting journals, none of them appear to have published any accounts of their adventures.

In its physiographic characteristics the river falls into five sections, which I shall now describe and discuss separately.

First Section. *From the source to Cartier (Little Bald) Mountain.*—The Northwest rises in a wooded swamp lying in the deep valley which is an extension of that in which runs the lower course of the South Branch Nepisiguit (see map accompanying note No. 77). This swamp is but little over a mile from the South Branch, into which it sends also a small brook. The Norwest flows east of South through a series of short open boggy deadwaters and alder-grown abandoned beaver ponds, separated by short stretches, mostly through woods, of little fall through boulders, until, somewhat over two miles from the source, it unites with another stream of nearly equal size, coming in part from behind Murdoch Mountain, and apparently in part from farther south. This upper two miles is to some extent navigable for canoes in fair water, though with more portaging than floating; the portaging, however, is very easy because of the open barren character of the country. Below the Upper Forks the stream swings somewhat west of South for nearly a mile and a half farther, and is readily navigable for canoes. At first there are some obstructions from shoals, and, after entering the woods, from deadfalls, but gradually it becomes an open, easy and very charming canoe stream, with little fall, gravel and boulder bottom, clear water, and pleasant wooded banks. Finally it makes a great bend to the eastward, receiving here a considerable stream from the south, and flows northeast, entering the remarkable region of steep, conical, perfectly bare, rocky hills amidst which it winds in a very deep sinuous valley down to Mount Cartier, receiving two important branches from the north on the way. This part of the river, as well as the part above to its source, is everywhere drift-bottomed, but the fall steadily increases, though the stream is without obstructions, so that with its swift clear current, gravel bottom, winding course and superb hill views, this part of the Northwest is one of the most charming pieces of canoe water that I have seen anywhere in New Brunswick.

We consider now the probable physiographic origin of this interesting part of the river. I have already pointed out (Notes 70, 77) that the source and upper four miles of the river lie in a valley which is a continuation of, and morphologically the head of, the valley of the South Branch Nepisiguit, which in turn formerly emptied by Portage Brook through the Upsalquitch, the entire valley being properly called the Upsalquitchian valley. Moreover, the presence of the very obvious glacial dam between the source of the river and the South Branch Nepisiguit shows that this valley doubtless emptied into the South Branch in immediately pre-glacial times. The remainder of the river down to Cartier is very much of a puzzle, and its history is intimately associated with the causes which have formed the remarkable, nearly isolated, conical hills here prevailing. That these have been carved by numerous streams (perhaps anciently flowing southeast) from the great central peneplain seems most probable, but the particular method awaits more detailed study than I could give the problem. It is very probable that Beaver Brook, the stream flowing from the Chiefs Plateau east of the Chiefs Ridge, is the true morphological head of the Northwest, and that the part thence to the Upsalquitchian valley is an old branch of it. All this part of the valley throughout is typically pre-glacial, the river flowing entirely over drift in a valley which, while deep and narrow, is obviously by no means new, and may be very ancient. An important question now arises as to the place and nature of the preglacial connection between this and the Upsalquitchian valley. We would expect that a post-glacial gorge or valley would be found just where the southward flowing upper course turns to the eastward, but in fact no such post-glacial portion appears, and I can only surmise that the quantity of drift thrown down in both these valleys was sufficient to completely bury the pre-glacial rock-boundary between them.

A notable feature of this part of the river consists in the remarkable hills already mentioned, all of those near the river being burnt completely bare. They have been hitherto unnamed, and I have given some of them names for reasons stated in Note 77. Among them one stands out with especial prominence, the one I named in 1898 *Mount Cartier*, and known to the guides and others as *Little Bald*. It has a bald, squarish top, almost like a "table-mountain," which, with its superiority in height over all others in its vicinity, makes it conspicuous from every direction, and causes it to seem to stand up higher than it really does.* The view from its summit is certainly one of the best in the Province, for it embraces all of the principal mountains of north central New Brunswick, and a wonderful expanse of typical northern wilderness, with boundless forests, interspersed here and there with anciently burnt barrens, which, with their occasional oases of vegetation, curiously simulate cultivated, and even park-like, landscapes.

SECTION 2. *From Cartier (Little Bald) Mountain to near Glory Hole Brook.*—Below Cartier the river swings to the south and later to the southeast, and down to the entrance of the South or Spruce Lake Branch it continues an ideal canoe stream, winding swiftly, but mostly smoothly, over gravel and amid alders and woods in a deep valley amid fine hills. In this part of the river are some beautiful pools filled with small salmon, which spawn here. At the entrance of the Spruce Lake Branch (much smaller than the main river), which enters in a large open basin, the character of the river begins to change, and it becomes broader and shoaler, and flows more swiftly over small cobbles and with some boulders. The valley also is now not so deep, and the hills, all heavily forested, begin to assume the flat-topped and continuous character distinctive of plateau or peneplain country. These characters become more and more marked in descending, the valleys become broader and riper, the hills lower and more plateau-like, and the river bed broader, shoaler, and with more drop. Finally after passing the bend above Glory Hole Brook the first ledges extending clear across the river are met with, and a new section of the river is reached.

The physiographic history of this part of the river seems

* It is not much, if any, over 2,200 feet. Compare Note 76.

sufficiently plain. It is the original valley of an ancient river flowing out of the central watershed, one of that radiating series established on the first elevation of the central watershed. It is possible that its present course past Cartier may not be the original one, but that it may have run across more directly to the present head of the river.

SECTION 3. *From above Glory Hole Brook to below Stony Brook.*—We now approach the most remarkable part of this most interesting river. At the bend above Glory Hole Brook, ledges extending across the stream are first met with, and below they become more frequent. The river has more fall, and becomes gradually rougher, making canoe navigation difficult, until finally, two miles below Glory Hole Brook, is a vertical ledge fall of some eight feet. Below this the river becomes still rougher, with incessant rocky rapids and low falls down to Mountain Brook, and a mile or more beyond, when it plunges over falls through a fine irregular post-glacial gorge (with a portage of a quarter-mile on the right bank). This is one of the wildest and roughest river gorges in New Brunswick, and its impressiveness is increased by the fact that one can view its entire length, with all its falls and irregular cliffs, from a single view-point, at a bend midway of its length. Below this the river continues rough for half a mile, when it plunges into another irregular gorge with fine falls and pools, in some ways wilder, though smaller, than the one above. There is here a portage of 160 yards on the right bank past a salmon club-house. This house, like the others above and below it, is reached by portage roads, cutting directly across country from the settlements to the southeast. A short distance below this gorge comes another, with typical vertical walls, but straighter and with smaller falls, so that a canoe can be worked through it with one short portage, though it would be easier to portage around it. Below this the river continues rough for a mile or more, when suddenly there loom up the great cliffs at the head of the finest gorge on the river, and in many ways the finest in the Province. The river here cuts across an elevated ridge or hill range, and above the vertical cliffs can be seen the lofty wooded hills extending off on both sides of the river. The walls of this gorge are almost perfectly vertical, and rise higher than any other cliffs I have seen in New Brunswick, nearly, I should say, 200 feet, and much higher than those of the Grand Falls of the St. John. The view from the top of these cliffs into the narrow gorge is one of the wildest I have seen in New Brunswick. The falls are insignificant, however, and possibly a canoe could be worked through it at low water; there is a portage of 500 yards over the hill on the left bank. Below the gorge the river continues somewhat rough, and for half a mile further the fine great cliffs continue on one side of the river or the other, though the river here does not fill the valley, and has not the typical post-glacial character. When these grand cliffs end the valley begins to open out, and continues to broaden, and the river becomes less rough, down to Stony Brook, where a new section of the river begins.

Considering now the physiographic origin of this section of the river, it is obvious that it is all very recent and mostly post-glacial. It seems to me plain, therefore, that the entire river from the bend above Glory Brook to Stony Creek is not in its ancient valley, and that either (1) there is a pre-glacial channel from that bend to Stony Creek along the south of the river and parallel with it, or else (2) the upper course of the Northwest flowed in pre-glacial times by some valley now drift-filled from the Glory Hole Brook Bend into the Sevogle to the south, in which case the present valley probably is that of Mountain Brook, into which the river was turned by the damming of its southern outlet. It is quite possible also that we are concerned not only with a post-glacial, but with an "interglacial" course of the river, for the remarkable cliffs below the gorge are certainly not in a typical post-glacial valley, and yet they certainly do not belong to an ancient river valley, for, except for the greater width of the valley here, they seem as new as the post-glacial cliffs of the gorge itself.

SECTION 4. *From Stony Brook to Portage River.*— Below Stony Brook the river flows over gravel and boulders instead of ledges; it is broader, shoaler and with less fall, making canoe navigation easy when the water is of fair height. The country becomes much lower, and finally quite flat, and seemingly little above the river level. In the upper part of this section there are occasional cliffs on one side or the other of the stream, and about a mile below Stony Brook the river passes through an interesting gorge, which appears not to be post-glacial, but probably belongs to the type described elsewhere as "inter-glacial," for, while it has vertical cliffs on both sides, the stream flows through it over drift, and its bed does not fill the gorge. Finally as the river nears the junction with Little River it is flowing over a broad shoal bed with low banks, rising to occasional cliffs on one side or the other, through a country showing no hills above the vegetation of the banks. It now bears a remarkable resemblance to the part of the Nepisiguit between the Narrows and the Grand Falls, and probably has had a similar origin and history. This character is preserved to the Tomogonops, a dark-colored stream from the northwest, or approaching which fertile intervales with some signs of cultivation begin to appear.* Here the river swings into what is obviously the Tomogonops valley, which it follows to Portage River, through a charming level country between intervales and terraces.

This part of the river is certainly puzzling physiographically. Its swing to the northeast when the general direction of the valleys of this region would lead us to expect a southeast course, suggests that the part below Little River at least should be post-glacial, but it obviously is not. Its course from Little River to Tomogonops suggests that it may have had a pre-glacial outlet into the Nepisiguit by way of Portage River, and this may have been the case, unlikely as it seems. An objection to this is that the same explanation would seem to have to be given for the direction of the South Branch Sevogle just above the Square Forks, and this is hardly at all probable. On the other hand this curious northeasterly turn is characteristic not only of this river and the South Branch Sevogle, already mentioned, but of other branches of the Miramichi, Dungarvon, Renous, Little Southwest, etc. (see map with Note 50), and of the Nepisiguit above Grand Falls, so that this change of direction of them all would seem to be due to a common cause. The Geological maps show that in general this common change of direction occurs just west of the line of Lower Carboniferous rocks, and hence it may in some way

* The arrangement of the rivers on the map suggests that Little River may at one time have followed the brook emptying near Tomogonops.

be connected with their presence. It may be that it represents the general line at which these many rivers, flowing radially out of the great central watershed, met the eastern Carboniferous plain, which had a general northeasterly slope. Another possible explanation of the part of the river under consideration is that while not post-glacial, it may be "inter-glacial," and hence not older than the glacial period. In this case a pre-glacial channel ought to exist running southeast to near Chaplins island. As confirmatory of the "inter-glacial" character of much of this valley, I may mention one striking fact. At the "inter-glacial" gorge a mile below Stony Brook, the river cuts through a lofty ridge, probably nearly 200 feet high. Now just west of this ridge, and parallel with it, is a deep, broad valley running nearly north and south, seeming to show that the original drainage was south or southeast, not east, as at present. And I fancied elsewhere that I detected evidence of a similar north and south drainage between ridges having that direction. But my visit was too hasty to allow me to obtain other evidence upon this interesting question.

In an earlier note (No. 33) on the physiographic history of the Nepisiguit River, I made the suggestion that some of the features of its course below Indian Falls are best explained by supposing that it is a composite river, parts of which formerly (of course in times long pre-glacial) flowed into the Miramichi system. I have no new evidence at present to offer, but all facts available seem to me in harmony with this view. In this case it is likely that Tomogonops headed in the main Nepisiguit near Indian Falls, and Forty-four Mile Brook was the head of that part of Nepisiguit below it, while Little River headed in Upper Forty-two Mile Brook, and the valleys in which its source-lakes lie.

Section 5. *From Portage River to Red Bank.*—At Portage River the Northwest turns to the south and keeps that general direction to Red Bank. For the most part the river flows with a strong current over gravel, and occasionally among boulders, but there are frequent long stillwaters and pools, and in one place at least its course is over ledges and through a small post-glacial gorge. The banks are mostly intervales and terraces, all well settled, but occasionally there are low cliffs on one or the other side of the river. Altogether it is a charming river, bringing ease to the canoeman fresh from the labors of rapids and portages on the river above.

The origin of this part of the river has been traced in an earlier note (No. 50). Its morphological head was no doubt Portage River, and the valley in which they lie is part of an anticlinal trough containing also the Lower Nepisiguit, and the curious right-angled bends in the Main Southwest Miramichi. No doubt this great trough has been formed by an uplift of the country to the eastward. Many details, however, remain to be worked out in this region, and it is one of the most attractive physiographically in the Province. The post-glacial bed and gorge below Trout Brook probably indicate nothing more than a slight change in the course of the river, and some search would no doubt reveal the pre-glacial channel of the river either to the east or the west, though if it should prove that the Northwest emptied pre-glacially into the Nepisiguit, this gorge would probably mark the position of the pre-glacial divide.

SECTION 6. *From Red Bank to the Main Southwest.*—This part of the river belongs morphologically to the Little Southwest, though it bears the name of the Northwest, this custom having originated, without doubt, in the desirability of making a clear distinction between it and the Main Southwest. Its physiographic history as the lower part of the Little Southwest is sufficiently plain. It is tidal, and a typical drowned valley.

79.—ON ADDITIONAL NATURAL CURIOSITIES SAID TO OCCUR IN NEW BRUNSWICK.

Read February 2, 1904.

In an earlier note (No. 57), I mentioned a number of curious natural objects or places reported from various parts of the Province, all of which seem deserving of investigation. It is worth while to ascertain the truth or falsity of such reports, and besides one may thus be led to some discovery of genuine scientific interest. Some others which have lately come to my notice are now to be described.

The Rumbling Mountain and Burning Mountain of Tobique.

In the former note (No. 57), I mentioned the statement made by residents on the Tobique that there is a spot on Blue Mountain which is much warmer than the surroundings; and also that there exists on the Wapsky a mountain from which strange rumblings are heard. During the last summer I was told by one of the best guides on Tobique, in all sincerity, that the mountain with the warm spot and the rumbling mountain are one and the same, that it is on the Odell, eight miles up on the southwest side of the portage road, and that it is commonly known both as the "Rumbling Mountain" and the "Burning Mountain."

The noise is heard only occasionally, and is said to resemble thunder, and persons new to the region are said to be much astonished when they heard what they take to be thunder from a clear sky. The ground is described as so warm that snow never lies long upon it, and leaves, etc., soon dry up. There is probably some exaggeration in these statements, but I believe they have some basis, which should be scientifically tested.

Abnormal Magnetic Variations.

Magnetic variation in New Brunswick is referred to in Note 58, but no cases of abnormal variation are there mentioned. Mr. W. B. Hoyt, deputy surveyor, of Andover, writes me that, as a result of studies he has made upon old surveys by H. M. G. Garden, he has found a certain variation in a part of the survey of Green River, which, "I am satisfied, indicates a small area of magnetic depression, and may be connected with an erratic movement on Green Mountain, which is founded, I think, probably on the existence of iron ore in that neighborhood."

Another and much more striking case is recorded upon Playford's "Plan of the Survey of the North Line of the New Brunswick and Nova Scotia Land Company Purchase," 1833, (in the Crown Land Office), which, at a spot not far southwest of Miramichi Lake, has this legend: "Find the magnet attracted from four to ten degrees."

The Poison Spring of Lake Stream.

A valued correspondent, Mr. P. H. Welch, of Fulton Brook, Queens County, writes me that at the head of the Lake Branch of Salmon River are two lakes (which, by the way, are not marked on any existent map of the Province), at the head of the upper of which is a spring, "the waters of which appear to be poisonous to fish. Perhaps a half ton or more will be found dead where they come from under the ice to drink the spring water. This occurs mostly in winter."

The publication of this note in the *Daily Telegraph* for February 13, 1904, brought me a communication from Mr. I. T. Hetherington, of Johnston, Queens County, who says: "The fact that thousands, in some seasons tons, of suckers, chubs, horned pouts and pickerel die annually in this lake, seems to be a fact patent to all lumbermen and hunters who frequent these lakes in the last part of February and March. The cause thereof has been much discussed by them. Some contend, as does Mr. Welch, that the spring poisoned them. But I am informed by our most experienced guides that the water in both summer and winter is a fine drinking water, cool in summer, and so warm in winter that it never freezes over. As the dead fish always are in greatest quantities when the snow is heaviest, it seems to me not improbable that when it becomes darkest under the ice on account of heavy snows, the fish press to the light, and as the open space is then so small as not to allow room for movement to the great numbers that congregate there in such quantities, those coming in under the others naturally lift the top tier above water and they freeze. This is as Fish-warden Curry explained it to me, and in my opinion it is the correct view. For the lumbermen use the fish as food, and if they had been poisoned they would certainly leave some bad effects on those who eat them." Dr. Hetherington also adds: "It is also said there are horned pout in those lakes weighing five to eight pounds, also a species of sucker or carp, also weighing seven to eight pounds."

I do not guarantee any of these statements, but I have no doubt they have a substantial basis in fact. Here is a grand opportunity for some of our young naturalists, who should survey those still unsurveyed lakes and their surroundings, investigate the fish life of those waters, study the vegetation in contact with the spring water, and bring out an ample supply of the latter for chemical analysis.

The Coal Creek Salt Springs.

Mr. Welch has also given the following description of the Coal Creek Salt Springs, which appear to be entirely undescribed in our scientific literature: "They rise out of a gravel bed or bar about a foot or more above low water, and are covered in high spring freshets. They are about ten feet across either way, and about a foot deep, and they taste quite salty. They are on the right bank ascending the stream, and about thirteen miles from its mouth." He also adds that they are the greatest resort for moose in New Brunswick. The study of these springs may yield some botanical results of interest, although the high freshets may prevent the occurrence there of a typical halophytic flora, such as the Sussex springs possess. (Note No. 7).

The Boulder Hill on Coy Brook.

Mr. Welch has also given me a description of another natural curiosity, in substance as follows: There is a curious rock formation on Coy Brook, a branch of Lake Stream. It occurs on the right bank as one ascends, five miles from Lake Stream, and half a mile above the forks of the brook. On the top of a high ridge, on the highest part, there is a heap of loose boulders (many would weigh 400 tons), piled up like a pyramid without any clay between them. Some are split, the parts lying ten feet apart, showing their fracture, with other rocks lying between them. One can go in through them, so loosely do they lie. The pile is perhaps thirty feet high, and the base covers nearly one-fourth of an acre. A lot of loose stones have rolled down and away from the pile for perhaps fifty feet. From the pile there runs a ravine which looks as if it has been a brook, but it is now dry.

