NOTES ON THE NATURAL HISTORY AND PHYSIOGRAPHY OF NEW BRUNSWICK.

By W. F. GANONG.

Reprinted from Bulletin of the Natural History Society of New Brunswick, No. XX, 1901.

ST. JOHN, N. B., CANADA:
Barnes & Co., Prince William Street,
1902.

ARTICLE II.

NOTES ON THE NATURAL HISTORY AND PHYSIOGRAPHY OF NEW BRUNSWICK.

By W. F. Ganong.

44.—On Forestry Literature Important for New Brunswick.

(Read January 8, 1901.)

A well-formulated forestry policy is the most pressing need of New Brunswick. Its development must be based upon a knowledge of the experience of other countries, particularly of those which, like some of the eastern United States, are conditioned as to the forestry problem not unlike this province. For this purpose the reports of the United States government, and of the different states which have established Forestry Boards or Commissions, are invaluable. It would be of the greatest service to the forestry interests of this province if these reports could be collected together in some accessible place in New Brunswick while they are still obtainable. This could most appropriately be undertaken by this Society working through a "Forestry Committee," whose duty it would be to apply in the name of the Society, and of the Province, for these reports, and to keep them, when obtained, classified and accessible to all inquirers. The committee should also collect newspaper and other articles relating to Canadian forests, and take the leading American journals devoted to the subject. The principal reports of value would be the following. The United States Government, both through the Division of Forestry of the Department of Agriculture and through recent reports of the Geological Survey, has published the most abundant and valuable matter upon American forestry. The following states, through their Forestry Boards or Commissions, have issued valuable reports,— New York, New Jersey, Pennsylvania, Wisconsin, Minnesota, North Carolina. Maine has a Forestry Board which has published two or three reports, but its work appears to be suspended. There are also some scattered

publications of lesser importance by other states. A most valuable summary of the forestry legislation of these states is given in a recent article, "Progress in Forestry Under State Control," by Spalding, in *Science*, for December 28, 1900.

The attention of young men in New Brunswick should be called to the fact that two universities, Cornell and Yale, have established schools of forestry. There can be no question that forestry is opening up to young men a most attractive and remunerative profession, and one which will be in demand in New Brunswick within another decade.

45.—On the Physiographic History of the Tobique River.

(Read February 5, 1901; re-written January, 1902.)

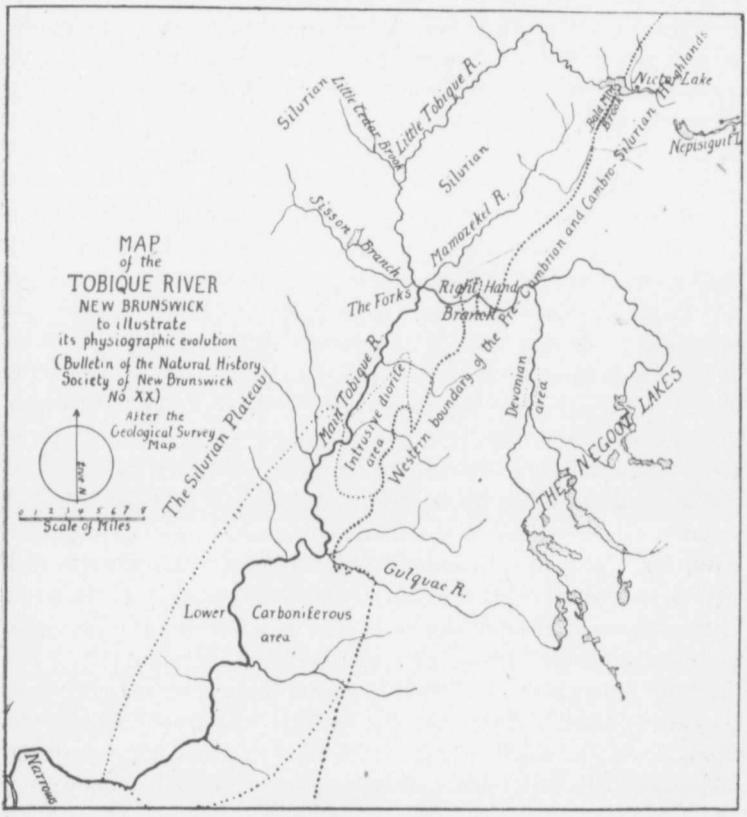
In earlier notes I have tried to trace the physiographic evolution of two of the finest of our northern rivers, the Restigouche and the Nepisiguit; I shall now attempt to treat in the same way the third of a noble trio, the Tobique. All three of these rivers are notable for their great natural beauty, but each has its own personality and differs from the others. The Restigouche is the lovelier, but the least varied. The Nepisiguit is the sterner, and the least friendly. The Tobique is the riper, most varied and most companionable.