Caves, Underground Waters, Etc.

A number of additional cases of those interesting phenomena have been cited by Professor Bailey in his paper read before this Society recently, and published in the present Bulletin.

Can any of my hearers give any further information about these places?

80. —The Walrus in New Brunswick.

Read April 5, 1904.

It is generally known that the Walrus or Sea-cow (*Trichechus rosmarus*) formerly occurred along the north coast of New Brunswick, but the evidence for its occurrence is not readily accessible. Cooney, (Northern New Brunswick and Gaspé, 1832, page 30), speaks of its former (traditional) occurrence on Portage Island, Miramichi; and Perley, (Reports on the Sea and River Fisheries of New Brunswick, 1852, page 33), speaks of the former prosperous fishery for these animals at Point Miscou, and tells us that on his visit to Grande Plaine, near Point Miscou, in 1850,—

The bones of the Walrus which had formerly been slain there, were found imbedded in the sand in large quantities, and in good preservation, some of the skeletons being quite complete.

So far as I can find, these two are the only positive original references to its presence in New Brunswick waters in the accessible New Brunswick literature.* Very much more exact and very satisfactory information on the subject, however, occurs in the very rare and little known book, "Narrative of an Extraordinary Escape out of the Hands of the Indians in the Gulph of St. Lawrence," by Gamaliel Smethurst, published in London in 1774. In the course of the description of his journey, in October to December, 1761, from Nepisiguit along the coast to Baie Verte, the author has the following references to the Walrus:

November 20. The Frenchman where I lodged, and most of the village [on the site of the present Neguac Village] set off this morning for Point Miscou, to hunt sea-cows for their oil, which they make use of in winter instead of butter. (Page 18).

December 9. Came to a large river, called Chedaick [Shediac] . . . . A sea-cow lifted its head out of the water, and came swimming after the canoe—the Frenchmen soon shot it—it had 2 large teeth out of water in the upper jaw pointing downwards—these serve for defence, to climb rocks with, &c.—a full grown sea-cow will make two barrels of oil in autumn, when they are fattest—they are easily killed with a ball—very unwieldy—

*Adams' Field and Forest Rambles, 39, and Gilpin, Trans. Nova Scotia Institute of Nat. Science, II. 126, also refer to the subject, but with no new facts.

An interesting account of the Sea-cow fishery in Prince Edward Island is given by A. B. Warburton in "Acadiensis," III, 116-119.

much like Anson's sea-lions*—I believe of the same species—this was larger than an ox—The French use the oil of these creatures to their meat—it is to me as rank as seal oil—The most noted places for their present resort, are the islands of Magdelines, and Point Miscou; but the sea-cows, wild fowl, Indians, and beaver, will leave us as we settle in the country, and go to places less frequented. (Page 24).

This is the only recorded observation of a living Walrus in New Brunswick waters known to me, and very satisfactory it is.

Two years later, in 1763, Smethurst, as he tells us in his book, was shipwrecked near Pictou, Nova Scotia, and made his way, in December, along the coast to Baie Verte. Near Tatamagouche Harbour,—

We passed by a great many rocky points, on one of which was a young sea-cow asleep—I went softly up to it before it awoke—exceedingly like Anson's sea-lions; only this had no snout, but a long brizly beard—we had no gun with us—upon Mr. Richardson's advancing, it started and slid down the rock into the sea—it was not quite the size of an ox. (Page 32).

Again, when near Tidnish, and nearly famished,—

saw some sea-cows upon the rocks—Mr. Richardson intercepted two calves, and easily killed them—they were very fat like seals—Stopt and made a fire—dressed some of the sea-veal, which we eat greedily—it would at another time have tasted very strong; but now we thought it very delicate.

It would be interesting to know when this animal became extinct upon our shores. It is very probable that the relentless onslaughts upon it as the country gathered population after 1767 soon drove it from these shores. It does not now occur nearer than Labrador.

* He refers here to the sea-elephant, formerly called scientifically *Morunga ansonii*, a huge seal of the Southern hemisphere.

NOTE BY THE EDITOR.

Relating to the Life of Dr. A. Gesner, the Geologist.

In Bulletin XIV of this Society will be found a life of Dr. Abraham Gesner, who made the first geological survey of this province. Many interesting incidents of Dr. Gesner's career are given in this biography, and it led to the writing of a letter from a grandson of the geologist to the secretary of this Society, giving additional details of Dr. Gesner's lineage, and a correction on one point:

"Arthur T. Gesner, Assistant Rector of the Shattuck Military School, Farebault, Minn., the writer of this letter, says that the founder of the family in America was John Gesner, of Old Tappan on the Hudson. His son, John Gesner (Jr.), born 1724 * * * and his wife were buried in the old graveyard at Old Tappan. Of their eight children, six sons and two daughters, *Henry* was the ancestor of the Nova Scotian branch; he married Sarah Pineo, May 4, 1786. Of their twelve children, Abraham (the sixth) was born May 2, 1797, at Halifax, lies buried in the Camp Hill cemetery in that city." This was the geologist.

Mr. Gesner also claims that the story that Major Andre was executed on the property of the Gesner family is a "tradition," and not substantiated.

ARTICLE V.

RECENT EARTHQUAKES IN NEW BRUNSWICK.

By Samuel W. Kain.

In an earlier Bulletin of this Society (No. XVI, pp. 16-22, 1898), I gave a short account of earthquake shocks felt in this province of which a record was obtainable.

Since the publication of that article some shocks have been felt, and it may be of interest to briefly record them. The time given in all cases is Atlantic Standard (60th meridian).

1898. August 14; 3 a. m.

Shock on St. John river between Torryburn and Oak Point; felt most severely in vicinity of Oak Point. Not felt in city of St. John.

1903. December 17; 10 p. m.

A shock felt in Upper Keswick and part of the Tobique valley, and also at Bathurst. A Fredericton despatch to one of the St. John papers thus refers to it: "Residents of Upper Keswick who were in the city to-day report that a distinct shock of earthquake was felt in their locality at 10 o'clock last night. It rattled dishes and window panes, but did no damage."

Mr. Craig C. Williams, of Maple Veiw, Tobique, in a letter to Professor W. F. Ganong, written some days after, thus refers to this shock: "One night last week there was a shock of an earthquake, or a rumbling, shaking noise heard in all the camps on the right hand branch of Tobique. In some camps the men got up and went out to see what was the matter. It was heard in six camps, one quite close to Bald Peak. It was not heard on any other part of Tobique."

In a letter to the writer, dated at Bathurst Village, April 13th, 1904, Dr. G. M. Duncan, one of our corresponding members, says: "Before New Year's a light quake felt here." This probably refers to the shock of December 17th.

1904. February 27; 11 p. m.

The same observer says: "There was a very slight tremor about 11 o'clock Saturday night, February 27th.

1904 February 28; 8.37 a. m.

This earthquake was of considerable violence, and was felt in parts of northern New Brunswick, more particularly in the region about Bathurst. Dr. G. M. Duncan wrote me thus about it: "This shock was preceded by, or announced by, a noise like a gunshot, loud and sharp, giving the impression of rending a large rock. It was followed at once by the sound that seems to introduce all quakes—a sound like the blowing of a high wind. Then came the noise of a grinding and the sound of grinding with the tremor of the earth and buildings. Rev. Mr. Read thought the sound was a gunshot on the roof of the manse."

1904. March 21; 2.04 a.m.

This earthquake was markedly felt in New Brunswick, Nova Scotia and New England, and naturally excited much interest throughout the region where it was felt. The daily newspapers gave very full accounts of the shock as felt in New Brunswick, and I have also secured some additional facts by correspondence with observers outside of St. John. The shock was undoubtedly one of the most violent felt here, but was not quite so severe as that of October 22, 1869. At the time of writing I have not seen any careful accounts of the shock observed outside of this province. From what evidence I have been able to get, it would appear that the shock was more violent in and about St. Stephen than elsewhere. I gather also that the motion was from southwest to northeast. There is very considerable difference of opinion as to the interval between the two shocks. Some observers say two minutes, some three, some four. Mr. H. E. Gould, of Sussex, who was awake reading at the time, tells me that the first shock took place at 2.04 a. m., lasting about fifteen seconds, and that after an interval of four seconds a second shock was felt lasting about ten seconds. Mr. C. F. Tilley made a like estimate of the time. I was not awake at the time, and so knew nothing of the matter till this morning. I will now give a few notes on the effect experienced at different places in the province.

St. John.—Many people were aroused by the shaking of houses and beds. In some parts of the city dishes and doors rattled. The shock was felt most severely in buildings erected on clay and gravel areas. The most marked result of the shock was a crack sixteen feet long in wall in Jones' brewery. This building is built on a deposit of gravel, sand and clay. Plaster was cracked in a house on the corner of Broad and Carmarthen streets. Mr. Charles F. Tilley, of the customs, informs me that at his house on the west side of the harbor, at the corner of Ludlow and Water streets, the shock was very pronounced, throwing a large silver dish from a marble top sideboard to the floor. A number of glasses and cruet stands on the same sideboard were overturned. Mr. Tilley's house is built on a deposit of clay and gravel.

Mr. D. L. Hutchinson went to the Observatory before daylight and found the standard clock going and in good order. He took a set of star observations for time correction and found that the clock was correct.

Bathurst.—Dr. G. M. Duncan says: "It lasted about twenty seconds. Judging by the position of my bed, and the wave-like motion of my bed, I concluded that the shock was from southwest to northeast. This was followed in about five minutes by a slight tremor quite distinct. It was less distinct in Youghal, fifty miles off."

St. Stephen.—It would seem as if the shock was felt at St. Stephen more severely than in any other part of the province. Several chimney tops were thrown to the ground, some bricks were loosened from the walls of the Methodist church, and a number of panes of glass were broken in the Chipman Memorial Hospital. A locomotive in the C. P. R. roundhouse started forward and had to be stopped by the driver in charge. One correspondent, in a letter to Prof. W. F. Ganong, says: "The pictures were hanging cornerwise the next morning." A number of people reported a third shock at six in the morning.

St. Andrews.—The shock was well marked in this town and vicinity. In some cases dishes were thrown to the floor and ornaments rolled over. On Minister's Island a crack was made in the corner of the stone wall of a house on the VanHorn farm.

Grand Manan.—One of our corresponding members, Mr. D. I. W. McLaughlin, of Grand Harbor, sent me very full notes on the effect of the shock there. It was not so violent as at St. Stephen.

NOTES ON CAMBRIAN FAUNAS, NO. 9.

In the Transactions of the Royal Society of Canada, the writer has from time to time offered additions to the Cambrian faunas under the title of "Studies, or Notes on Cambrian Faunas." The following may be considered a continuation of those notes:

PROTOLENUS.

This genus is represented at a later time in Europe in Anomocare of Angelin, found in the Upper Paradoxides beds of Sweden. This genus like Protolenus was characterized by an elongated eye-lobe, and usually by a cylinderical glabella ; the species also in most cases had a broad anterior limb to the moveable cheek. This latter feature is not clear for *A. lœve* from Angelin's figure,* but it is more evident from Gronwall's represtation.** This character seems to have been overlooked by authors who haye referred to Anomoacre species with shorteyelobes, perhaps depending on Angelin's figure of the type species.

But while Protolenus has a rather broad anterior limb to the fixed cheek, it has not the exaggerated expansion found in most of the Swedish species of Anomocare; neither has it the small lobes found on the fixed cheeks near the glabella in most spiecies of this genus; the variety *bituberculatus* of *P. paradoxoides,* however, has a small swelling near the base of the glabella, corresponding nearly to that seen in *A. aculeatum* (= *difforme).* It is probable that the pygidium was more feebly developed in Protolenus than in Anomocare, and at least one species of the former (*P.* (*B.*) *articephalus*) had one more joint in the thorax than Angelin represents for any species of Anomocare. Nevertheless there may have been a relationship of descent between the two genera, Angelin's being the later.

* Pal Scandinav; Tab. xviii, fig. 1.

** Bornholms Paradoxideslag, Tab. 4 fig. 8.

ARTICLE VI.

NOTE ON THE GENUS HYLOPUS OF DAWSON.

By G. F. Matthew, LL.D., F.R.S.C.

Read November 3, 1903.

Sir Wm. J. Dawson describes the several footprints of quadrupeds of the Carboniferous age obtained from the Joggins, Parrsboro, Horton and Sydney, Nova Scotia, under the two genera, Sauropus and Hylopus.

The latter genus being Dawson's own, it behooves us to examine the types and learn what its characters are. He defined the genus Hylopus as follows: " Smaller footprints [than Sauropus, Lea] digitigrade, and made by animals having a long stride, and hind and fore feet nearly equal. Five toes. Probably footprints of Microsauria, and possibly of Dendrerpeton."*

This genus was based upon three species described in Sir William's " Air-breathers of the Coal Period,"** and figured in the same essay, but not then named; in the later essay they have names given them, and an additional species is described. There is so much variation in the form of these footprints that they cannot all be contained in the genus Hylopus, and it becomes necessary to select a type or types to represent the genus. There are two forms which appear to come nearer the ideal of Dawson's genus than the others, these are *H. Logani* and *H. Hardingi.*

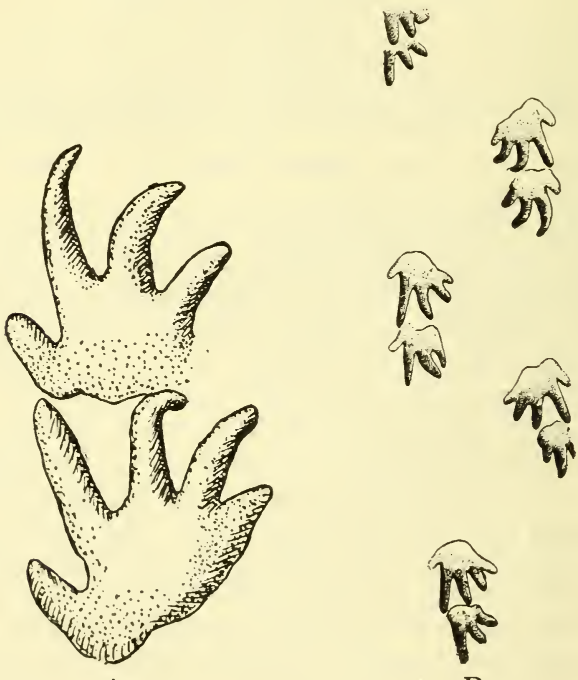
It would appear from the figures given in the " Airbreathers" that both of these species were described from casts, one of which, *H. Logani,* is in the Redpath Museum, Montreal, the other, *H. Hardingi,* in that of King's College, Windsor, N. S. Both species are of Lower Carboniferous age, and come from measures underlying the Carboniferous limestone. The author has been favored with an opportunity to examine both of these casts, and

* Trans. Roy. Soc. Canada, Vol. XXII, Sec. iv, p. 77, 1894.

** Air breathers of the Coal period . . . . . of Nova Scotia, Montreal, 1863.

so has seen the objects on which Sir William has based the genus Hylopus.

The series of footmarks which are the type of *H. Logani,* are supposed by Sir William to have been made in soft mud by an animal partly water-borne, and they are decidedly "digitigrade," in some cases only the long middle toes scrape the surface of the



A B

FIG. 5.—Hylopus Hardingi, Dawson. A—Print of the hind and fore foot, B—A series of footprints, one-fourth of the natural size.

mud, and were not impressed upon it, and in the most distinct only the toe-marks are preserved, hence the track is truly digitigrade. But this is not the case with any of the other species; all of them have the print of the sole of the foot preserved.

The imperfection and irregularity of the track in *H. Logani,* which by Sir Wm. Dawson himself is said probably to be that of an animal partly water-borne, prevents one from using this as the type of the genus; we therefore fall back on the second species as the one which can be taken as a generic type. This species is *H. Hardingi.*

The first reference we have to this fossil is in Lyell's Elements of Geology (New York, 1866, p. 510), where the author says: "Footprints of two reptiles of different sizes had previously been observed by Dr. Harding and Dr. Gesner on ripple-marked slabs of the lower coal-measures in Nova Scotia, evidently made by quadrupeds walking on the ancient beach, or out of the water, just as the recent Menopoma is sometimes observed to do."

The footprints are again referred to in Dawson's Acadian Geology (London, 1868, p. 356), with figures). Here Sir William says (p. 356) that Dr. Harding, of Windsor, when examining a cargo of sandstone from Parrsboro, N. S., found on one of the slabs a very distinct series of footprints, each with four toes, and a trace of a fifth. Dr. Harding's specimen is now in the museum of King's College, Windsor. Its impressions are more distinct, but not very different otherwise from those found at Horton Bluff [*H. Logani.*]

According to "Airbreathers," (p. 9, Explanation of Plates, Fig. 2), the figure of *Hylopus Hardingi* is from a rubbing taken by Professor How, of Windsor College, and was evidently taken from the cast of the fossil. Prof. How apparently failed to perceive and to indicate the impression of the sole, or "heel," and so the drawing appears to be taken from a digitate print, whereas the imprint shows plainly that the animal rested on the sole of the foot as well as on the toes, in walking. There is therefore no species of Hylopus in which the impression of the sole is entirely wanting, except that of *H. Logani,* whose peculiar impressions we have noted above.

There is a marked advantage in the regularity as well as in the distinctness of the tracks of *H. Hardingi* to the observer who wishes to learn what the characteristics of the genus Hylopus are, for they show distinctly the sole of the foot, and so approach a type of footmark common in the Carboniferous system. Hylopus, therefore, was made by an animal which did not walk on the toes alone, but also pressed the sole of the foot to the ground.

Hylopus (as represented in the species *H. Hardingi*), clearly had five toes to the hind foot, but the fifth toe of the forefoot is mistakenly shown. In his "Airbreathers," Sir William Dawson says (p. 7): "One pair of feet [the hind feet?] appears to have had four claws; the other pair may have had three or four." So that the number of toe prints is variable in *H. Hardingi*, but it better represents the type of the genus than *H. Logani*.

Sir William's description of *H. Hardingi* is as follows ("Airbreathers," p. 8): "Dr. Harding found on one of these slabs a very distinct series of footprints, each with four toes and a trace of the fifth."

As the stride in *H. Hardingi* was five and a half inches, the track was probably that of an animal more than twice this length, *i. e.*, more than a foot long. The width of the track was two and a half inches.

In this species the print of the inner pair of toes was faint, indeed as regards the fore foot there was not any print of the first digit. There were, especially as regards the fore foot, three master toes, which always made a strong impression; in the hind foot this preponderance of the three central digits is not so marked, but still it is observable. The absorption, or weakening of the side toes, was thus in progress in these early forms. This process, if continued mainly in the forefoot, would in time give a species which would have the characters of Asperipes, in which the forefoot shows only three toe marks, but the hind retains five, and a form of footprint, not unlike that of the hind foot of *Hylopus Hardingi*.

The tendency to this absence of the print of the outer toes is seen in the more advanced footmarks in the typical series of footprints of *H. Hardingi*, where only three toe marks can be observed in the print of the fore foot.

In examining the track of this animal in detail, it will be seen that the creature had the habit of placing the hind foot directly behind the fore foot in walking, so that the two prints made by these feet were just clear of each other. An exception is seen in the first track of the series where the print of the hind foot overlaps that of the fore foot; and a partial exception is seen in the second pair of footprints where the third digit is flexed, apparently by coming in contact with the fore foot before that had been removed to make another step. In the succeeding footsteps of the series it will be observed that the toes are not bent, for in these cases the two feet did not interfere.

The reduction in the number of the toe marks of the hind foot in such ungulate forms of moderate size as Hylopus cannot be traced to forms with fewer toes, for though there are several genera that possess five toes on the hind foot, I know of no genus hitherto described with four, except the blunt-toed genus Nanopus. But in species of a smaller size, Ornithoides presents us with a form in which the three master toes of each foot, only, are represented in the foot mark. Further than this the reduction in the number of digits seems not to have gone; at least the author is unacquainted with any Carboniferous species having a smaller number of toe prints than three.

In offering conjectures about the known animals which might be represented by these footmarks, Sir William Dawson, in his "Airbreathers," compares *H. Logani* to Dendrerpeton, but in his latter work, in the Transactions of the Royal Society of Canada, he favors the view that the Microsauria, notably Hylerpeton and Hylonomus, are the creatures which most likely left these footmarks. These Sir William separates from the Labyrinthodonts, as their teeth do not have the involved foldings of the enamel which Labyrinthodonts possessed. Other writers consider the Microsauria as a section of this order. In any case the footprints of Hylopus conform more to those of Amphibia than to those of Reptiles.

Since writing the above, I have received a letter from Prof. Geo. T. Kennedy, of King's College, Windsor, N. S., who has examined the original of *Hylopus Hardingi* in the museum of that college; and he states positively that there is no basis for a fifth toe in the print of the fore foot. The slight protuberence in the cast of that foot in one of the figures, he says merely represents one of numerous little projections scattered over the stone, and is not actually related to the footprint alongside of which it occurs. This finally disposes of a possible fifth toe in the impression of the fore foot of Hylopus, as in neither *H. Logani* nor *H. Hardingi* can it be said to exist.

It is true that there is a fifth toe to the footprint of *Hylopus minor,* Dawson, but the heavy print of the sole in this marking does not conform to the ideal of Dawson's genus. On the whole, we conclude that five toemarks of the hind foot and four of the fore is the typical number for Hylopus.

ARTICLE VII.

PHYSICAL ASPECT OF THE CAMBRIAN ROCKS IN EASTERN CANADA, WITH A CATALOGUE OF THE ORGANIC REMAINS FOUND IN THEM

Observed and described by G. F. Matthew, LL. D., F. R. S. G.

Read April 5, 1904.

About twelve years ago the writer contributed to this Society a "List of the Fossils found in the Cambrian rocks in and near St. John." Prefixed to this list was a synoptical view of the groups of Cambrian strata in this district, with statements of their approximate thickness; four sections were given. See Bulletin X, page xv.

These sections form the basis of the estimates of the thickness of the Cambrian rocks in the St. John basin, and of the nature of the sediments of which the Cambrian system here is composed. Other sections, showing further details of the strata and comparing them with Cambrian rocks in other countries, will be found in the Transactions of the Royal Society of Canada, Vol. VIII, Sec. iv, pp. 123-130, and Vol. VII, Sec. iv, p. 142.

The range of the several species of animals that are found in the Cambrian of this district is shown in the same Transactions, Vol. V, Sec. iv, p. 161; Vol. X, Sec. iv, p. 16, and a full table of the species in Vol. XI, Sec. iv, pp. 113-119.

Since the list first above referred to was published, many additions have been made to the Cambrian faunas of this region, and studies have been extended over a wider field, and the time has now come when a more general review of the Cambrian deposits can be profitably made. The Atlantic seaboard of America has in the meantime been the field of study of a number of noted geologists, both those connected with governmental geological surveys, and of those who are students from universities, as well as of others who are amateurs. In this way a considerable fund of knowledge has been accumulated, which helps to a better understanding of the problems involved in the study of the Cambrian rocks.

For a thousand miles along the Atlantic coast of North America the Cambrian sediments show a remarkable uniformity, both in the composition of the materials that form the strata, and in the similarity of the succession of members of which these stratified deposits are composed.

The same physical causes appear to have operated with much uniformity throughout Cambrian time along this coast from Massachusetts to Newfoundland, giving rise to a parallel series of strata in all the undoubted Cambrian districts.

As the following remarks are based on the conditions in explored Cambrian areas, it may be said that these are five in number, viz., Eastern Massachusetts, Southern New Brunswick, the Southeastern side of Nova Scotia, Cape Breton Island, and the peninsula of Avalon, in Newfoundland.*

Of the Cambrian age of portions of the rocks that have been referred to this system in Nova Scotia, some doubt may be expressed, for though large areas in that province have been referred to the Cambrian, and have been closely studied by capable geologists, no distinctively Cambrian fossils have been found. And the enormous thickness claimed for the quartzites would seem to imply that their base would have come within the region of severe metamorphism, if not of fusion, since their deposition. It is far in excess of the known thickness of strata in the undoubted Cambrian areas to northwest and northeast of them. Also no beds similar to the Basal Cambrian as known in the areas to the northwest and northeast, have been found at the base of the Cambrian in the peninsula of Nova Scotia. It seems, therefore, not impossible that this Nova Scotia Cambrian may include a part or the whole of some more ancient system.

Confining our attention to the areas where Cambrian fossils have actually been found, we note throughout this North Atlantic

* There is another area in northwestern New Brunswick, but neither the succession of members nor the faunas can be fully paralleled with those above named; it is therefore not considered in this account.

region the prevalence of volcanic deposits, or of red and green mud beds, in the initial period of Cambrian time. If the former are not actual lava flows, or the cores of old volcanic cones and ridges, they are the compacted ashes, mud and stones from such a source.

Resting on these volcanic deposits, though sometimes intercalated with them, are beds of sand and mud that easily show their relation to such a source as the volcano, by the fact that this sand consists largely of feldsphatic particles, while the mud beds are pale green, or red accumulations of volcanic dust, that have fallen into or been swept into the sea. Hence it would appear that while the first volcanic eruptions occurred over land surfaces, the land soon sank, and the later ones were thrown into the sea. It is in the levigated volcanic material thus thrown into the sea, or swept into it by rivers, that we meet with the earliest organic remains of the Cambrian time. These levigated deposits are chiefly in the Etcheminian terrane, and contain a very ancient group of Cambrian organisms. They also exhibit a cycle of deposits corresponding to that of the St. John terrane above them, for they have in the middle coarse sandy sediments, that separate two groups consisting largely of mud-beds; of these the lower has conglomerates and sandstones intercalated, while the upper are found to contain flaggy sandstones.

The principal sandstones, however, are in the middle member, which is comparatively barren of fossils, but contains much diffused hematite, giving the rock a markedly red color. These beds also, like those of the corresponding stage of the St. John terrane, frequently show ripple-marked layers replete with worm burrows, worm trails, and other marks of a shallow-water origin.

The oscillations of land and sea in this earlier part of Cambrian time in the areas of Southern New Brunswick and Cape Breton exhibit the following succession of conditions:

1st.—An emerged region that became loaded with volcanic deposits—lava, ashes and scoria.

2nd.—A sinking of the earth's crust, so that later ejections were cast into the sea, and the wash from the still emerged surfaces added to the accumulating deposit.

3rd.—A moderate elevation of the crust bringing the affected area near the sea level.

4th.—Renewal of the subsidence, with prevalence of more tranquil conditions than in the second stage, and a longer continuance of these conditions.

This period closes Etcheminian time, and there is a break, more or less distinctly marked between it and the later Cambrian. In New Brunswick there is a sandstone or a quartzite at the beginning of the latter, with a decided change in the color and aspect of the sediments, and in Cape Breton a conglomerate marks the transition to the later terrane. In Newfoundland the conglomerate base is more faintly marked in the west (Smith Sound), but sufficiently distinct in the east (Conception Bay). The reverse conditions of surface distribution prevail in Massachusetts, where fine sediments are found in the eastern part (Boston) but conglomerates are found on the west side of the area (Attleboro',) As previously remarked, the Etcheminian terrane has not been found on the mainland of Nova Scotia, where gray quartzites appear to be the oldest sediments

In the outer areas of the Cambrian rocks of the Atlantic coast the Etcheminian terrane is easily traced by the prevailing red color, as well as by its fossils. In this outer-zone fine slates prevail, and there are beds of limestone as may be seen in the Massachusetts and Newfoundland areas. In the inner zone (New Brunswick and Cape Breton) the sediments are coarser and limestones are wanting; it is in this inner zone that a middle member of sandstones and flags is most distinctly marked.

The organic remains of this middle member are similar to those of the lower sediments, so that the Etcheminian rocks have only two faunas, an upper and a lower. The volcanic rocks beneath them have yield a scanty fauna, which may not be more than a sub-fauna of the Lower Etcheminian. More material is required to determine the importance of this fauna.

So far as the St. John terrane is concerned, it is clear that the basins we have now are but fragments of deposits that have been spread over large areas of the Atlantic coast, and there may be extensive tracts occupied by slates and flags so far metamorphosed that Cambrian fossils cannot be recognized. The materials which make up the flags and slates of the Johannian division (see below) glisten with water-born particles of mica, the sands are of uniform texture, and there are no traces of shore lines, though shallow water beds abound.

Also the Bretonian division, with its fine grained dark gray mud beds holding graptolites, and the perfect preservation of its delicate organisms, indicate the presence of a water-cushion of considerable depth above its muds, when these were being deposited, a cushion which we can hardly think was less than 1,000 feet deep. But a sea of this depth would have covered a wide area along the Atlantic coast, and we therefore infer that the known basins of Cambrian rock are but small fragments of the wide spread mantle of sediments that covered this region at the beginning of Ordovician Time.

The group of organic remains of the outer zone of the Etcheminian rocks appears to differ widely from that of the inner. This may be because they do not come from the same time-horizon; but it seems more likely to be due to some physical cause, either difference in the depth of the sea in the two zones. or paucity or abundance of sediment in the waters, or difference of temperature of the sea water in the two zones. Whatever the cause, Olenelloid trilobites have not been recognized in the strata of the inner zone, while they are characteristic of the faunas of the outer zone.

In the following catalogue the several districts where the fossils described in it were found are indicated by letters in the fourth column, viz.:

A is eastern Massachusetts (Boston to Attleboro'). No fossils from this are mentioned, because the author's work did not extend there.

B is southern New Brunswick. The numbers following indicate the basin of this area where the fossil was found, numbered from N. W. to S. E. These basins once united, have been separated by crustal movements and great denudation.

C is the peninsula of Nova Scotia. No characteristic fossils are known from this area.

D is Cape Breton. The basins of Cambrian rocks are indicated as those of New Brunswick by numbers.

E is the area of Avalon in Newfoundland. The more important basins are indicated by numbers.

N is the St. Lawrence valley area, from which a few fossils are named.
W is the Cambrian area of Mt. Stephen, in the Canadian Rocky Mountains.

The date of publication of the several species and varieties is indicated in the first column.

In order to make this catalogue more useful for reference, and so that it may serve as an index to the author's papers, the names of the species, etc., are arranged alphabetically in the several classes, and the place of publication is shown in brief, thus:

R. S.= Transactions of the Royal Society of Canada.
S. R.= Report on the Cambrian Rocks of Cape Breton, Geological Survey of Canada, 1903.
N B.= Bulletin of the Natural History Society of New Brunswick.
N. Y.= Transactions of the New York Academy of Sciences.
C. R.= Canadian Record of Science, Montreal.
Acad. Geol.= Acadian Geology, Sir J. W. Dawson.
Pal. Foss.= Palæozoic Fossils of E. Billings.
A. J. S.= American Journal of Science and Arts.
Pal. N. Y.= Palæontology of New York, Jas. Hall.
Quar. Jour. Geol. Soc.= Quarterly Journal of the Geological Society of London.
Geol. Mag.= Geological Magazine, London.
U. S. Geol. Survey = Bulletin of the U. States Geological Survey.
U. S. Nat. Mus.= Bulletin of U. States National Museum.
Can. Nat.= Canadian Naturalist, Montreal.
Geol. Verm.= Report on Geological Survey of Vermont, Adams.
Am. Geol.= American Geologist, Minneapolis.
Palæon. Scan.= Palæontologica Scandinavica, N. Angelin.

The last column of the list shows the faunas and sub-faunas that have been recognized in the Cambrian terranes in the Maritime Provinces of Canada, beginning with the oldest. The following symbols are used:

Co.—COLDBROOK TERRANE. This consists mostly, sometimes entirely of volcanic flows and ejectamenta, though in Cape Breton there are some shales and conglomerates.
E.—ETCHEMINIAN TERRANE. (Basal Cambrian).
E. 1.—Lower Etcheminian red and gray shales, etc.
E. 2.—Lower Etcheminian red sandstones. This and E. 1 contain the *Lower Etcheminian Fauna* (Holasaphus Fauna).
E. 3.—Upper Etcheminian red and gray shales, etc. This has the *Upper Etcheminian Fauna* (Holmia Fauna).
C.—THE ST. JOHN TERRANE. (Mostly Cambrian, but the uppermost beds are Ordovician).

C. 1.—*The Acadian Division,* has two faunas.
C. 1*a*.—A white-gray quartzite (no fossils).
C. 1*b*.—Greenish gray shales and sandstones (Protolenus Fauna).
C. 1 *c*1.—Gray shales (Paradoxides lamellatus sub-fauna).
C. 1 *c*2.—Gray shales (P.—— eteminicus sub-fauna).
C. 1*d*.—Dark gray shales (P.—— abenacus sub-fauna).
C. 1 *d*2.—Dark gray shales and limestone lentiles (Dorypyge sub-fauna).
C. 2.—*Johannian Division,* has one or more faunas.
C. 2*a* & *b*.—Gray quartzites, flags and slates (Upper Paradoxides Fauna).
C. 2*c*.—Gray flags and slates (Place of Olenus Fauna).
C. 3.—*Bretonian Division,* has four faunas.
C. 3*a*.—Dark gray slates, some flags (Parabolina Fauna).
C. 3*b*.—Dark gray slates, limestone lentiles and seams (Peltura Fauna).
C. 3*c*.—Dark gray and black slates (Dictyonema Fauna).
C. 3*d*.—Dark gray and black slates (Tetragraptus Fauna).
C. 3*e*.—Gray flaggy sandstones (Fauna of small brachiopods, not distinctive).

It should be explained that the relative position of one of these assises is determined by the palæontology and not supported by the stratigraphy. In the St. John basin (B3 of the locality Column). *Paradoxides abenacus* is *clearly* subordinate to (underlies) *P. eteminicus.* But in Sweden the position of the representative species is reversed, for *P. Tessini* there is below *P. exsulens.* In the Kennebecasis basin (B2) at Hastings' Cove, the *P. eteminicus* fauna is wanting and the *P. abenacus* rests on an assise having a peculiar grouping of species (Dorypyge sub-fauna),which contains genera of a higher range in Sweden and North America than *P. Tessini* and *P. abenacus*.. The latter form of trilobite is usually found in dark gray or black shales, and it seems likely that habitat has much to do with its perplexing relation to other species and genera. It lived in deep and quiet waters, while the *exsulens-eteminicus* type preferred shallower water in which species with calcareous tests and shells were common.

The Dorypyge sub-fauna, also preferred shore or shallow-water conditions. These prevailed on the border of the Kennebacasis basin (B2) until a sinking of the land brought in a purely *P. abenacus* fauna. This fauna is included under the symbol of C1d2 given above, while C1d is the *P. abenacus* fauna of the St. John basin.

Another fauna of doubtful position is that marked C3e, which is placed as the highest fauna, because both at the east and west end of the St. John basin it is in the highest visible beds of the St. John terrane; hence it is thought that this fauna is of later origin than the others.

Catalogue of Species, and varieties of Organic remains found in the Cambrian terranes of the Atlantic provinces of Canada, &c., described in the writer's publications, alphabetically arranged.

Year	Generic and Specific Name	Place of Publication	Locality	Horizon
	ALGAE.			
	Bythotrephis, Hall.			
89	B.—— antiqua, Brong.....	R. S. VII, 144, V, 1-3,	B. 3	E. 1.
	Hydrocytium.			
89	H.——(?) siculum,..	R. S. VII, 146, VI. 2,	B. 3	C. 1*b*.
89	Microphycus, genus, ...	R. S. VII, 146,		
89	M.—— catenatus, ...	R. S. VII, 146, V, 6*a, b,*	B. 3	C. 1*b*.
	Oldhamia, Forbes.			
	O.—— sp., ...	Can. Rec., ...	B. 1. 3	C. 1, *b*, *c*1.
	Palæochorda, McCoy.			
89	P.—— setacea, ...	R. S. VII, 145, VI, 1*a-g*.	B. 3	E. 1.
89	Phycoidella, gen., ...	R. S. VII, 144,		
89	P.—— stichidifera, ...	R. S. VII, 144, V, 5*a-d*.	B. 3	E. 1.
	PROTOZOA.			
	Globigerina, d'Orb.			
95	G.—— cambrica, ...	N. Y. XIV, 111, I, 5*a-c,*	B. 3	C. 1*b*2.
	G.—— didyma, ...	" " " 7*a, b*.	B. 3	"
	G.—— grandis, ...	" " " 6,	B. 3	"
	G.——(?) turrita, ...	" " " 8*a, b*.	B. 3	"
89	Monadites, gen., ...	R. S. VII, 147,		
89	M.—— globulosus, ...	R. S. VII, 147, VII, 1*a-b*	B. 1	E. 1.
89	M.—— pyriformis, ...	" " " 2*a-b*,	B. 1	"
89	M.——urceiformis, ...	" " " 3,	B. 1	"
89	Radiolarites, gen., ...	R. S. VII, 148,		
89	R.—— ovalis, ...	R. S. VII, 148, VIII, 4,	B. 1	E. 1.
	Orbulina, d'Orb.			
95	O.——(?) ingens, ...	N. Y. XIV, 110, I, 4,..	B. 3	C. 1*b*2.
"	O.—— intermedia, ...	N. Y. XIV, 110, I, 3, ..	B. 3	C. 1*b*2.
"	O.——(?) ovalis, ...	" " " 2, ..	B. 3	"
"	O.—— c f. universa, Lam.,	N. Y. XIV, 109, I, 1, ..	B. 3	"
	SPONGIDA.			
	Archæocyathus, Billings.			
85	A.——(?) pavonoides, ...	R. S. III, 29, V, 1*a-d,*	B. 3	C. 1*c*1.
	Astrocladia, Zittel.			
89	A.——(?) elegans, ...	R. S. VII, 149, VII, 7,	B. 1	C. 1*b*.
"	A.——(?) elongata, ...	R. S. VII, 149, VII, 6,	B. 1	"
"	A.——(?) virguloides, ...	R.S. VII, 149, VII, 8*a-c*	B. 3	"
89	Dichoplectella, gen.,..	R. S. VII, 149,		
89	D.—— irregularis, ...	R. S. VII, 149, VII, 9*a-b*	B. 1	E. 1 C. 1*b*.