The reader can the better follow the present discussion if he has before him the excellent sheet of the Geological Survey including this river, from which the accompanying reduced sketch is taken (Map No. 1). Although both topography and geological boundaries are necessarily inaccurate in some details, we may, as a whole, assume their essential correctness.

From our present point of view the Tobique falls into four portions as follows: (1) The river below the Forks, which I shall call the Main Tobique, (2) the Right Hand Branch, (3) the Little Tobique, and (4) the Mamozekel. Of these, all are a complete wilderness except the Main Tobique. I am personally acquainted with them all except the Mamozekel, and the following observations and conclusions have, for the most part, been worked out upon the ground.

We must, first of all, note the general structure of the region. Excepting the Right Hand Branch, the Tobique flows southwest, approximately parallel with the line of contact of two distinct series of geological formations. On the southeast lie the Central Highlands, of

crystalline Pre-Cambrian, fringed by a border of Cambro-Silurian or Cambrian, rocks, having a minimum water-elevation on the principal lakes of over 1,200 feet, and rising thence into broken plateaus and hills from 1,700 to 2,700 feet in height. As will later be shown (Note No. 49), these highlands are the remnants of an ancient much-



MAP NO 1.

dissected, warped, and perhaps faulted, peneplain,—the same, I believe, as that described by Daly in Nova Scotia, which he homologizes with the Cretaceous Peneplain of New England. Sharply marked off from this is the great rolling plateau on the northwest, in which the Tobique runs, with minimum lake levels of over 700 feet and a general elevation of 800 to 1,000 feet. It is composed, for the most part,

of highly disturbed Upper Silurian rocks, but includes a large area of little disturbed Lower Carboniferous on the Lower Tobique. Evidently this plateau represents the remnant of a second and younger peneplain, far less dissected than the older, which, although much higher above the sea level, is without doubt the equivalent of the newer peneplain recognized by Daly in Nova Scotia, and homologized by him with the Tertiary Peneplain of New England. Whatever we may think as to the mode of origin of these peneplains, or as to their age, there can be no question as to their real existence. This conception of the two peneplains throws a flood of light upon the topography of Central New Brunswick, which, without them, is most confused and well nigh impossible of interpretation.

We turn now to the Right Hand Branch. As already described (Note No. 39), this includes a number of valleys deeply cut into the Pre-Cambrian highlands, and converging northward. All that we can be sure of as to their age is that they are at least as old as the peneplain into which they have cut, which, tentatively, we may agree with Daly in assigning to Cretaceous age, but they may be very much older. An important point about them, however, is this: that their direction of flow is nearly in reverse of that of the Main Tobique river. This can only be explained by the supposition that the peneplain, when they began to cut into it, had a slope to the northward and sent these rivers draining into waters whose modern representative is the Bay Chaleur. The entire Silurian plateau would at that time have been filled with rocks to the level of this Cretaceous plateau, and the remainder of the Tobique could not then have been in existence.

In this connection we may well consider another part of the Tobique which has probably had a similar history, namely, the upper part of the Little Tobique, together with the Nepisiguit Lakes. As has been pointed out by Chalmers (Note 33), in Pre-Glacial times the Nepisiguit Lake valley doubtless emptied into the Nictor Valley; and the direction of flow of this Nictor Nepisiguit valley, parallel with the Right Hand Branch, and its similar general relation to the formations of the region, makes it seem certain that it is of the same age and has had the same history as the Right Hand Branch.