Year	Generic and Specific Name	Place of Publication	Locality	Horizon
	Hyalostelia, Zittel.			
89	H.—— minima, ...	R. S. VII, 150, VII, 10,	B. 1	E. 1.
	Plococyphia, Reuss, ...			
89	P.——(?) perantiqua, ...	R. S. VII, 148, VII, *5a-b*	B. 1	E. 1.
	Protospongia, Salter.			
85	P.——(?) minor, ...	R. S. III, 30, V, 2,....	B. 3	C. 1*c*.
	P.——(?) v. distans, ...	R. S. III, 30, V, 3,....	B. 3	C. 1*d*.
95	P.——(?) sp., ...	N. Y. XIV, 113, ...	B. 3	C. 1*b*2.
	HYDROZOA.			
	Bryograptus, Lapworth.			
95	B.—— lentus, ...	N.Y. XIV, 270, XLVIIII *2a, b*, ... , ...	B. 3	C. 3*c*.
1, 92	B.—— patens, ...	R. S. IX, 39; R. S. 10, 95, VII, *1a-d*, ...	B. 3	C. 3*b*.
95)	B.——(?) retroflexus, Brögg?	N. Y. XIV, 271, ...	B. 3	C. 3*b*.
92	B.—— spinosus, ...	R. S. X, 97, VII, *2a, b*,	B. 3	C. 3*b*. *c*.
	Callograptus, Hall.			
95	C.—— sp., ...	N. Y. XIV, 271, *2a-b*,	B. 3	C. 3*c*.
	Clonograptus, Hall.			
92)	C.—— flexilis, Hall, ...	R. S. X, 97, ...	B. 3	C. 3*d*.
95	C.—— proximatus, ...	N.Y. XIV, 265, XLVIII, *1a-d*, ...	B. 3	C. 3*c*.
	Dendrograptus, Hall, ...			
85	D.—— primordealis, ...	R.S. III, 31, V, 5, *5a, b*.	B. 3	C. 1*d*.
	Dichograptus, Salter.			
92)	D.—— Logani, Hall,.. ..	R. S. X, 97, ...	B. 3.	C. 3*d*.
	Dictyonema, Hall.			
92)	D.—— delicatulum, Dn.	R. S. X, 96, ...	B. 3	C. 3*d*.
	D.—— flabelliforme, Eich..			
91	v. Acadicum, ...	R. S. IX, 34, III, 1, 2, *3a, b*,	B. 3	C. 3*c*.
"	v. confertum, Brögg. ..	" " 36, ...	B. 3	C. 3*b*, *c*.
"	v. Norvegicum, Kjer...	" " 37, ...	B. 3	C. 3*c*.
92)	D.—— quadrangulare, Hall	" X, 96, ...	B. 3	C. 3*d*.
	Didymograptus, McCoy, ..			
92)	D.—— indentus, Hall,.. ..	R. S. X, 99, ...	B. 3	"
"	D.—— nitidus, Hall, ...	R. S. X, 98, ...	B. 3	"
"	D.—— patulus, Hall, ...	R. S. X, 98, ...	B. 3	"
"	D.—— narrow, threadlike,	R. S. X, 98, ...	B. 3	"
"	D.——(?) sp. very narrow,	R. S. X, 98, ...	B. 3	"
85	Protograptus, gen., ...	R. S. III, 31.		
85	P.—— alatus, ...	R. S. III, 32, V, 6, ...	B. 3	C. 1*d*.
	Retiograptus, Hall.			
(92)	R.—— tentaculatus, Hall,	R. S. X, 100, ...	B. 3	C. 3*d*.

Yaer	Generic and Specific Name	Place of Publication	Locality	Horizon
	Tetragraptus, Salter.			
(92)	T.—— quadribranchiatus, Hall.	R. S. X, 98,	B. 3	C. 3*d*.
	ECHINODERMATA.			
93	Crinoid?	R. S. XI, 87, XVI, 1,	B. 3	C. 1*b*2.
	Eocystites, Billings.			
68	E.——primaevus, Bill,	Acad. Geol., 643, *f*. 220,	B. 3	C. 1*c*1, 2,
	Platysolenites, Pander.			
(89)	P.—— antiquissimus, Eich.	R. S. VII, 150, VII, 11*a-c*	B. 3	E. 3*a*.
(98)	Trochocystites, Barr?	R. S. 2nd, IV, 128,	B. 3	C. 1*b*3
	BRACHIOPODA.			
	Acrothele, Linnarsson.			
02	A.—— abavia,	N. B., IV, 398, XV*a-d*. 100, IV, 3*a, d*, 4*a, b*,.	D. 1	E. 3*a-e*.
99	A.—— avia,	N. B. IV, 202, III., 1*a-h*, 396, XVI, 1*a-f*, 2*a, b*.	D. 1	E. 3*d-e*.
02	m. puteis,	N. B. IV, 398, XV, 5*a, b*, 100, IV, 5*a, b*,	D. 1	E. 3*d*.
68	A.——Matthewi, Hartt,	Acad. Geol., 644, *f*. 221, R. S. III, 39, V, 15, 15*a*.	D. 1	C. 1*c, d*.
95	m. costata,	N. Y. XIV, 128, V, 9.	B. 3	C. 1*b*2-5.
85	m. lata,	R. S. III, V, 17, 17*a*.	B. 3	C. 1*b*.
97	m. multicostata,	R. S. 2nd, III, 168,	B. 2	C. 1*d*.
85	m. prima,	R. S. III, 41, V, 16, 16*a*.	B. 3	C. 1*b*.
02	A.—— proles,	N. B. IV, 400, XVI, 3*a-e*	D. 1	E. 3*f*.
01	Acrothyra, gen.,	N. B. IV, 303, *f*. 1-5,		
85	A.——(?) inflata,	R. S. III, 33, V, 7, 7*a*,.	D. 1	C. 1*d*.
	v. ovalis,	R. S. 2nd, IV, 127, V, 4*a-c*,	D. 1	C. 1*b*1,
02	A.—— proavia,	N. B. IV, 386, XIV, 2*a-g*, 3*a-f*,	D. 1	E. 3*d, e*..
92	m. crassa,	N. B. IV, 389, XIV, 5*a-c*	D. 1	E. 3*e*.
02	m. prima,	N. B. IV, 389, XIV, 4*a-f*	D. 1	E. 3*a*.
02	A.—— signata,	N. B. IV, 381, XIII, 2*a-e*	D. 1	E. 1*b*.
02	m. orta,	N. B. IV, 385, XIII, 4*a-f*	D. 1	E. 2*c*.
02	m. prima,	N. B. IV, 382, XIII, 1*a-g*	D. 1	Co.
02	m. sera,	N. B. IV, 383, XIII, 3*a-f*	D. 1	E. 1*c*.
02	m. tarda,	N. B. IV, 384, XVI, 1*a-d*	D. 1	E. 1*c, d*.
	Acrotreta, Kutorga.			
85	A.—— Baileyi,	R. S. III, 36, V, 13, 13*a-c*	B. 1	C. 1*c*2.
02	A.—— bisecta,	N. B. IV, 275, V, 5*a-g*;	B. 3	C. 3*c*.
		394, S. R. XVI, 2*a-g*,	D. 1	C. 3*c*.
(95)	A.—— gemma, Bill?	Pal. Foss. I, 216, 201,*a-f*, N. Y. XIV, 126,	B. 3	C. 1*b*1.
93	A.——gemmula,	R. S. XI, 87, XVI, 2*a-d*.	B. 3	C. 1*b*2, 3.
02	A.—— papillata,	N. B. IV, 390, XV, 2*a-f*.	D. 1	E. 1*d*.
02	v. lata,	N. B. IV, 391, XV, 3*a-c*.	D. 1	E. 1*d*.

Year	Generic and Specific Name	Place of Publication	Locality	Horizon
02	m. prima, ...	N. B. IV, 391, XV, 1*a-c*.	D. 1	Co.
99	A.—— proavia, ...	N. B. IV, 203, III, 2*a-f*.	D. 1	E. 3*e*.
02	A.—— sipo, ...	N. B. IV, 406, XVIII 1, 2, ...	D. 1	C. 3*d*.
02	A.—— cf. socialis, v. Seeb.	N. B. IV, 392, XV, 5*a-k*	D. 2	C. 2*c*.
"	A.—— sp., ...	N. B. IV, 394, ...	D. 1	E. 2*a*.
92	Billingsella, Hall.			
95	B.——retroflexa, ...	R. S. 2nd, I, 266, II, 1*a-c*; S. R. 148, X, 2*a-e*,....	D. 1	E. 2(*a*?)
91	Botsfordia, s. gen., ...	R. S. IX, 63, ...		
89	B.—— pulchra, ...	R. S. VII, 151, VIII, 1*a-m*, 2*a-c*, ... R. S. XI, 90, XVI, 3*a-b*.	B. 1	C. 1*b*.
	Camarella, Billings.			
92	C.—— parva, Bill?	R. S. X, 103, VII, 9*a, b*.	B. 3	C. 3*a*.
	Dalmanella, see Orthis.			
93	Discinopsis, gen., ...	R. S. XI, 114.		
85	D.—— Gulielmi, ...	R. S. III, 37, V, 14, 14*a-c*	B. 3	C. 1*c*1.
03	Eoobolus, s. gen., ...	R. S. 135.		
03	E.—— equiputeis, ...	R. S. 139, VIII, 2*a-e*,..	D. 1	E. 2(*a*?)
"	E.—— discus, ...	R. S. 138, VIII, 3*a-d*,..	D. 1	E. 1*e*.
"	E.—— triparilis, ...	R. S. 136, VIII, 4*a-e*; XI, 1*a, b*, ...	D. 1	E. 1*b, c*.
	Heterorthis, see Orthis.			
	Kutorgina, Billings.			
99	K.—— granulata, ...	N. B. IV, 189, I, 2*a-d*.	E. 1	E. 3.
85	K.—— Latourensis, ...	R. S. III, 42, V, 18, 18*a-c*	B. 3	C. 1*c*2.
85	K.——(?) pterineoides, ..	R. S. III, 43, V, 19,	B. 3	C. 1*c*1.
98	K.—— (?) sp., ...	R. S. 2nd, IV, 136,	B. 2	C. 3*a*.
	Leptobolus, Hall, note on.	S. R. 105.		
99	L.—— atavus, ...	N. B. IV, 200, II, 1*a-f*.	D. 1	E. 3*d, e*.
03	m. tritavus, ...	S. R. 109, VI, 5*a-c*, ...	D. 1	E. 2(*a*?)
99	L.—— collicia, ...	N. B. IV, 200, I, 3*a-e*,..	D. 1	E. 3*c, e, f*.
03	L.—— flumenis, ...	S. R. 189, XI, 7*a-f*, ...	D. 2	C. 2*c*.
91	L.—— gemmulus, ...	R. S. IX, 41, XII, 8*a-c*.	B. 3	C. 3*c*.
85	L.—— linguloides, ...	R. S. III, 34, V, 8, 8*a, b*.	B. 3	C. 1*d*.
02	cf. linguloides, ...	S. R. 192, ...	D. 1	C. 3*d*.
	L.—— grandis, ...	R. S. XI, 91, XVI, 7*a-c*.	B. 3	C. 3*e*.
98	L.——(?) cf. Lingulella granvillensis, Walc.,.. ..	R. S. 2nd, IV, 128, ...	B. 3	C. 1*b*.
	Lingulella, Salter.			
(93)	L.—— Billingsiana, Whit.,	R. S. IV, 151, ...	E. 3	C. 2*b*.
	L.——cf. Billingsiana, . ..	R. S. XI, 93, XVI, 6*a, b*.	B. 3	C. 2*c*.
(95)	L.——(?) cælata, Hall,..	Pal. N.Y. I, 290 LXXIX, 9*a-c*, ...	B. 3	C. I*b*1.
00	L.—— concinna, ...	N. B. IV, 273, V, 3*a-h*.	D. 1	C. 3*a*.
02	L.——cf. Davidis, McCoy..	N. B. IV, 407.	D. 1	C. 2 C. 3*d*.
85	L.—— Dawsoni, ...	R. S. III, 33, V, 9*a-d*..	B. 3	C. 1*c, d*.

Year	Generic and Specific Name	Place of Publication	Locality	Horizon
95	L.—— Howleyi, ...	R. S. 2nd, I, 259, I, *3a, b.*	E. 3	C. *2c.*
	L.—— lævis, ...	R. S. IX, 39, XII, *4a, b.*	B. 3	C. *3a.*
00	L.—— lens, ...	N. B. IV, 274, V, *2a, b.*	D. 1	C. *3a.*
02	L.—— lepis, ...	N. B. IV, 408.	D. 1	E. *1c, e.*
03	L.—— longovalis, ...	S. R. 123, VII, *3a-f,* ..	D. 1	Co.
03	cf. longovalis, ...	R. S. 75, VII, 2,..	D. 1	C. *3a-d,*
(93)	L.—— Nicholsoni, Call?	Quar. Jour. Geol. Soc. xxxiii, 657,		
		R. S. XI, 115, ...	B. 3	C. *3c.*
90	L.—— radula, ...	R. S. VIII, 147, XV,		
95	L.—— Selwyni, ...	R. S. 2nd, I, 255, I, *1a, b;*		
		S. R. VII, *1a-c,*	D. 1	E. *2(a?)*
99	L.—— tumida, ...	N. B. IV, 200, I, *2a-c,..*	D. 1	E. *3e.*
		7a, b, 8a-e, ...	B. 3	C. *2c.*
97	L.—— sp., ...	R. S. 2nd, IV, 136, ...	B. 2	C. *3a.*
	Lingulepis, Hall.			
91	L.—— cuneata, ...	R. S. XI, 92, XVI, *5a, b.*	B. 3	C. *1b.*
99	L.—— Gregwa, ...	N. B. IV, 199, I, *1a-f*	D. 1	E. *1b-d,*
03	v. robusta, ...	S. R. 131, ...	D. 1	E. *1d.*
03	L.—— longinervis, ...	S. R. 133, VII, *6a-g,*	D. 1	E. *2b.*
89	L.—— Martinensis, ...	R. S. VII, 155, VIII, 4.	B. 3	C. *1b.*
03	L.—— pumila, ...	S. R. 75, VII, *5a, b,* ..	D. 1	Co.
95	L.—— Roberti, ...	R. S. 2nd, I, 256, I, *2a, b.*	D. 1	E. *2(a?)*
90	L.—— Starri, ...	R. S. VIII, 146, XV,		
		5a-c, 6a-b, ...	B. 3	C. *2b.*
03	m. exigua, ...	S. R. 197, XIV, *3a-d,* ..	D. 2	C. *2a.*
91	v. minor, ...	R. S. IX, 58, XII, *5a, b.*	B. 2	C. *2(b?)*
03	L——var., ...	S. R. 193, XIV, *2a-c,* ..	D. 2	C. *2b.*
94	Lingulobolus, gen., ...	R. S. 2nd, I, 260, ...		
(94)	L.—— affinis, Bill, ...	R. S. 2nd, I, 261, I, *4a, b.*	E. 3	C. *2c.*
95	v. cuneata, ...	R. S. 2nd, I, 262, I, *4c, d.*	E. 3	C. *2c.*
	Linnarssonia, Walcott.			
(91)	L.—— Belti, Dav., ...	R. S. IX, 42, XII, *7a-e;*		
		S. R. 209, XVI, *3a-e.*	B. 3	C. *3c.*
97	m. magna, ...	R.S. 2nd, III, 169, I, *a, b,*	B. 2	C. *1d.*
(85)	L.—— misera, Bill., ...	R. S. III, 35, V, 12,		
		12a-e, ...	B. 3	C. *1d.*
68	L.—— transversa, Hartt,..	Acad. Geol., 644..		
		R. S. III, 35, V, 11, *11a-e*	B. 3	C. *1c.*
		N. Y. XIV, 125, V, *1a-c.*	B. 3	C. *1b5.*
	Monobolina, Salter.			
91	M.—— refulgens, ...	R. S. IX, 44, XII, *6a-d.*	B. 3	C. *3c.*
	Obolella, Billings.			
(99)	O.—— atlantica, Walc., ..	R. S. 2nd, V, 70, ...	E. 1	C. *1b1.*
	O.—— cf. chromatica, Bill.	N. B. IV, 189, I. 1, ..	E. 1	E. 3.
	O.—— gemmula, see Leptobolus.			

Year	Generic and Specific Name	Place of Publication	Locality	Horizon
(95)	O.—— nitida, Ford? . . .	A. J. S. 3rd, V, 213; N. Y. XIV, 125, II 8*a, b*, ...	B. 3	C. 1*b*.
97	O.—— sp., ...	R. S. 2nd, III, 170	B. 2	C. 1*d*.
98	O.—— sp., ...	R. S. 2nd, IV, 136, . .	B. 2	C. 3*a*.
	Obolus, Eichwald.			
89	O.——(?) major, ...	R. S. VII, 155, VIII, 3,	B. 3	E. 2*a, b*.
95	O.—— pristinus, ...	N. Y. XIV, 121, IV, 1*a-c*	B. 3	C. 1*b*2.
	O.—— pulcher, see Botsfordia.			
03	O.—— torrentis, ...	S. R. 76, VIII, 1, ...	D. 1	Co.
	O.—— refulgens, see Monobolina.			
03	O.—— sp., ...	S. R. 209, ...	D. 1	C. 2*b*.
	Orthis, Dalman.			
(92)	O.—— Carausii, Hicks? . .	R. S. X, 102, VII, 7*a, b*.	B. 3	C. 3*a*.
	O,——(Dalmanella?) Electra Bill., ...			
92	v. lævis, ...	R. S. X, 100, ...	B. 3	C. 3*d*.
92	v. major, ...	R. S. X, 100, VII, 3*a-c*.	B. 3	C. 3*d*.
"	O.—— Euryone, Bill?	R. S. X, 101, VII, 5, . .	B. 3	C. 3*d*.
	O.—— lenticularis, Wahl., ...		B. 3	C. 1.
91	v. atrypoides, ...	R. S. IX, 48, XII, 11*a, b*.	B. 3	C. 3*b*.
"	v. lyncioides, ...	R. S. IX, 49, XII, 10*a-c*.	B. 3	C. 3*b*.
"	v. strophomenoides,	R. S. IX, 49, XII, 12*a, b*.	B. 3	C. 3*b*.
	O.——(Heterorthis?) Menapiæ, Hicks.			
92	v. Acadica, ...	R. S. X, 101, VII, 6*a, b*.	B. 3	C. 3*d*.
(92)	O.——orthambonites, Pand.	R. S. X, 101, VII, 4, . .	B. 3	C. 3*d*.
95	O.—— sp., ...	N. Y. XIV, 128, V, 10.	B.3	C. 1*b*1,
	Orthisina, d'Orbigny.			
91	O.—— Johannensis, ...	R. S. IX, 49, XII, 13*a-c*.	B. 3	C. 3*a*.
99	Palæobolus, s. gen., . . .	N. B. IV, 201.		
99	P.—— Bretonensis, ...	N. B. IV, 202, II, 2*a-i*.	D. 1	E. 3*d*.
03	P.—— lens, ...	S. R. 144, X, 1*a-f*, ...	D. 1	E. 3*b, c*.
"	v. longus, ...	S. R. 146, VII, 4*a, b*, . .	D. 1	E. 3*c*.
	Protorthis, Hall & Clarke.			
68	P.—— Billingsi, Hartt, . .	Acad. Geol., 644 *f*. 223; R. S. III, 43, ...	B. 3	C. 1*c, d*.
85	P.—— Quacoensis, ...	R. S. III, 43, V, 20, 20*a-c*	B. 3	C. 1*c*.
96	Protosiphon, gen. described	Geol. Mag., 4th, IV, 68, 1-4, ... R. S. 2nd, III, 170, ...		
(98)	P.—— Kempanum, . . .	R. S. 2nd, IV, 129, I, *a-f*.	B. 2	C. 1*b* 3-4.
	Schizambon, Walcott.			
00	S.—— priscus, ...	N. B. IV, 227, V, 4*a-d*. S. R. 187, XI, 6*a-d*, . .	B. 3 D. 1	C. 3*c*.
95	Sphærobolus, gen., ...	R. S. 2nd, I, 263.		

Year	Generic and Specific Name	Place of Publication	Locality	Horizon
(95)	S.—— spissus, ...	Pal. Foss. II, pt. I, 66, 36a-c,.		
		R. S. 2nd, I, 263, I, 5*a-c*.	E. 3	C. 2*c*.
	Strophomena, Hall.			
92	S.—— atava, ...	R. S. X, 102, VII, 8*a-f*.	B. 3	C. 3*a*.
93	Trematobolus, gen., ...	C. R. Jan. '93, 276, 1*a-d*.		
93	T.—— insignis, ...	R. S. XI, 88, XVI, 4*a-d*.	B. 3	C. 1*b* 3-4.
	Westonia, s. gen., Walc.,			
00	W.—— Escasoni, ...	N. B. IV, 270, V, 1*a-i*,	D. 1	C. 3*b*.
	LAMELLIBRANCHIATA.			
	Modiolopsis, Hall.			
02	M.—— cf. solvensis, Hicks,	N. B. IV, 408, ...	D. 1	C. 3*c*2,
99	M.—— thecoides, ...	N. B. IV, 191, I, 7*a-c*.	E. 1	E. 3.
	PTEROPODA.			
	Creseis, Rank.			
92	C.—— corrugata, ...	R. S. X, 105, VII, 12*a-b*.	B. 3	C. 3*d*.
"	C.—— minuta, ...	R. S. X, 105, VII, 11*a-c*.	B. 3	C. 3*d*.
	Styliola LeSueur.			
92	S.—— primæva, ...	R. S. X, 104, VII, 10*a, b*.	B. 3	C. 3*d*.
	GASTEROPODA.			
	Bellerophon, Montfort.			
02	B.—— Bretonensis, ...	N. B. IV, 409, XVIII, 4*a-d*, ...	D. 1	C. 3*c*2.
02	B.—— insulæ, ...	N. B. IV, 409, XVIII, 3	D. 1	"
02	B.—— semisculptus, ...	N. B. IV, 410, XVIII, 5	D. 1	"
	Harttia, Walcott.			
84	H.—— Matthewi, Walc., . .	U. S. Geol. Surv. Bul., 19, I, 6, ...	B. 3	C. 1*c*.
85	Parmophorella, s. gen., . . .	R. S. III, 59, ...		
68	P.—— Acadica, Hartt, . .	Acad. Geol. 644, *f*. 222.	B.3	C. 1*c*[1], 2.
(99)	P.—— panpera, Bill. sp.. . .	N. B. IV, 190, ...	E. 1	E. 3.
	Platyceras, Conrad.			
90	P.—— apertum, ...	R. S. VIII, 132, XI, 4*a-d*, ...	B. 3	C. 1*c*[1].
99	P.—— cymbula, ...	N. B. IV, 191, I, 6*a-b*.	E. 1	E. 3
99	P.—— radiatum, ...	N. B. IV, 191, I, 5*a, b*.	E. 1	E. 3.
99	P.—— transversum, ...	N. B. IV, 191, I, 4*a, b*.	E. 1	E. 3.
95	Pelagiella, gen., ...	N. Y. XIV, 131, ...		
95	P.—— atlantoides, ...	R. S. XI, 94, XVI, 8*a, b*.		
		N. Y. XIV, 131, VI, 6*a-c*	B. 3	C. 1*b*, 2, 3.
99	Randomia, gen., ...	N. B. IV, 190.		
99	R.—— Auroræ, ...	N. B. IV, 190, I, 3*a-c*	D. 1	E. 3.
47	Raphistoma, Hall, ...			
98	R.——(?) Kelliensis, ...	R. S. 2nd, V, 70, III, 4a, b,	D. 3	C. 2*b*.

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	Scenella, Billings.			
99	S.—— cf. reticulata, Bill ..	N. B. IV, 190, ...	E. 1	E. 3.
"	S.—— cf. retusa, Foord, ..	N. B. IV, 190, ...	E. 1	E. 3.
	CEPHALOPODA.			
	Orthoceras, Breyn.			
92	O.—— cf. Priamus, Bill.,..	R. S. X, 106, VII, 13*a, b.*	B. 3	C. 3*d.*
92	O.—— cf. Catulus, Bill., ..	R. S. X, 106, VII, 14*a-d.*	B. 3	C. 3*d.*
	ANNELIDA.			
99	Byronia, gen., ...	R. S. 2nd, V, 41.		
99	B.—— annulata, ...	R. S. 2nd, V, 42, I, 2,..	W.	C. 3*b.*
	Coleoides, Walcott.			
	C.—— typicalis, Walc.? ..	U. S. Nat. Mus., XII, 37	E. 1	E. 3.
	Hyolithellus, Bill.			
(99)	H.——(?) flexuosus, Walc.	N. B, IV, 192, I, 9, ..	E. 1	E. 3.
(95)	H.—— micans, Bill.?	R. S. XI, 94.	B. 3	C. 1*b*2.
	Hyolithes, Eichwald, (Camarotheca Diplotheca included).			
85	H (D)—— Acadica, ...	R. S. III, 54, VI, 6, 6*a.*	B. 3	C. 1*d.*
"	v. crassa, ...	R. S. III, 55, VI, 9, ..	B. 3	C. 1*b*2.
(72)	H.——Americanus, Bill. ..	Can. Nat. 2nd, VI, 215,	N.	C. 1*b*3.
85	H (C)—— caudatus, ...	R. S. III, 53, VII, 5, 5*a.*	B. 3	C. 1*d.*
99	H.—— carinatus, ...	R. S. 2nd, V, 42, I, 5*a, b.*	W.	C. 3*b.*
85	H (C.)—— Danianus,.. ..	R. S. III, 49, VI, 11*a-c.*	B. 3	C. 1*c*, 2*d.*
93	H.—— decipiens, ...	R. S. XI, 96, XVI, 11a-*d*, ...	B. 3	C. 1*b*2.
(99)	H.—— excellens, Bill., ..	N. B. IV, 194, III, 3*a, b.*	E. 1	E. 3.
95	H (C)—— gracilior, ...	N. Y, XIV, 130, VI, 3*a, b*	B. 3	C. 1*b*3.
85	H (C)——gracilis, ...	R. S. III, 50, VI, 2, 2*a-c.*	B. 3	C. 1*d.*
01	m. gracillimus, ...	R. S. 2nd, VII, 109, *f.* 3*a, d,*	B. 3	C. 1*c.*
99	H.—— Hathewayi, ...	R. S. 2nd, V, 73, III, 5*a-d*, ...	E. 3	C. 1*b.*
85	H (D)—— Hyattiana,....	R. S. III, 52, VI, 4, 4*a.*	B. 3	C. 1*b*3.
93	H.——cf. obesus, Holm ..	R. S. XI, 96, ...	B. 3	C. 1*d.*
95	H.——cf. obtusa, Bill.,....	Geol. Verm., II, 955, N. Y. XIV, 130, ...	B. 3	C. 1*b*3.
85	H.—— obtusata, ...	R. S. III, 55, VI, 8, ..	B. 3	C. 1*c.*
95	H.——cf. princeps, Bill.,..	Can. Nat. 2nd, VI, 216, 4a, b, N. Y. XIV, 129,	B. 3	C. 1*b*3.
99	H.—— rugosus, ...	N. B. IV, 194, III, 4*a, b.*	E. 1	E. 3.
85	H.—— sericea, ...	R. S. III, 55, VI, 7, 7*a, b*	B. 3	C. 1d.
63	H.——cf. tenuistriata, Lnrs.	S. R. 83, IX, 4*a, b,*	D. 1	E. 2(*a*?
	Helenia, Walcott.			
99	H.——granulata, ...	N. B. IV, 192, II, 7*a-e.*	E. 1	E. 3.
	Orthotheca, Novak.			
99	O.—— bayonet, ...	N. B. IV, 193, III, 1*a-f.*	E. 1	E. 3.
99	O.—— corrugata, ...	R. S.2nd, V, 42, I, 3, ..	W. 1	C. 3*b.*

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93	O.—— cf. deGeeri, Holm..	R. S. XI, 95, XVI, *9a-d*.	B. 3	E. 3.
"	O.—— cf. Emmonsi, Ford.	R. S. XI, 95, XVI, 10,	B. 3	E. 3.
85	O.—— micmac, ...	R. S. III, 51, VI, 3, *3a*.	B. 3	C. *1c-d*.
99	O.—— pugio, ...	N. B. IV, 193, II, *4a-d*.	E. 1	E. 3.
99	O.—— sica, ...	N. B. IV, 193, II, *5a-c*.	E. 1	E. 3.
"	mut., ...	N. B. IV, 193, II, *6a-b*.	E. 1	E. 3.
03	O.—— sp., ...	S. R. 83, ...	D. 1	E*1a-d, 2b*.
99	Urotheca, gen., ...	R. S. 2nd, V, 40.		
99	U.—— flagellum, ...	R. S. 2nd, V, 40, I, 1. . .	W.	C. *3b*.
"	U.—— parva, ...	R. S. 2nd, V, 41, VII, 2,	W.	C. *3b*.
"	U.—— pervetus, ...	N. B. IV, 192, I, 8, ...	E. 1	E. 3.
02	U.—— sp., ...	N. B. IV, 411, XVII, 6,	D. 1	C. *3c2*.
	Volborthella, Sshmidt, '88, (Orthotheca probably belongs here).			
89	V.—— tenuis, ...	R. S. VII, 156, VIII, *5a-d*, ...	B. 1	E. 3 C. *1b*
	OSTRACODA.			
96	Aluta, gen., ...	N. Y. XV, 198.		
96	A.—— flexilis, ...	N. Y. XV, 198, XV, 4,	B. 3	C. *1c1*.
	Beyrichia, McCoy.			
98	B.—(?) primæva, ...	R. S. 2nd, IV, 133, 1, *2a-c*, ...	B. 3	C. *1b* 3-4.
03	B.—— triceps, ...	S. R. 219, XVI, *4a-c*,. .	D. 2	C. *2b*.
85	Beyrichona, gen., ...	R. S. III, 65.		
85	B.—— papilio, ...	R. S. III, 65, VI, 20, *20a, b*,.	B. 3	C. *1b4*.
95	B.—— rotundata, ...	N. Y. XIV, 136, VII, 2,	B. 3	C. *1b2*.
85	B.—— tinea, ...	R. S. III, 66, VI, 21,	B. 3	C. *1b4*.
		21a, b; XI, 97, ...	B. 3	C. *1b* 2-3.
95	B.—— triangula, ...	N. Y. XIV, 135, VII, 5,		
99	Bradoria, gen., ...	N. B. IV, 204.		
85	B.——(?) Acadica, ...	R. S. III, 66, VI, 22, *22a, b*,.	B. 3	C. *1c1*.
93	B.—— aurora, ...	R. S. XI, 98, XVII, *5a-c*	B. 3	C. *1b1*.
95	B.—— oculata, ...	N. Y. XIV, 136, VIII, *2a, b*,.	B. 3	C. *1b3*.
03	B.——(?) ornata, ...	Can. Rec. 456, II, *4a-c*,	D. 1	E. *1c*.
99	B.—— rugulosa, ...	N. B. IV, 205, III, *3a-d*,	D. 1	E. *1d*.
03	mut., ...	S. R. 166, ...	D. 1	E. *1c*.
99	B.—— scrutator, ...	N. B. IV, 204, IV, *1a-c*.	D. 1	E. *3c*.
99	B.—— vigilans, ...	R. S. XI, 205, XVII, 2a-c	D. 1	E. *3c*.
	m. obesa, ...	Can. Rec. Sci., 455. . .	D. 1	E. *1b*.
	mut., ...	Can. Rec. Sci., 455, . .	D. 1	E. *1d*.
03	Bradorona, gen. described	Can. Rec. 444.		
"	B.—— observator, ...	Can. Rec. 448, I, *15a-c*,	D. 1	E. *1d*.
"	v. benepuncta, ...	Can. Rec. 449, I, 16, . .	D. 1	E. *1d*.

Year	Generic and Specific Name	Place of Publication	Locality	Horizon
"	m. lævis, ...	Can. Rec. 450, ...	D. 1	E. 1*b*, 2*e*.
"	m. ligata, ...	Can. Rec. 451, I, 17, . .	D. 1	E. 3*e*.
"	B.—— perspicator, ...	Can. Rec. 444, I, 8*a-d*,	D. 1	E. 1*d*.
"	m .magna, ...	Can. Rec. 446, I, 11*a, b*,	D. 1	E. 2*b*.
"	m. maxima, ...	Can. Rec. 445, I, 9*a, b*,	D. 1	E. 1*c*.
"	m. major, ...	Can. Rec. 446, I, 10*a, b*,	D. 1	E. 3*f*.
"	B.—— spectator, ...	Can. Rec. 447, I, 12*a-d*,	D. 1	E. 1*b, d*.
"	acuta, ...	Can. Rec. 447, ...	D. 1	E. 1*b*.
"	m. spinosa, ...	Can. Rec. 448, I, 13*a, b*,	D. 1	E. 1*e*.
"	m. æquata, ...	Can. Rec. 448, I, 4*a, b*,	D. 1	E. 3*d*.
"	Escasona, gen. described . .	Can. Rec. 457.		
"	E.——?? ingens, ...	Can. Rec. 459, II, 7*a-c*,	D. 1	Co.
95	E.—— ovata, ...	N. Y. XIV, 135, VII, 8,	D. 1	C. 1*b*2.
03	E.—— rutellum, ...	Can. Rec. 458, II, 5*a-c*,	D. 1	E. 3*f*.
"	E.——(?) vetus, ...	Can. Rec. 458, II, 6*a-b*,	D. 1	E. 3*d*.
85	Hipponicharion, gen., ...	R. S. III, 64.		
93	H.—— cavatum, ...	R. S. XI, 99, XVII, 3*a, b*	B. 3	C. 1*b*1.
85	H.——eos., ...	R. S. III, 64, VI, 19, 19*a, b*, ...	B. 3	C. 1*b*1.
93	H.—— minus, ...	R. S. XI, 99, XVII, 4*a, b*, ...	B. 3	C. 1*b*3.
02	Indiana, gen. described, . .	Can. Rec. VIII, 460.		
95	I.—— fusiformis, ...	N. Y. XIV, 137, VIII, 3*a, b*, ...	B. 3	C. 1*b*3.
02	I.—— lippa, ...	Can. Rec. 463, II, 10*a-d*,	D. 1	E. 3*f*.
"	I.—— ovalis, ...	Can. Rec. 461, I, 8*a-c*. .	D. 1	E. 1*e*.
97	I.—— pyriformis, ...	R. S. 2nd, IV, 132, I, 3*a-c*, ...	B. 2	C. 1*b* 3, 4.
"	I.—— robusta, ...	R. S. 2nd, IV, 132, I, 4*a-c*, ...	B. 2	C. 1*b* 3, 4.
95	I.—— secunda, ...	N. Y. XIV, 136, II, 11*a, b*, ...	B. 2 & 3	C. 1*b* 3, 4.
	Isochilina, T, R. Jones.			
89	I.——(?) Steadi, ...	R. S. VII, 160, VII, 13*a-c*, ...	B. 3	C. 1*b*.
89	I.——(?) ventricosa, ...	R. S. VII, 159, VII, 12*a-d*, ...	B. 3	C. 1*b*.
	Leperditia, Rauoult.			
95	L.——(?) minor, ...	N. Y. XIV, 138, VIII, 4*a, b*, ...	B. 3	C. 1*b*3.
"	L.——(?) primæva, ...	N. Y. XIV, 138, VIII, 6*a, b*, ...	B. 3	C. 1*b*3.
03	L.——(??) rugosa, ...	Can. Rec. 443, I, 7*a-c*, . .	D. 1	E. 3*f*.
	Schmidtella, Ulrich, note on,	Can. Rec. 463, ...		
99	S.——(?) acuta, ...	N. B. IV, 205, IV, 4*a-c*,	D. 1	E. 3*e, f*.
95	S.—— (?) Cambrica, . .	N. Y. XIV, 137, VII, 10*a, b*, ...	B. 3	C. 1*b*3.
99	S.——(?) pervetus, ...	N. B. IV, 206, IV, 3*a-c*,	D. 1	E. 3*e*.
02	m. concinna, ...	Can. Rec. 464, ...	D. 1	E. 1*d*.