We next turn to the Main Tobique and the Mamozekel, the latter a direct continuation of the former. It seems plain that these two are morphologically one river, and together form the real Main Tobique. With the Mamozekel I am not familiar, though I have seen

its valley at its mouth, and from the mountains near Nictor Lake. The Main Tobique has cut from three or four to six or seven hundred feet into the Silurian plateau in a winding rock-walled but well-matured valley, provided frequently with extensive intervales. Its age must therefore be at least that of the peneplain into which it has cut, which tentatively we may assume with Daly as of Tertiary age, and it may be very much older. The question now arises as to why it flows southwest into the St. John, instead of northeast into Bay Chaleur, as the Right Hand Branch doubtless once did? There can be no doubt, I believe, that the same causes sent it southwest (in fact, originated it) which turned the St. John from its proper course into Bay Chaleur and sent it through the highlands southward, a peculiarity which has greatly complicated not only the physiographic, but also the human history of this region.*

There are three possible explanations of the age and cause of this change of course of the St. John and origination of the Main Tobique. First, it may be co-temporaneous with the beginning of the elevation of the newest peneplain. In this case we must hold that the peneplanation (Tertiary?) of the Silurian plateau was effected by rivers flowing into Bay Chaleur, and that all through this period the St. John, the Right Hand Branch and the Nictor-Nepisiguit thus emptied while the Main Tobique did not exist. With the beginning of the elevation of this peneplain, however, inaugurating the present cycle, and allowing the rivers to cut their present deep channels, that elevation would have commenced, and must been comparatively rapid on the northward, thus turning back the slow-moving St. John, Right Hand Branch and Nictor from their courses into Bay Chaleur, and throwing their waters southwest where they would accumulate, perhaps in a huge lake, until this reached the height of the lowest point in the highlands, when they would escape southward, thus originating the course of the present St. John and the Tobique. The Main Tobique would therefore have originated by the turning southwest of the drainage of the Right Hand Branch, while the Mamozekel, similarly originated by the same turning of the Nictor-Nepisiguit waters, which as will presently be shown, formerly emptied by the Mamozekel. Both Main Tobique and Mamozekel would follow the trough between this uplift on the north and the higher land on the southeast. On

* Particularly in connection with political boundaries, as I shall show in a later note.

this supposition the change of the St. John and origin of the Main Tobique would be Tertiary, or post-Tertiary. Second, it is possible this change was one cycle older, namely, that it took place by the same method of more rapid elevation northward (and scarcely any other explanation is under the circumstances imaginable) with the elevation of the earlier (Cretaceous) peneplain, and that the peneplanation of the later plateau was effected largely by rivers flowing into the St. John. There are certain facts which tend to substantiate this view, notably the very winding course of the rock-valley of the Main Tobique, which is best explained by the supposition that it existed as a ripe river wandering in a matured flood plain when the latest elevation began. This would make its age Cretaceous, or post-Cretaceous, on the hypothesis of that age for this older peneplain. Third, the presence of little-disturbed Lower Carboniferous rocks in the lower valley of the Main Tobique suggests an early connection with the sea by way of the present St. John valley, for fragments of that formation are found at intervals along the St. John down to the great central Carboniferous basin; while on the other hand, in the northeasterly direction, no traces of it are known until the present Bay Chaleur is reached. Both the St. John and the Tobique may therefore be the successors of rivers which have flowed in their respective directions from pre-Carboniferous times. In this case the change of direction of the St. John and the formation of the Tobique would have occurred in consequence of an elevation northward accompanying the profound disturbances which took place in this region in the Devonian period, disturbances which affected the Upper Silurian rocks of this region, but did not affect those of the Lower Carboniferous.