Year	Generic and Specific Name	Place of Publication	Locality	Horizon
	PHYLLOPODA.			
	Aptychopsis, Barrande.			
99	A.—— terranovicus, ...	N. B. IV, 194, III, 5,..	E. 1	E. 3.
"	m. arcuata, ...	N. B. IV, 195, III, 6,..	E. 1	E. 3.
85	Lepiditta, gen. described, ..	R. S. III, 61, ...		
85	L.—— alata,..	R. S. III, 61, VI, 16, 16*a*,	B. 3	C. 1*c*2.
93	L.—— auriculata, ...	R. S. XI, 99, XVII, 2*a*, *b*,	B. 3	C. 1*d*.
85	L.—— curta, ...	R. S. III, 62, VI, 17, ..	B. 3	C. 1*b*3.
93	L.—— sigillata, ...	R. S. XI, 98, X, VII, 1,		
	Stenotheca, Salter.			
85	S.—— concentrica, ...	R. S. III, 57, VI, 11; VIII, 133, ...	B. 3	C. 1*d*1.
85	v. radiata, ...	R. S. III, 57, VI, 12; VIII, 133, ...	B. 3	C. 1*c*, *d*.
85	S.—— Hicksiana, ...	R. S. III, VI, 14, ...	B. 3	"
"	S.—— nasuta, ...	R. S. III, 58, VI, 13, ..	B. 3	C. 1*c*2.
"	S.—— triangularis, ...	R. S. III, 58, VI, 15, 15*a*; VIII, 134, ...	B. 3	C. 1*c*2, *d*.
	TRILOBITA.			
98	Acantholonus, s. gen., ...	R. S. 2nd, IV, 142, ...		
98	A.—— spiniger, ...	R. S. 2nd, IV, 142, II, 4*a*-*e*, ...	B. 2	C. 3*b*.
	Agnostus, Brongniart,.. ..	N. Y. XV, 207, ...		
68	A.—— Acadicus, ...	Acad. Geol. 665, *f*. 229, R. S. III, 70, VII, 5*a*, *b*,	B. 3	C. 1*c*2.
85	v. declivis, ...	R. S. III, 70, VII, 6*a*, *b*,	B. 3	C. 1*d*1.
03	cf. v. declivis, ...	S. R. 223, ...	D. 2	C. 3*b*.
91	A.—— bisectus, ...	R. S. IX, 50, XIII, 2*a*, *b*,	D. 1	"
03	A.—— cf. cyclopyge, Tull..	S. R. 222, ...	D. 1	"
(96)	A.—— Davidis, Salt.,.. ..	N. Y. XV, 225, XVI, 6,	E. 2	C. 1*d*2.
(96)	A.—— fallax, Linrs., ...	N. Y. XV, 214, ...		
85	v. concinna, ...	R. S. III, 70, VII, 4*a*-*c*,	B. 3	C. 1*d*1.
		N. Y. 15, 216, XV, 7*a*-*c*, 8*a*, *b*, ...	B. 3	" ..
96	v. trilobata, ...	N. Y. XV, 216, XV, 9,	B. 3	C. 1*c*1.
85	v. vir., ...	R. S. III, 69, VII, 3, ..	B. 3	C. 1*c*1.
(96)	A.—— fissus, Lundg., ...	N. Y. XV, 230, XVI, 9*a*, *b*, ...	B. 3	C. 1*d*1.
96	v. trifissus, ...	N. Y. XV, 231, XVI, 10,	B. 3	"
(96)	A.—— gibbus, Linrs,.. ..	N. Y. XV, 226, ...	B. 3	C. 1*c*1.
85	v. acutiloba, ...	R. S. III, 73, VII, 10,..	B. 3	C. 1*d*1.
85	v. partita, ...	R. S. III, 68, VII, 2, 2*a*, *b*, ...	B. 3	"
96	var., ...	N. Y. XV, 228, ...	B. 3	"
(96)	A.—— lævigatus, Dalm.			
"	v. ciceroides, ...	N. Y. XV, 234, XVII, 2*a*, *b*, ...	E. 2	"
"	v. mamilla, ...	N. Y. XV, 234, XVII, 3*a*, *b*, ...	E. 2	C. 1*d*1.

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95	var., ...	R. S. 2nd, III, 173, I, 7,	B. 2	C. 1*d2*.
96	v. terranovicus, ...	N. Y. XV, 233, XVII, 1*a, b*, ...	E. 2	C. 1*d2*.
99	A.—— montis, ...	R. S. 2nd, V, 43, I, 6,..	W.	C. 3*b*.
(96)	A.—— Nathorsti, Brögg.,	N. Y. XV, 229, ...	B. 3	C. 1*d*1.
96	v. confluens, ...	N. Y. XV, 230, XVI, 9*a, b*, ...	B. 3	"
97	mut., ...	R. S. 2nd, III, 171, I, 2,	B. 2	C. 1*d2*.
(96)	A.—— nudus, Beyr., ...	N. Y. XV, 235, ...	E. 2	C. 1*d*1.
85	A.—— obtusilobus, ...	R. S. III, 72, VII, 9, ..	B. 3	"
(96)	A.—— parvifrons, Linrs.,	N. Y. XV, 220; 132, XVI, 4*a, b*, ...	B. 3	C. 1*d*, 1, 2.
	A.——cf. nepos, Brögg, ..	R. S. 2nd, III, 172, I, 5,	B. 3	C. 1*d2*.
85	v. tessella, ...	R. S. III, 71, VII, 7*a-c*,	B. 3	"
96	v. truncata, ...	N. Y. XV, 222, ...	B. 3	"
(93)	A.——pisiformis, L., var. *a*,	R. S. XI, 59, XIII, 1*a, b*,		
98		R. S. 2nd, IV, 136, II, 1*a-c*, ...	B. 2	C. 3*a*.
"	m. rugulosa, ...	R. S. 2nd, IV, 137, II, 2,	B. 2	"
"	m. affinis, ...	R. S. 2nd, IV, 137, II, 3,	B. 2	"
"	m. valida, ...	R. S. 2nd, IV, 137, ...	B. 2	"
(96)	A.—— punctuosus, Aug.,..	N. Y. XV, 232, XVI, II,	E. 2	C. 1*d2*.
95	var., ...	R. S. 2nd, III, 172, I, 3,	B. 2	"
85	A.—— regulus, ...	R. S. III, 67, VII, 1*a-c*,	B. 3	C. 1*c*1.
	A.—— rex., Barr., ...			
96	v. transsectus, ...	N. Y. XV, 214, XVI, 2,	B. 3	C. 1*c2*.
	A.—— trisectus, Salt.,.. ..			
00	m. germanus, ...	N. B. IV, 279, ...	D. 1	C. 3*b*.
	m. ponepunctus,.. ..	N. B. IV, 278, V, 8*a-c*,	D. 1	"
85	A.—— umbo, ...	R. S. III, 71, VII, 8*a, b*,	B. 3	C. 1*d*1.
96	mut., ...	N. Y. XV, 173, XVI, 6*a, b*, ...	B. 2	C. 1*d2*.
	Agraulos, Corda.			
86	A.—— affinis, Bill., ...	R. S. IV, 153, 2, 2*b*,....	E. 2	C. 1.
	A.—— ceticephalus, Barr.,			
85	v. carinatus, ...	R. S. III, 176, II, 2*a, b*,	B. 2	C. 1*d2*.
87	A.—— Halliana, ...	R. S. V, 132, I, 2*a-m*,..	B. 3	C. 1*c2*.
90	A.——(?) holocephalus, ..	R. S. VIII, 138, XI, 5*a-d*,	B. 2	"
97	A.——(?) nanus, ...	R. S. 2nd, III, 178, II, 5*a, b*, ...	B. 2	"
"	A.——(?) pusillus, ...	R. S. 2nd, III, 178, II, 6*a, b*, , ...	B. 2	"
"	A.—— Roberti, ...	R. S. 2nd, III, 177, II, 4*a, b*, ...	B. 2	"
86	A.—— socialis, Bill., ...	R. S. IV, 151, 1, 1*a, b*,..	E. 2	C. 1.
90	A.——(?) Whitfieldiana, ..	R. S. V, 130, II, 1*a-f*,.. R. S. VIII, 138, XI, 6*a-d* (*e*?)	B. 3	C. 1*c*1.
	v. compressa, ...	R. S. V, 131, I, 1*g-i*, ..	B. 3	"
99	Anadoxides, sub-gen., ...	N. B. IV, 142.		
02	Angelina, sp., ...	N. B. IV, 413, XVIII, 8,	D. 1	C. 3*c2*.

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	Anomocare, Angelin.			
99	A.——magnum, Brögg., var.	R. S. 2nd, III, 184, III, 5*a-e*, ...	B. 2	C. 1*d*2.
(97)	A.—— tucer, Bill., ...	Geol. Verm. II, 951, *f*. 356 R. S. 2nd, III, 198, IV, 8,	N.	E. 3.
	Asaphellus, Callaway,.. ..	N. B. IV, ...		
02	A.—— Homfrayi, Salt., var., ...	N. B. IV, 413, XVIII, 10*a-e*, ...	D. 1	C. 3*c*2.
"	A.—— planus, ...	N. B. IV, 419, XVIII, 11,	D. 1	"
	Atops, Emmons, a sub-gen,	R. S. 2nd, V, 88.		
(99)	A.—— trilineatus, Emm.,	R. S. 2nd, V, 89, IV, 8,	E. 3	C. 1(*d*?)
	Avalonia, Walcott.			
99	A.—— plana, ...	R. S. 2nd, V, 81, IV, 7,	I. 3	"
	Bathyuriscus, Meek.			
(99)	B.—— Howelli, Walc., ..	R. S. V, 50, ...	E. 3	C. 3*b*.
99	B.—— pupa, ...	R. S. V, 51, II, 5, ...	W.	C. 3*b*.
(97)	B.—— senectus, Bill.,.. ..	R. S. III, 196, IV, 4,..	N.	E. 3.
95	Bergeronia, s. gen., ...	N. Y. XIV, 146, ...		
95	B.—— Acadica, ...	N. Y. XIV, 140, IX, 5,	B. 3	C. 1*b*3.
85	B.—— articephala, ...	R. S. III, 65, VII, 14*a*, *b*, N. Y. XIV, 147, X, 5*a*, *b*,	B. 3	"
92	B.—— elegans, W. D. Matthew, ...	N. B. Bull. 10, 25, *f*. 1,.. N. Y. XIV, 147, XI, 3*a-e*.	B. 3	"
	Catadoxides, s. gen., ...	N. B. IV, 142.		
	Conocephalites, Barrande,			
99	C.—— cf. (Conaspis), perseus, Hall, ...	R. S. 2nd, V, 46, II, 4..	W.	C. 3*b*.
91	C.—— contiguus, ...	R. S. IX, 58, XIII, 14*a*, *b*	B. 3	C. 3*b*.
(97)	C.—— miser, Bill., ...	R. S. 2nd, III, 200, IV, 7, 7*a*, ...	N.	E. 3.
93	C.—— sp., ...	R. S. XI, 110, XVII, 15*a*, *b*, ...	B. 3	C. 3*a*.
	Conocoryphe, Corda.			
84	C.—— Baileyi, Hartt, ...	R. S. II, 111, I, 22-27; VIII, 135, XI, 10, ...	B. 1, 3	C. 1*c*2.
"	v. arcuata, ...	R. S. II, 113, I, 23, 23*b*,	B. 3	"
"	C.—— elegans, Hartt,.. ..	R. S. II, 115, I, 28-33,..	B. 3	"
"	v. granulata, ...	R. S. II, 116, I, 34, ...	B. 3	"
97	C.—— pustulosa, ...	R. S. 2nd, III, 174, I, 8*a*, *b*, ...	B. 2	C. 1*d*.
84	C.—— Walcotti, ...	R. S. II, 119, I, 36, 36*b*; VIII, 134, XI, 7*a-c*,..	B. 3	C. 1*c*1.
	Corynexochus, Angelin.			
99	C.—— Rœmingeri, ...	R. S. 2nd, V, 47, II, 3,	W.	C. 3*b*.
	Ctenocephalus, Corda.			
84	C.—— Matthewi, Hartt, ..	R. S. II, 103, I, 6-21, ..	B. 3	C. 1*c*.
84	v. geminispinosus, Hartt (sp.)..	R. S. II, 106, I, 21, ...	B. 3	"

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"	v. hispidus,..	R. S. II, 106, I, 7, ...	B. 3	C. 1*c*2.
"	v. perhispidus, ...	R. S. II, 107, I, 12, ...	B. 3	C. 1*c*[1].
	Ctenopyge, Linnarsson.			
91	C.—— Acadica, ...	R. S. IX, 57, XIII, 13*a, b* XI, 109, XVII, 13*a-c,*	B. 3	C. 3*b*.
"	C.—— flagillifer, Ang., ..	R. S. IX, 56, XIII, 12*a, b,*	B. 3	"
"	C.—— pecten, Salt.,..	R. S. IX, 58; S. R. 229, XVII, 5*a, b,*	B. 3, C. 1	"
	Cyclognathus, s. g., Linrs.,			
92	C.—— rotundifrons, ...	R. S. X, 107, VII, 16*a, b,*	B. 3	C. 3*d*.
	Dolichometopus, Angelin.			
97	D.—— Acadicus, ...	R. S. 2nd, III, 185, III, 6*a-d,*	B. 2	C. 1*d*.
99	D.—— occidentalis, ...	R. S. 2nd, V, 49, II, 2..	W.	C. 3*b*.
	Dorypyge, Dames.			
99	D.—— Dawsoni, ...	R. S. 2nd, V, 56, III, 1,	W.	C. 3*b*.
97	D.—— horrida, ...	R. S. 2nd, III, 190, IV, 3*a, b*, ...	B. 2	C. 1*d*.
(97)	D.—— parvula, Bill., ...	R. S. 2nd, III, 197, IV, 5, 5*a*,..	N.	E. 3.
	D.—— quadriceps, H. & W. v. valida, ...	R. S. 2nd, III, 189, IV, 2*a, b,*	B. 2	C. 1*d*.
	D.—— Wasatchensis, H. & W., ...			
97	v. Acadica, ...	R. S. 2nd, III, 188, IV, 1,	B. 2	"
	Ellipsocephalus, Zenker, ..			
"	E.—— galeatus, ...	R. S. XI, 103, XVII, 7*a-c*	B. 3	C. 1*b*3.
"	E.—— grandis, ...	R. S. XI, 105, XVII, 6*a-c*	B. 3	C. 1*b*2.
87.	E.—— cf. polymetopus, Linrs., ...	R. S. V, 129, II, 8*a-c,* ..	B. 3	C. 1*b*[1].
	Erinnys, Salter.			
(99)	E.—— breviceps, Ang., ..	R. S. 2nd, V, 91, IV, 9,	E. 3	C. 1(*d*?)
	Euloma, Angelin.	R. S. X, 108, ...		C. 1*d*.
	Eurycare, Angelin.			
93	E.—— spinosum, ...	R. S. XI, 106, XVII, 14*a-c,*	B. 3	C. 3*b*.
	E.—— cf. angustatum, Ang...		B. 3	"
95	Holasaphus, gen., ...	R. S. 2nd, I, 268; S. R. 174, ...		
"	H.—— centropyge, ...	R. S. 2nd, I, 268, II, 4*a, b;* S.R. 174, X, 3*a-c,*	D. 3	E. 2(*a*?)
	Leptoplastus, Angelin.			
91	L.—— latus, ...	R. S. IX, 54, XIII, 10*a-c,*	B. 3	C. 3*b*.
	var., ...	R. S. IX, 55, XIII, 11,..	B. 3	"

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	Liostracus, Angelin.			
87	L.—— Ouangondianus, Hartt sp.,	R. S. V, 138, I, 4*a*, *l-q*, II, 7*a-f*,	B. 3	C. 1*c*2, *d*2,
87	v. aurora (sp. Hartt)	R. S. V, 139, II, 7*a-f*,	B. 3	C. 1*c*.
87	v. gibba,	R. S. V, 140, I, 4*h-k*,	B. 3	C. $1c^1$.
87	v. immarginata,	R. S. V, 139, I, 4*b-d*,	B. 3	C. 1*c*.
87	v. plana,	R. S. V, 140, 4*e-g*,	B. 3	C. $1c^1$.
87	L.—— tener, Hartt sp.,	R. S. V, 137, I, 3*a-c*	B. 3	"
95	v. acuminata,	R. S. XI, 118,	B. 3	C. 1*c*2.
"	v. lævis,	R. S. XI, 118,	B. 3	C. 1*d*.
97	L.—— validus,	R. S. 2nd, III, 179, II, 7*a*, *b*,	B. 2	"
	Metadoxides, Bornemann.			
99	M.—— magnificus,	N. B. IV, 137, III.	E. 3	C. 1*b*.
	Microdiscus, Emmons.			
96	sub-sections of	N. Y. XV, 235-237.		
	M.—— bellimarginatus, S. and F.			
99	m. insularis,	R. S. 2nd, V, 75,	D. 3	E. 3.
68	M.—— Dawsoni, Hartt,	Acad. Geol. 564, *f*. 228.	B. 3	C. $1c^1$.
85	M.—— precursor,	R. S. III, 75, VII, 13,	B. 3	C. 1*c*2.
(96)	M.—— pulchellus, Hartt,	R. S. 2nd, III, 74, VII, 12*a-c*, N. Y. XV, 242, XVII, 8*a-f*,	B. 3	C. 1*d*.
(96)	M.—— punctatus, Salt.,	N. Y. XV, 244,	E. 3	C. 1*d*2.
96	M.—— Schucherti,	Am. Geol. July, '96, no fig., N. Y. XV, 238, XVII, 4*a*, *b*,	N.	E. 3.
95	Micmacca, gen.,	N. Y. XIV, 141.		
99	M.—— angimargo,	R. S. 2nd, V, 80, IV, 6,	E. 3	E. 3.
95	M.—— Matthevi,	N. Y. XIV, 141, X, 1*a*, *b*,	B. 3	C. 1*b*3.
"	M.——(?) plana,	N. Y. XIV, 143, XI, 2*a*, 3*b*,	B. 3	"
95	M.—— recurva,	N. Y. XIV, 142, X, 2*a*, *b*,	B. 3	"
"	M.—— VanIngeni,	N. Y. XIV, 142, XI, 1*a*, *b*,	B. 2, 3	C. 1*b*3.
99	M.—— Walcotti,	R. S. 2nd, V, 79, IV, 5*a-d*	E. 3	E. 3.
99	Neolenus, gen.,	R. S. 2nd, V, 52.		
(99)	N.—— serratus, Roeminger	R. S. 2nd, V, 53,	W.	C. 3*b*.
99	N.—— granulatus,	R. S. 2nd, V, 55, II, 1*a-c*,	W.	"
	Ogygia Brongn. (Ogygopsis) (Walcott).			
(99)	O.—— Klotzi, Roemin.	R. S. 2nd, V, 58,	W.	C. 3*b*.
	Oryctocephalus, Walcott.			
99	O.—— Walkeri,	R. S. 2nd, V, 60, III, 2,	W.	C. 3*b*.

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	Parabolina, Salter.			
00	P.—— Dawsoni.	N. B. IV, 282, V, *6a-f*,..	D. 1	C. *3b*.
91	P.—— grandis, ...	R. S. IX, 52, XIII, 7,	B. 3	"
	P.—— heres, Brögg., ...			
91	v. lata, ...	R. S. IX, 51, XIII, *6a-f*,	B. 3	C. *3b*.
(91)	P.—— spinulosa, Wahl.,..	R. S. IX, 51, XIII, *5a-d*,	B. 3	C. *3a*.
	Parabolinella, s. gen., Brögg.			
00	P.—— cf. limitis, Brögg.,..	N. B. IV, 412, ...	D. 1	C. *3c2*.
92	P.—— posthuma, ...	R. S. X, 107, VII, *15a, b*,	B. 3	C. *3d*.
00	P.—— quadrata, ...	N. B. IV, 411, XVIII, 7,	D. 1	C. *3c2*.
	Paradoxides, Brongniart.			
85	P.—— Abenacus, ...	R. S. III, 78, ...	B. 3	C. 1*d*.
97	mut., ...	R. S. 2nd, III, 175, I, *9a-c*, ...	B. 2	C. 1*d*.
97	form 2, ...	R. S. 2nd, III, 175, II, *1a-d*, ...	B. 2	"
82	P.—— Acadicus, ...	R. S. I, 103, ...	B. 3	C. 1*c2*.
85	v. suricus, ...	R. S. III, 77, ...	B. 3	"
82	P.—— Eteminicus,..	R. S. I, 92, ...	B. 3	"
"	v. breviatus, ...	R. S. I, 99, ...	B. 3	"
"	v. malicitus, ...	R. S. I, 101, ...	B. 3	"
"	v. quacoensis, ...	R. S. I, 102, ...	B. 3	"
"	v. suricoides, ...	R. S. I, 97, ...	B. 3	"
78	P.—— Forchhammeri, Ang.	Palæon. Scan. p. 2, pl. II, N. B. IV, 379; S.R. pp. 47, 48,	D. 3	C. 2*b*.
68	P.—— lamellatus, Hartt, ..	Acad. Geol. 656, R. S. I, 105; VIII, 135, XI, 9, ...	B. 3	C. 1c^1.
85	v. loricatus, ...	R. S. I, 106, IX, 19, ..	B. 3	C. 1*c*.
85	P.—— micmac, ...	R. S. III, 80, ...	B. 1, 3,	"
82	v. pontificalis, ...	R. S. I, 102, IX, 15, 15*a*, R. S. VIII, 136, XI, 8,	B. 3 B. 3	C. 1*c2*. C. 1c^1.
87	P.—— Regina, ...	R. S. V, 115, III, ...	B. 3	C. 1*c*.
03	Paradoxidoid trilobite,.. ..	S. R. [1]76, XI, *1a-e*,.. ..	D. 1	E. 2(*a*?)
	Peltura, M. Edwards.			
(03)	P.—— scarabeoides, Wahl.	S. R. 230, ...	B. 2	C. 1 C. *3b*. ..
95	Protagraulos, gen.,..	N. Y. XIV, 138.		
95	P.—— priscus, ...	N. Y. XIV, 139, IX, 1,	B. 3	C. 1*b3*.
	Protopeltura, s. gen., Brögg			
	P.—— acanthera, Ang.			
91	v. tetracanthura,.. ..	R. S. IX, 53, XIII, *8a-c*,	B. 3	C. *3b*.
	Ptychoparia, Corda.			
	P.—— Adamsi, Bill., ...	R. S. 2nd, III, 199, IV, 9,	N.	E. 3.
	var., ...	R. S. 2nd, III, 189, IV, 9,	B. 2	C. 1*d*.
	narrow form, ...	R. S. 2nd, III, 182, III, *2a, b*, ...	B. 2	"
87	P.—— alata, ...	R. S. V, 147, II, *2a-f*,..	B. 3	C. 1*d*.

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(99)	P.—— cordilleræ, Roeming.	R. S. 2nd, V, 44, I, 7, ..	W.	C. 3*b*.
97	P.—— limbata, ...	R. S. 2nd, III, 180, III, 1*a-d*, ...	B. 2	C. 1*d*.
87	P.—— Linnarssoni, Brögg.,	R. S. V, 143, II, 1*a-m*,	B. 3	C. 1*d*.
	Solenopleura, Angelin.			
85	S.—— Acadica, Whiteav.,	R. S. III, 56, VII, 15; V, 157, II, 5*a*, ...	B. 3	"
87	v. elongata, ...	R. S. V, 159, II, 6, ...	B. 3	"
	S.—— arenosa, Bill. sp., ..	R. S. 2nd, III, 182, IV, 10 R. S. 2nd, III, 199, IV, 9,	N.	E. 3.
97	v. angilimbata, ...	R. S. 2nd, III, 183, III, 3*a, b*, ...	B. 2	C. 1*d*.
86	S.—— bombifrons, ...	R. S. IV, 156, *f*. 5, 5*a, b*,	E. 3	E. 3.
03	S.—— Bretonensis, ...	S. R. 176, XI, 5*a-c*, ...	D. 1	E. 2(*a*?).
86	S.—— communis, Bill., ..	R. S. IV, 155, *f*. 4, 4*a, b*,	E. 3	C. 1*d*.
87	S.—— Robbii, Hartt sp., ..	R. S. V, 153, II, 3*a, b*, and 4*a-e*, ...	B. 3	C. 1*c*2.
	v. Orestes, ...	R. S. V, 154, II, 4*a-e*,..	B. 3	"
95	m. parva, ...	R. S. 2nd, III, 183, III, 4*a, b*, ...	B. 2	C. 1*d*.
99	Sphærophthalmus, Angelin.			
(03)	S.—— alatus, Boeck, ...	S. R. 228, ...	B. 3	C. 2 C. 3*b*.
00	S.—— Fletcheri, ...	N. B. IV, 280, V, 7*a-f*,..	D. 1	"
99	Strenuella, s. gen., ...	R. S. 2nd, V, 75.		
	S.—— attleborenis, S. & F.			
99	m. vigilans, ...	R.S. 2nd, V, 78, IV, 4*a-c*	E. 3	E. 3.
	S.—— strenua, Bill. sp., ..	R. S. 2nd, V, 76, ...	E. 3	"
99	m. robusta, ...	R. S. 2nd, V, 76, IV, 3,	E. 3	"
	Triarthrus, Green.			
02	T.—— Belli, ...	N. B. IV, 412, XVIII, 8,	D. 1	C. 3*c*2.
	Zacanthoides, Walcott,			
(99)	Z.—— spinosa, Walc.	R. S. 2nd, V, 57, ...	W.	C. 3*b*.
	CIRRIPEDA.			
(96)	Plumulites, Barrande, note,	N. Y. XV, 199.		
96	P.—— Manuelensis, ...	N. Y. XIV, 200, XIV, 7,	B. 3	C. 1*d*2.
96	Cirripodites, gen., ...	N. Y. XIV, 205.		
96	C.——, types A to G, ...	N. Y. XIV, 206, XIV, *a-n*, ...	B. 3	C. 1*c*.
03	Eurypterid Crustacean, ...	S. R. 177, XI, 3, ...	D. 1	E. 2(*a*?)
	TRAILS, TRACKS AND BURROWS.			
	Arenicolites, Salter.			
(99)	A.—— antiquatus, Bill, ..	R. S. 2nd, V, 7, 1, IV, 1*a, b*, ...	E. 3	C. 2*b*.
90	A.——brevis, ...	R. S. VIII, 159, XI, 13*a-c*	B. 3	C. 2*c*.
		R. S. 2nd, V, 72, ...	D. 3	C. 2*b*.
89	A.—— Lyelli, Torrel, v. minor, ...	R. S. VII, 159, IX, 2*a-c*,	B. 3	E. 2.

Year	Generic and Specific Name	Place of Publication	Locality	Horizon
90	Ctenichnites, n. gen., ...	R. S. VIII, 151.		
03	C.—— bisulcatus, ...	S. R. 239, ...	D. 1	C. 2*a*.
90	C.—— ingens, ...	R. S. VIII, 151, XIV, 1-12, ...	B. 3	C. 2*c*.
		R. S. 2nd, V, 72, ...	B. 3	C. 2*b*.
	Eoichnites, gen., ...			
90	E.—— Linnæanus, Torrell, .	R. S. VIII, 148, XIII, 2-6, ...	B. 3	C. 2*c*.
90	Fræna Rauault, ramosa, . .	R. S. VIII, 157, XI, 11,	B. 3	C. 2*c*.
90	F.—— Goniadichnites gen., trichiformis, ...	S. R. VIII, 160, XI, 12,	B. 1	C. 2*a*.
90	Medusichnites (and Taonichnites), . .	R. S. VIII, 143, XII, 1-3, 4*a-d;* XIII, 1, . .	B. 1	C. 2*a*.
	Monocraterion, Torrell (69)			
90	magnificum, ...	R. S. VIII, 161, XVI, 1, 1*a, b*, ...	B. 3	C. 2*c*.
89	Psammichnites, Torrell, P.—— gigas, ...	R. S. VII, 157, IX, 1*a-k;* VIII, 157, ...	B. 3	E. 2.
85	Eocoryne, gen. . . . . E.—— geminum, ...	R. S. III, 31, V, 4*a, b,* VIII, 130, XI, 1*a-c*, . .	B. 3	C. 1*c*2.
	Lepiditta, gen., ...			
85	L.—— anomala, ...	R. S. III, 62, VI, 18, 18*a;* VIII, 130, XI, 2, ...	B. 3	C. 1*c*2.

SUMMARY.

	Genera	Sub-genera	Species	Muta-tions	Vari-eties
Algæ, ...	6		5+1= 6		
Protozoa, ...	4		12		
Spongida, ...	6		8+1= 9		1
Hydrozoa, ...	10		18+1=19		3
Echinodermata, ...	3		3		
Brachiopoda, ...	24	4	84+7=91	15	13
Lamellibranchiata, ...	1		2		
Petropoda, ...	2		3		
Gasteropoda, ...	8		15		
Cephalopoda, ...	1		2		
Annelida, ...	7		34+2=36	2	1
Ostracoda, ...	11		39	11	1
Phyllopoda, ...	3		9	1	1
Trilobita, ...	35	9	120+2=122	12	47
Tracks, Trails and Burrows,	9		12		1
	130	13	380	41	68

The preceding summary gives a "bird's-eye view" of the relation in numbers of the several classes and orders of Cambrian animals and plants found in the eastern provinces of Canada, and serves to emphasize the prevalence of certain types and the absence of all the higher orders as well as some of the lower ones that are common at the present day. No vertebrates and none of the higher crustacea appear. True corals and the Bryozoa are absent.

The Echinoderms are represented by a few Cystids. The extreme weakness in number of the Lamellibranchs or Pelycepods is notable, for though regarded as one of the lower classes of Molluscs, they do not show as much strength as some of the higher.

The removal of Hyolithidæ (which are to be regarded as Benthos rather than Plankton), greatly weakens the Pteropoda; there remains in this division only two genera of small species of pelagic habit which are thought to have relations with this group rather than with the worms.

The Gasteropoda show a number of varied and ancient types, but the Cephalopoda would not appear in this list if there were not an Ordovician fauna in the uppermost part of the St. John terrane which otherwise is Cambrian.

The large number of species included in the Annelida is due to the fact that we have included here the Hyolithidæ which by the great Barrande and many subsequent writers were included in the Pteropoda. The arguments for this have been shown in some of the papers referred to in this catalogue and need not be repeated here. It will probably be found that Orthotheca should be included in Volborthella; the writer cannot distinguish the latter from a small decollated Orthotheca. A study of the question by some Russian author with larger material in hand is desirable.

It will easily be seen that Brachiopoda and Trilobita are the dominating types of Cambrian animals.

OBSERVATIONS OF PLANTS, 1902.

By G. U. Hay.

The winter of 1902 was remarkably open. Snow and sleighing disappeared the last week in February. A snow storm at the end of the first week in March renewed the sleighing, but only for a few days. Weather cold during March, but there were many bright, warm days, followed by cold rains in late March and early April. The St. John river was clear of ice on the 27th of March, the earliest on record. Tussilago farfara (coltsfoot) in bloom in the open places in St. John, April 8; in St. Stephen, April 7. (J. V.)

Wild Garden at Ingleside (12 miles from St. John).

April 5.—Frost out of the ground in the clearings. A few mayflowers in bloom on the barrens near by. Alder catkins descharging pollen when shaken. Willow and poplar catkins out.

April 19.—Not much advance in vegetation the past fortnight. Fine days, followed by hard frost at night, keeping the ground frozen. Flower buds of red maple becoming red and showing signs of bursting. The catkins of populus tremuloides shedding pollen. Mayflowers in full bloom on the barrens; but just opening in the Garden.

April 25.—White violets and wild strawberries beginning to bloom. Dirca palustris in bloom. Dog-tooth violet showing leaves above ground, and leaf buds swelling on deciduous trees. Red maples in full bloom. Mayflowers in Garden in full bloom.

May 1-5.—Last three days of April fine and tolerably warm, followed by cold winds in early May. Nights continue cold with frost, and but little rain. White violets in full bloom, and a few blue violets appearing. Painted trillium beginning to bloom. Wind anemone in leaf and bud. Blood-root, dog-tooth violet, and hepatica in bloom. The red maple trees a mass of bloom. Mountain fly-honeysuckle in leaf and flower.

May 16.—Weather very cold from May 11 to 19. Frost nearly every night, sometimes severe enough to freeze the ground and form ice in shallow pools. Cold north winds every day and no rain. Caltha palustris, dandelion, wind anemone in bloom; uvularia, amelanchier, bluets, gold thread in sunny places beginning to bloom. Viburnum lantanoides expanding its floral involucre. Red cherry trees putting forth leaves and flower buds. The osmunda ferns unfolding their fronds, and the woodsias on rockeries fully expanded. The long catkins of the mountain alder pendulous and discharging pollen. The spring flowers of nearly every species are few in number, shrivelled in appearance, and lacking size and freshness. The weary waiting for genial skies and grateful showers and the prevalence of March winds in May have retarded vegetation. An exception is the red maple, which still continues to bloom, its masses of crimson flowers forming a beautiful contrast to the delicate green of myriads of unfolding leaves. The pure white blossoms of the amelanchier mingling with the soft purple-brown of the fresh-opening leaves, followed a week later by the bloom of the red cherry, makes up a picture that is unequalled in beauty in our northern woodlands.

May 22.—In bloom: viola pubescens, caltha palustris, trientalis americana,trillium grandiflorum (not native), trillium erectum, trillium cernuum (in bud), veronica serpyillifolia, claytonia, virginica, sambucus pubens. Rock maple, poplar, white and red maples, birches, rowan tree, all in leaf, except betula populifolia.

June 24.—A bright, pleasant day, but with cool breeze. The weather which has been cold, with chilly winds, is now warm and summerlike. Lilacs, rowan tree and honeysuckle coming into bloom, and ampelopsis and acacia bursting into leaf. Stemless lady's slipper and pinguicula in bloom (June 4).

October 31.—A wet season, with mushrooms and toadstools in every color in greatest profusion, especially in the evergreen woods. About 150 species collected and named. Material all too abundant during the season, which lasted until the frosts of early November. The weather in September and October was more changeable than usual, and toward the last of the latter month strong gales prevailed. Light frosts occurred in late September and early October. The night of October 9 was very cold, with frost sufficient to make ice, with a snow storm early the following day. Some severe weather with northwest gales between the 20th and last of month, alternating with milder weather, southwest winds and rain. The deciduous trees have not shown this season their usual variety and beauty of coloring in their foliage, and there has been apparently no Indian summer up to date (October 31).

Observations of Plants in Wild Garden, Ingleside, 1903.

May 9.—The weather dry and variable, with cold nights. The spring opened early, as in the previous season, but cold winds, absence of rain and occasional frosts have retarded vegetation. White violets and dog-tooth violet in full bloom, with a few of the following: Dandelion, viburnum lantanoides, blue violets, lonicera ciliata, strawberry. Going out of bloom: Mayflowers (in Garden), dirca palustris, red maple.

May 16.—Weather cold, with northwest winds for the past few days. Heavy frosts at night and ice forming in places. In bloom: Painted and purple trilliums, gold thread, bluets, viburnum lantanoides, wind flower, caltha palustris, uvularia; amelanchier and white trillium unfolding. White birch, red maple, amelanchier, trembling poplar, horse chestnut, black cherry, red cherry, lilac just coming into leaf.

May 25.—Cold, with northwest winds for the past three days. Weather bright and sunny. Rain needed. Red oak, elm and populus grandidentata just coming into leaf. In flower: trillium cernuum, dewberry, rhodora, blueberry, actæa alba, bog bean, cornus canadensis.

May 31.—Plants in bloom: Trientalis americana, clintonia borealis, nemopanthes canadensis, viola pubescens, cypripedium acaule, red cherry.

June 8.—Frost first few nights in June, but not heavy enough to do damage. No rain, except a few scattered showers since April 29. Everything very dry, and forest fires raging for the past fortnight doing much damage to the timber lands, and destroying buildings in the Inglewood, Musquash and other districts west of the St. John river. Nothing growing in the parched and smoke-laden atmosphere.

June 15.—The copious showers of the past week are quenching forest fires and bringing relief to fire-threatened districts. Belated plants have sprung from the ground as if by magic, the foliage has freshened, and the grass promises an abundant crop. East winds prevail, and there has been no warm weather yet, except an occasional day.

June 30.—Rains and fine weather prevailed alternately during the last half of June. Cold at times. Little warm weather yet, but a fine growing time.

APPENDIX.

FORTY-SECOND ANNUAL REPORT

OF THE

COUNCIL OF THE NATURAL HISTORY SOCIETY

OF

NEW BRUNSWICK.

The Council of the Natural History Society of New Brunswick submits the following report for the year ending December 31st.

Membership.

During the year the membership has been increased by the admission of five ordinary and fourteen associate members, one corresponding and one junior member. Three ordinary members have died, one has removed from the city—Mr. Geoffrey Stead, who has been elected a corresponding member. The names of the deceased members are: Franklin Stetson, John MacKinnon, E. G. Scovil.

The following shows the numbers, classes and total enrolled membership:

Honorary,	4
Life,	5
Corresponding,	24
Ordinary,	54
Associate,	84
Junior,	2
Total,	173

Treasurer's Report.

Income—

Balance from 1901-2,	$441 18	
Interest on investments,	56 25	
Bulletins sold,	10 63	
Government grant,	200 00	
Membership fees,	215 00	
Fredericton N. H. S. for publishing report,	27 50	
Dividend Botsford estate,	10 00	
Donation to improve the Botanical Collection by adding specimens of native woods, preserving the plants from the ravages of insects and otherwise adding to its usefulness and educational value,	40 00	
		$1,000 56

Expenditure—

Maintenance of Museum,	$ 33 56	
Library, books and binding,	41 25	
Printing and distributing Bulletin XXI,	204 37	
Sundries,	143 74	
Balance,	577 64	
		$1,000 56

Of the above balance $33.00 is held in trust for the Ladies' Association.