Further research will doubtless yield facts which will permit a decision as to these three possibilities. In the meantime it seems most probable that the Main Tobique existed prior to the latest elevation and assisted with the St. John in the peneplanation of this Silurian plateau.*

*In my earlier note on the Restigouche (No. 37), I imply too great an age to that river by speaking of it simply as post-Silurian. Its age must, I think, be the same as that of the Tobique, although in many ways it seems much newer. Thus, although in rocks at least as soft as the Main Tobique, its valley is much narrower and more V shaped, and almost entirely lacks intervales, which the Tobique nearly everywhere has. Were it not for its very winding valley in the lower part of its course, implying that it, like the Tobique, was a mature river wandering on a flood plain at the beginning of the last elevation, I would consider it as originating only after the elevation of the peneplain, and hence much newer than the Tobique. In any case I think there is no doubt its upper waters from the Kedgewick, if not from Tracy's Brook, have been captured from the St. John.

Turning attention more particulary to the Mamozekel, we note that it forks at its head into two branches, which approach respectively the Nictor and Nepisiguit Lakes. As shown in an earlier note (No. 29), there are but low valleys between the lakes and these branches, indicating a former connection and drainage into the Mamozekel. All of the facts seem in harmony with the explanation of this region already given, that the Nepisiguit-Nictor-Valley and the upper part of the Little Tobique, as far as the right-angled bend, form part of an ancient valley, whose waters, by the same causes which turned the Right Hand Branch southward to form the Main Tobique, were turned southward to form the Mamozekel. Which of the two connections with the Nictor-Nepisiguit-Valley is the older, remains to be determined. Subsequently the latter valley was captured from the Mamozekel by the Little Tobique, and finally the Nepisiguit part of the valley was turned by glacial drift down the Nepisiguit River.

We turn next to the Little Tobique which winds about in a wide gravel-bottomed valley. It enters the Main Tobique at exactly the same point as the Right Hand Branch, a fact which can hardly express a mere coincidence, and which, doubtless, indicates some casual connection. This is, probably, because the lower part of the Little Tobique occupies the ancient valley by which the Right Hand Branch flowed northward before the Main Tobique was formed. Possibly the Sisson Branch occupies the position of that ancient river, and the Little Tobique may originally have been but a branch of it. Probably the Little Tobique at first headed in the present Little Cedar Brook, and then sent off a branch which captured the Nictor Valley at the right, angled Bend.

The present Tobique River, therefore, has had its present approximate form and extent since, at least, the beginning of the elevation of the younger peneplain, and, perhaps, much longer. It is still steadily cutting its channel into the peneplains, giving origin to its charming scenery, and cutting back at its heads. One phase of this extension deserves special mention, namely, one of its branches, the Gulquac, has extended back at its head until it has actually tapped the system of lakes at the head of the Right Hand Branch. Theoretically, this process can go on until all of those lakes are turned by shorter courses into the Tobique, thus further complicating the physiography of this region. The Main Tobique has cut down in one place into ancient

intrusive rocks which, no doubt, underlaid the Silurian rocks when the valley of the river began to cut its present channel.

It remains but to speak of the effect of the glacial period upon the development of the river as we find it to-day. I can trace but four effects. First, the various lakes were formed, at least in part, by dams of glacial drift. Second, the Nepisiguit Lake valley was, doubtless, turned from the Nictor into the Nepisiguit by glacial drift. Third, all of the Little Tobique and the Main Tobique are smooth-flowing, gravel-bottomed rivers, because of the masses of drift available to the rivers for thus smoothing their beds. That they lack the boulder rapids, so abundant in most of our rivers, is due to the character of the drift brought into them from the north west — the soft Silurian slates easily worn down, instead of granite and felsite. Fourth, several falls and gorges have been formed on the river by the blocking of the old valley in places with drift. Of this nature are, probably, at least some of the falls on the Right Hand Branch, the Little Falls, the Ledges, Red Rapids, certainly Sisson Falls with their grand gorge, and the Narrows in which the fall is extinct.

The Tobique, then, despite its apparent complexity, appears to be a comparatively simple river with a steady and homogeneous development. It has captured no other rivers, and it has lost to other rivers nothing but the part of the Nictor Valley turned into the Nepisiguit in glacial times.

46.—Great Forest Fires in New Brunswick.

(Read March 5, 1901.)

By far the deadliest enemies of forests are fires, and their prevention is the greatest problem of the forester. In New Brunswick they have been abundant and disastrous from very early times, doubtless from the one near St. John two thousand years ago, which Dr. Matthew has described,* down to the present. A list of these great fires, with dates and extent, would have much interest and considerable economic use in helping to determine the rate of rapidity of natural reforestation in given districts. Such data about forest fires are being gathered by the Division of Forestry of the United States. I wish here to call attention to early accounts of two of our greatest fires. The worst

* Canadian Record of Science, viii, 213.

the province has ever suffered was, of course, the great Miramichi fire in 1825, of which we have a vivid description by Cooney in his History of Northern New Brunswick and Gaspé. A brief reference to the effects of a great fire before 1677 between the Nepisiguit and Miramichi is given by Father Christian LeClercq in his "Nouvelle Relation de la Gaspesie," in 1691, of which the part of interest to us is translated into English and published in Hay's Canadian History Readings (St. John, 1900), page 275. It is of interest to note that Father LeClercq attributes this fire, which must have nearly or quite equalled the later great fire of Miramichi, to lightning. In a still unpublished report on a survey of the river St. John, by Chas. Morris, in 1765, in the Public Record Office, a great fire of 1761 is referred to. Thus, he says of the Belleisle: "the Timber of all the Lands having been burnt about Four years ago by the Indians." Later he says: "All the Timber upon both sides Washademoak has been burnt by the Indians." Of Grand Lake, he says: "The Lands for a good way up the lake have suffered the same mischief as the lands of Washademoak, being burnt and all the timber destroyed." The implication in Morris' words is that the fires were set purposely by the Indians, which, if true, would recall the fires set periodically in the west by the Indians for purposes connected with hunting, and which are believed to be a chief cause of the treelessness of those regions.

47.—Measurements of Magnetic Dip in New Brunswick.

(Read March 5, 1901).

In the Society's Bulletin, No. XVII, page 105, Professor Duff gives a brief account of the scientific status of the study of magnetic dip, together with the results of some measurements made by himself in different parts of the province. He states that earlier observations are not known to him. Some earlier observations, over three hundred in number, were made, however, in 1840–41, by the surveyors of the north line from the source of the St. Croix, under charge of Major Graham. (United States, Executive Documents, 27th Congress, 2nd Session, 1841–42 Doc. 70). The results appear not to have been published in detail, but are doubtless preserved in manuscript in Graham's report in the Department of State at Washington.

48.—The Morphology of New Brunswick Waterfalls.

(Read March 5, 1901).

New Brunswick is a glaciated land of many rivers, and hence has many waterfalls. Waterfalls interest us in three ways: for their æsthetic charm, for the scientific problems involved in their origin, and for their economic value. I shall here discuss particularly the second of these phases of the subject.

Considered as to their origin, waterfalls group themselves into the following categories, which, like all of our classifications of natural objects and phenomena, are not distinct and exclusive, but merge into one another in the most varied combinations. Nor is it possible to draw any line between falls and rapids, for not only are there all gradations between, but there are some undoubted rapids which are much higher than some undoubted falls.

1. Glacial Falls.—This class includes the greater number, the best known and the largest of our waterfalls. Their mode of formation is familiar to all. In the Glacial Period masses of drift were often thrown into and across our river valleys. Where the valleys were deep and not completely filled, the drift was easily washed out again, leaving only the larger boulders to form the falls and rapids to be considered in the next class. Where the valleys were shallower, or the sides very irregular, the glacial dam often forced the water to leave its old channel and flow along or over a part of the rocky wall of the valley to fall again into the old valley below the obstruction. At the latter point a fall would be formed into a basin receiving both the old and the new courses of the river. But the fall, as falls always do, would begin to cut back into the rock over which the river flowed until a deep gorge is formed with the fall at its head. Above such falls, the river, still dammed back, often shows but a gentle current for a long distance. In this condition are most of the greater falls of the province, particularly those in the main courses of our principal rivers. Such are the Grand Falls of the St. John, with its pre-glacial valley on the right bank, the Grand Falls of the Nepisiguit, with its old valley on the left bank,* the Falls of the Magaguadavic at St. George, with the old valley on the left bank, where the town stands, Aroostook Falls and the great falls on the Sisson branch of Tobique.