The Society owns besides a $1,500.00 mortgage, $1,000.00 special deposit Bank of Nova Scotia; ($11.84) $11.86 special deposit Bank of Montreal (Building Fund).

Special attention is directed to the Building Fund, as it will be noticed that the $10.00 donated in December, 1897, has not been increased by any additions except the interest which it has earned.

The mortgage is protected by insurance.

The collections in the Museum are protected by an insurance of $2,500.

A. Gordon Leavitt,
Treasurer.

January 19th, 1904.

Library.

A rough list has been made by the assistant curator of the books and pamphlets in the library, preparatory to a re-cataloguing and re-arrangement, so that the library may be made more useful to the members. This book the librarian and library committee hope to have completed during the present year, and the Council has appropriated a sum not exceeding fifty dollars for the purpose of defraying the expenses.

Publications.

Bulletin XXI has been published during the year, containing 152 pages, comprising many useful articles, illustrating the progress of scientific work and discovery in New Brunswick. Other papers of more popular interest have been published in the local papers.

Lectures.

Ten regular meetings, including the annual meeting, were held, and two special meetings. The following are the dates of the meetings and the titles of papers read:

1903.

Jan. 6 (a) On the reported appearance of the Panther (Felis concolor) in New Brunswick, by Prof. W. F. Ganong.
(b) The Parasite, by Geo. G. Melvin, M. D.
(c) Some Rare Plants and their Habits, by H. F. Perkins, Ph.B.

Jan. 20. Annual Meeting. President's Address. Election of Officers.

Feb. 3. (a) Notes on the Natural History and Physiography of N. B., by Prof. W. F. Ganong.
(b) Notes on New Brunswick Fishes, by Chas. F. B. Rowe.

Mar. 3. (a) The Forestry situation in New Brunswick, by Prof. W. F. Ganong.
(b) Notes on the Violets; "Wintering;" by J. Vroom.

April 7. (a) The structure of the Common House Fly, by W. H. Mowatt.
(b) Some remarkable Tree Forms in New Brunswick, by W. F. Ganong.

May 5. (a) Birds and their Structure, by A. Gordon Leavitt.
(b) Birds and their Nests, by J. W. Banks.

June 2. Report of the Royal Society Meeting at Ottawa, by Dr. G. F. Matthew.

Oct. 6. (a) Notes on New Brunswick Mushrooms, by G. U. Hay, D. Sc.
(b) The Highest Land in New Brunswick, by W. F. Ganong, Ph. D.

Nov. 3. (1) Fossil Foot Prints; (2) Genus Hylopus—Dawson; by G. F. Matthew, D. Sc.
Two papers on the Physiography and Natural History of New Brunswick (read by title), W. F. Ganong.

Dec. 1. Caverns, Caves and Cavities, by Professor L. W. Bailey, Ph. D.
Papers by Dr. Ganong (read by title).

December 30 a special meeting was called, which was addressed by Mr. M. L. Fernald on the distribution of certain plants on the Gulf of St. Lawrence shores.

A special meeting was also held on the evening of February 10th to hear the address of Hon. H. A. McKeown on "The Border Land between Insanity and Crime."

An elementary course of lectures was given on the Tuesday evenings not occupied by the regular meetings during the months of January, February, and a part of March. The following programme was carried out: Dr. G. F. Matthew gave two lectures: January 13, "Volcanoes, their Origin and Effects." January 27, "Water as an agent in modifying the Earth's Surface."

Dr. G. U. Hay gave two lectures on Ferns, their mode of growth, reproduction, habits and uses—February 17 and 24.

Mr. A. Gordon Leavitt gave one of the course of elementary lectures, on Bird Structure, and another was given on Exotic Ferns by Mr. Wm. McIntosh.

Ladies' Association.

The following course of lectures, carried out on Thursday afternoons during the winter by the Ladies' Association, was in marked agreement with the objects of our Society:

Jan. 15. Thoreau. Mrs. E. S. Fiske.
22. Reminiscences of the American Museum. Mrs. G. F. Matthew.
29. Children's Day—
A Talk on Insects. Mr. Wm. McIntosh.
Feb. 5. Wordsworth: A Nature Poet. Mrs. G. A. Hamilton.
12. Color in Nature. Miss A. Jack.
19. A Pre-historic Mound in Ontario. Miss A. L. Hunt.
26. Children's Day—
A Talk on Birds. Mr. A. Gordon Leavitt.
Mar 5. The Scientific Basis of Art. (Illustrated). Miss M. Barry Smith.
12. A Ramble in Switzerland. Miss Christine Matthew.
19. Nature Study in the Public Schools. Miss G. Murphy.
26. Reunion of Members.

There are eighty-four names on our associate membership roll, a slight increase over the previous year. The organization continues to be a very active one, and the ladies have shown themselves at all times desirous to assist heartily in the work and objects of our Society. Unfortunately our rooms, difficult of access and cramped in space, do not afford the opportunity of carrying out some work that we might attempt in the way ot a better arrangement and display of our archæological, botanical and other natural history specimens, and fitting up a more attractive library room.

Library and Museum.

The library and museum have been open to visitors three afternoons of each week—Tuesday, Thursday and Saturday. The assistant curator, Miss Florence A. Hoyt, has attended very promptly and faithfully to her duties.

The number of visitors during the year has been seventy-eight adults and 357 children.

Additions have been made to the collections in the museum during the year, the most valuable being that of specimens of insects, representing the beetles, by Mr. Wm. McIntosh.

Changes are now being made in two of the principal rooms of the museum,—adding to the cases, cleaning the walls, renovating the specimens and displaying them to greater advantage. These changes will be greatly appreciated by members and visitors.

Archaeology.

During the year this subject of archaeology has received attention from Dr. A. C. Smith, of Tracadie. He has for many years been an energetic member of our Society, and has made a number of valuable contributions to our museum. He has carried on researches in the vicinity of Tracadie which have shed much light on the life and early history of that part of the province.

At our January meeting he presented, through Dr. Matthew, a note on ancient modes of sepulture observed by him in an old graveyard near Tracadie. Accompanying his note were several illustrative specimens. He has received our hearty thanks for the excellent work he has done.

S. W. Kain has published two short papers during the year:

(1) An Old Religious Medal, *Acadiensis,* Vol. III, pp. 96-97, 1903.

(2) Trade Pipes, *Acadiensis,* Vol. III, pp. 255-258, 1903.

Geology.

The following note on a new locality for post-pleioscene shells may be taken as the report of the geological committee for the past year:

In December last Mr. J. P. Clayton, the superintendent of Fernhill cemetery, brought to this Society a lump of clay which he had dug up in making a catch-basin for one of the drains in the cemetery grounds.

In digging for this basin he stated that he had first passed through about a foot and a half of gravel and sand, then through six feet of red clay, and finally had struck the layer of black clay or mud of which the sample consisted.

The notable feature about this black clay is that it abounds in shells of the common mussel. These shells are in an excellent state of preservation; some of them with valves applied to each other as in life, and all having the color and nacre of the shell perfectly preserved.

In the same bed, but at a somewhat higher level, were a few sea-urchins, which must have been recently living or dead when they were entombed, as the plates of the skeleton were applied to each other, and the spines were in juxtaposition to the bosses on the plates to which they had been attached.

A few colonies of bryozoans also were observed and plates that may have belonged to barnacles.

Remains of strap-like and confervoid seaweeds are abundant in the upper layers of the bed, the black color of which seems largely due to the decomposed organic matter of these seaweeds and the animal fossils.

It is evident that the bed of shell-bearing clay, which is a few inches thick, was deposited in water of some depth, as the remains are in such perfect condition and show no evidence of having been subjected to the wash of the waves, nor does the deposit contain any strictly littoral shells.

It is interesting to compare the height of this bed above the present sea level with those of other localities where sea-shells have been found. A well known level of this kind, where the remains of shell fish were found, was at the east end of Lawlor's Lake, where, at the level of about sixty feet above the sea, there is a bed of clay and sea-sand containing shells of the common clam, the sea-urchin, the rock barnacle, and other species.

Another place where marine shells have been found is at the gravel bank north of the dam of the reservoir of the city water works on Little River, where the late Gilbert Murdock, Esq., found clam shells *in situ*. This place is about 160 feet above high tide mark.

Mr. William Murdock, the superintendent of the city water supply, informs me that the locality, where the clay bed with shells found by Mr. Clayton is situated, is ninety-five feet above high tide mark. The Leda clay (brick clay) has been found as high as 200 feet above the present sea level in this district; so this mussel bed must have been some scores of feet below the sea level when the Leda clay sea was at its greatest depth over the district around St. John.

ENTOMOLOGY.

The most important work in this department is the preparation of a list of the lepidoptera.

BOTANY.

Late in December Mr. M. L. Fernald, of the Gray Herbarium, Cambridge, Mass., paid a visit to St. John, and spent some time in examining the plants of our collection. He found here several rare species of flowering plants, the discovery of which adds to the knowledge of the distribution of our plants.

An examination of the plants in our herbarium reveals the presence of insects which must be removed if we hope to save the collection. This should be done at once, as the plants, representing our field work for nearly forty years past, are of great value from a historical and from other points of view to the students of our flora.

We need more space than our rooms afford to make a display of plants for educational purposes and to illustrate their economic uses. We need especially at the present time a collection of the native woods of the province and facilities in our museum to show them to advantage. Our plants at present are only useful for reference. Little opportunity is given to the student for examination and study, especially of the shrubs and trees, the most important section of our flora.

The botanical committee is keeping in view the early publication of a revised up-to-date list of the plants of the province.

Professor W. F. Ganong made an important study of the salt marshes under the title of "The Vegetation of the Bay of Fundy Salt and Diked Marshes: an Ecological Study." It was published in the Botanical Gazette, Vol. XXXVI, pp. 161-186, 280-302, 349-367, 429-445. September to December, 1903.

Additions have been made to the list of fungi published in last year's Bulletin. These additions representing some rare species of our larger fungi will be published in the next Bulletin.

Field Work.

The field work of the Society, as a whole, was confined to a series of Saturday excursions in the month of June. These were conducted by different members of the Society for the purpose of studying the geology, plants and animals of the park and other places near the city. An effort should be made to carry out these field meetings in future seasons on a more extensive scale, and especially to get as large a number of young people as possible interested in nature-study. If these become interested in summer, they will be desirous of crowding into our lecture-room and museum in the winter months.

If our members could devote a little more time and enthusiasm to field meetings, and to the holding of a summer camp, which has been a great source of interest and advantage to us in years past, it would be a great benefit to the Society.

General.

The grateful acknowledgments of the Society are tendered to those gentlemen who have prepared papers for the meetings and for publication in the Bulletin, especially to Professor W. F. Ganong, who has done so much in his papers on physiography and natural history to make us acquainted with the wild and little-known regions of the interior of the province. Our thanks are also due to the press for the free publication of notices and reports.

In planning the elementary course of lectures for the current year, the committee has sought to make them available for pupils in the higher grades of the schools; and there is evidence that many will avail themselves of the advantages of these lectures.

In the proposed Ter-centenary of the discovery of St. John by de Monts and Champlain, our Society has felt from the first that it would be desirable to have the Royal Society meet in St. John on the occasion. Accordingly an invitation from this Society, and from the Historical and Loyalist societies, was extended to the Royal Society at its meeting in Ottawa in May last to meet in St. John about the 24th of June, 1904. The invitation was favorably considered, but action was left to the Council, which meets in Ottawa early in February. It is the feeling among members of this Society, that should the Royal Society accept the invitations and honor the city by its presence, this Society will do everything possible to make the meeting a pleasant one.

DONATIONS TO THE MUSEUM, 1903.

DATE.	DONOR'S NAME AND DESCRIPTION OF GIFT.
Feb., ...	Dr. Geo. A. Hetherington. Garter snake. Stanley Thompson. Plumbago and can.—Sinter.
March, ...	Inglis C. Craig, M.A. Specimens of copper ore.
May, ...	Dr. G. F. Matthew. Two specimens of serpentine rock. Miss B. Bowman. Specimens of Continental money.
June, ...	Master Lynch. Piece of root with stone embedded. Dr. G. U. Hay. Specimens of fungi. Miss G. Ross. New Testament in different languages.
Oct., ...	Mrs. Hendershot. Specimens of minerals and rocks from Yellowstone National Park.
Nov., ...	S. W. Kain. Collection of pipes. Wm. McIntosh. Three cases of beetles. Dr. G. F. Matthew. Cast of largest footmarks found in Canada.
Dec..	Duncan London. Stone knife and ornaments (Indian. Dr. A. C. Smith. Iron knife, scrapers, ochre fish hook, harpoons, etc., dug from Indian grave at Tracadie, N. B.; also a "flint and steel."

DONATIONS TO THE LIBRARY, 1903.

Donor's Name.	Residence.	Works.
Academy of Natural Science,	Philadelphia,	Proceedings
Academie Imperiale des Sciences,	St. Petersburg,	Bulletins
Americal Entomological Society,	Philadelphia,	Circulars
American Museum of Natural History,	New York,	Bulletins
Australian Museum,	Sydney, N. S. W.,	Reports
Amherst College,	Amherst, Mass.,	Reports
Boston Society of Natural History,	Boston,	Bulletins
Boston Free Public Library Reports,	Boston,	Report
Buffalo Society of Natural Science,	Buffalo,	Bulletins
Bureau of Ethnology,	Washington,	Transactions
California Academy of Science,	San Francisco,	Proceedings
Canadian Institute,	Toronto,	Transactions
Cincinnati Society of Natural History,	Cincinnati,	Bulletins
Colorado Scientific Society,	Denver,	Transactions
Connecticut Academy of Science and Art,	New Haven,	Bulletins
Comite Geologique,	St Petersburg,	Report
Cornell University Library,	Ithaca, N. Y.,	Report
Davenport Academy of Natural Science,	Davenport,	Proceedings
Director Royal Gardens,	Kew, G. B.,	Bulletins
Department Inland Revenue,	Ottawa,	Report
Entomological Society,	London, Ont.	Journal
Feuille desJeunes Naturalistes,	Paris,	Journal
Field Naturalist Club,	Ottawa,	Ottawa
Geological Survey,	Perth, W. Austral.	Annual Rep'rt
Geological Society,	London,	Report
Geological Survey,	Ottawa,	Report
Historical and Scientific Society of Manitoba,	Winnipeg,	Bulletin
Iowa Geological Survey,	DesMoines,	Report
Indiana Geological Survey,	Indianapolis,	Proceedings
Johns Hopkins University,	Baltimore,	Circulars
Linnæan Society,	New South Wales,	Report
Liverpool Biological Society,	Liverpool,	Proceedings
Lloyd's Museum,	Cincinnati,	Report
Manchester's Geological Society,	Manchester,	Proceedings
Minnesota Academy of Natural Science,	Minneapolis,	Bulletins
Minister of Mines,	Sydney, N. S. W.,	Journal
Missouri Botanical Gardens,	St. Louis,	Bulletins
Maryland Geological Survey,	Baltimore,	Report
National Museum Library,	Washington,	Report
Natural Science Association,	New Brighton,	Proceedings
New York Academy of Science,	New York,	Report
New York Public Library,	New York,	Report
Philadelphia Museum,	Philadelphia,	Report
Public Museum of Milwaukee,	Milwaukee,	Report
Rochester Academy of Science,	Rochester,	Proceedings
Royal Academy of Science,	Stockholm,	Proceedings
Royal Colonial Institute,	London,	Journal
Royal Geographical Society,	London,	Proceedings
Royal Society,	London,	Proceedings
Royal Society of Canada,	Ottawa,	Proceedings
Smithsonian Institution,	Washington,	Reports
South Dakota School of Mines,	Rapid City,	Reports
Texas Academy of Science,	Austin,	Proceedings
University of Toronto,	Toronto,	Report
University of California,	Berkley,	Bulletin
U. S. Coast and Geodetic Survey,	Washington,	Report
U. S. Fish Commissioner,	Washington,	Report
U. S. Commissioners of Agriculture,	Washington,	Circulars
U. S. Geological Survey,	Washington,	Report
Wisconsin Academy of Science and Art,	Madison,	Bulletins
Wisconsin Natural History Society,	Milwaukee,	Proceedings
New York State Museum,	Albany,	Report

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ST. JOHN OBSERVATORY.

METEOROLOGICAL ABSTRACT FOR 1903.

Latitude 45.17 N. Longitude 66.4 W.

Month.	Barometer			Thermometer			Cloudiness: 0 = Clear 10 = Wholly Clouded	Precipitation: Rain & Melted Snow	Thunder Storms	Fogs
	Mean	Highest	Lowest	Mean	Max.	Min.				
Jauuary,...	29.82	30.69	29.04	21.8	47.0	—12.5	6	3.49	0	3
February,..	29.87	30.45	28.86	22.6	49.3	— 4.7	5	3.57	0	1
March,.....	30.23	30.78	29.33	34.8	49.8	4.0	3	7.37	0	2
April,.. .	29.89	30.43	29.34	40.4	72.3	16.8	6	5.76	0	3
May, ...	30.14	30.56	29.64	48.9	72.	28.3	4	3.13	0	4
June,......	30.03	30.44	29.72	57.3	75.	41.8	7	3.12	2	6
July, ...	29.84	30.12	29.38	60.9	80.	48.2	7	2.31	5	14
August,....	30.00	30.37	29.39	60.3	74.2	48.	5	1.55	2	4
September,.	30.07	30.59	29.67	58.2	82.5	39.	4	2.17	2	8
October, ...	30.01	30.45	29.20	47.3	63.	27.5	6	4.06	1	3
November,.	29.92	30.74	29.34	36.7	61.8	12.	5	4.67	0	1
December,..	29.89	30.45	29.13	22.	51.5	— 5.5	5	3.99	0	0

The mean height of the barometer was 29.98. The highest reading was 30.78, and the lowest 28.86. The mean temperature for the year was 42.6, being 0.7 warmer than the average. Maximum temperature 82.5 on September 14; minimum—12.5 on January 19. The total precipitation was 46.95 inches, which is +0.13 different from average.

First frost occurred on the 22nd of October, and the last on the 14th of May.

Aurora was observed on the 5th of April, 21st of August, 31st of October and 13th of December. A meteor of exceptional brilliancy was observed at 8.15 o'clock (60th Meridian time) on the night of the 13th November. For a second or more the city was as brightly lighted as at mid-day. The meteor moved from east to west, followed by a trait of light visible for several seconds.

D. LEAVITT HUTCHINSON,
Director, St. John Observatoty.

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