* On this channel, see this Bulletin, No. XIX, 318.

Here belong also, no doubt, Gordon Falls on Pollet River, all the principal falls of the St. Croix (Salmon, Sprague's, Grand, Chepednec, Little and Tagwaan), those at the mouth of the Digdeguash, Upper Falls on the Magaguadavic, the four fine falls on the Lepreau* (Ragged, Big, Little, and that at the mouth), the Upsalquitch Falls at Ramsay's Portage, Pabineau and other falls on the Lower Nepisiguit, and numerous others on various streams throughout the province. Many of these, particularly those flowing in the hardest rocks, have insignificant gorges, but some of them possess gorges of great extent and impressiveness, of which the finest are those of the Grand Falls of the St. John, of the Nepisiguit and of the Sisson Branch.†

In some cases, where falls of this class once existed, there is now but a gorge, for the fall has worked completely back through the rocky ledges to the level of its old channel. The four greatest examples of such gorges in the Province are, that at the mouth of the St. John, the Narrows at the mouth of the Tobique, the Narrows on the Nepisiguit, four miles above Grand Falls, and the Narrows described by Ells on the Northwest Miramichi.‡ Probably most of the many places on our rivers which have the name Narrows, have had this origin.

Looking next at the distribution of the greater falls of this class, we at once observe that they are much more abundant on rivers, or portions of rivers, running in a general north and south (more exactly south-east) direction than on those running in a general west and east (more exactly north-east) direction. No doubt special local conditions of strike of formations, depth of valleys (in such a river as the Restigouche) and amount of drift available, etc., explain this peculiarity to a great extent, but they do not entirely; and the fact that the falls are most common in valleys following the direction of movement of the glaciers suggests that the glacial dams causing the falls are mostly of the nature of terminal moraines.

2. Boulder Falls.—When glacial drift was thrown into valleys in quantities not too great, the rivers afterwards removed it all except the boulders too large to be moved, which remained as obstructions in the channel, forming bad rapids and even small falls. Thus are caused

* I am surprised that the great and picturesque falls on this river, particularly Ragged and Big Falls, seem so little known in the province.

† The Sisson gorge, unlike the others mentioned, which are U-shaped, and with mostly bare walls, is V-shaped, and with heavily-wooded walls.

‡ Geological Report for 1851, D. 29.

most of the troublesome rapids on our rivers, notably on the St. Croix, the Nepisiguit, and the Southwest Miramichi. Small falls of this type occur also commonly at the outlets of lakes, and at the lower ends of long dead-waters.

3. Affluent Falls.—In the process of erosion of any country, the larger, especially if sediment-carrying, rivers tend to wear down their channels more rapidly than do the smaller branches, especially if these be clear streams. This process may often have been aided by glacial erosion of the greater streams.* Hence, the smaller branches must enter the larger valley with a fall, which will not be a vertical drop, but an irregular sloping fall or rocky rapid. Very large branches would not show such a fall, since they would cut down as rapidly as the main stream. If now we note the way in which the smaller branches of our principal rivers enter the main valleys, we will find that it is usually with either a broken fall or else with rocky rapids. This is true, for instance, of most of the streams entering the St. John between Grand Falls and the head of tide above Fredericton. The phenomenon is less marked than it would otherwise be since the main river is, for the most part, not flowing in its ancient rock bed, but upon drift with which it is partially filled. Some of the falls at the mouths of these branches may be of glacial origin; indeed, they may all be, for the subject has not received, though it deserves, investigation from this point of view.

4. Plateau Falls.—New Brunswick is largely of the physiographic character known as rejuvenated, that is, consists of great imperfect peneplains which have been re-elevated, thus allowing the rivers to cut their valleys deeply into them. On the resulting plateaus new streams are of course forming; and where these reach the valleys of the older rivers, they make a long fall into them, which may be steep even to vertical. Thus is produced, I believe, the highest fall in the province, namely, that on Fall Brook, on the southwest Miramichi, a few miles above Boiestown. This fall, 120 feet in height, and a single vertical drop into a beautiful rocky basin, occurs just where the brook meets the valley of the main Miramichi. The next highest, Hays, or Thompson's Fall, below Woodstock, is also of this character, as are the falls on the brook emptying Milnagek or Island

*Davis (Science, xiv, 779) appears to advocate the view that where such "hanging valleys" occur, the main stream has been deepened by glacial ice.

Lake into Long Lake, and innumerable other small ones in various parts of the province. Such falls will, of course, occur in their most typical form only upon very small and new streams. As those streams grow larger the falls will become reduced in height until they disappear, and they will pass through a stage in which they will merge with those of the preceding class.

Here also belong falls which occur where streams drop from a plateau to lower levels, even if these be not river valleys but have been formed by faulting or other method. Of this nature is probably the fall of ninety feet said to occur upon the stream emptying Lake Antonio into Sparks Lake in Charlotte.* Moreover, the many small falls on any streams coming from elevated land to lower levels belong partially here, but not entirely, for the mere slope alone would produce smooth sluices and not falls, and the actual fall comes rather under the next class.

5. Erosion Falls.—Where streams are flowing down a sloping bed and cross bands of harder and softer rocks, they erode out the softer, forming falls over the harder. The same result follows where portions of the rock are met with, more jointed than elsewhere; these parts are more easily removed, leaving a fall over the less jointed part. Thus are formed many of the minor falls along the courses of our smaller streams, and especially along torrents flowing in rocky beds, such, for example, as the small rivers entering the Bay of Fundy between Quaco and Point Wolfe. By this method, also, falls formed in other ways are often given a more irregular character than they would otherwise possess. Usually falls of but a few feet in height are thus formed.

6. Tidal Falls.—Where heavy tides pour through narrow channels into large basins, there must be a considerable drop towards the water level beyond the barrier. If now in addition there is a shallow reef at the narrow place, the conditions are present for a true tidal fall, which may run inward with the rising and outward with the falling tide. Our best example of such a fall, and doubtless the best anywhere known, is that at the mouth of the St. John. Another of

*I have not seen this fall. It is mentioned in a pamphlet issued by the Magaguadavic Fish and Game Association, which states that Lake Antonio (locally Anthony) is 500 feet above Sparks Lake. An early plan by Holt gives it as 250 feet above Sparks Lake. All printed maps are in error in making this lake empty into Forked Lake; it empties into Sparks Lake, between Red Rock and Clear Lakes. The maps make it also far too small.

lesser perfection occurs in Cobscook Bay, and there are approaches to it in some of the passages in the Passamaquoddy region.

There may be yet other methods of formation of waterfalls not here considered;* and there lies open to us an attractive field for investigation, not only in the search for new types of falls, but also in the examination, description and reference to their proper types of all the leading falls of the province.

So far as concerns the economics of our water falls, it is plain that their value lies more in the past and future than in the present, for very few of them are now utilized, even of those which were once valued mill privileges. In the future, however, when fuel becomes dearer and methods of transmitting and storing power become improved, they are sure to rise again into lasting importance, and they may fairly be reckoned among the potential resources of the Province. It would be a great advantage from this point of view if exact data as to their height, volume, constancy and surroundings were available, such data as the United States Geological Survey has gathered for those of Maine.† Such data could best be secured as a part of the work of that thorough topographical, economic and scientific survey of New Brunswick which would be invaluable to the province in all of its greatest interests. The need for such a survey offers to some citizen of great wealth the opportunity to make to the province a gift of the most serviceable, lasting and satisfying character.

49.—The Origin of the New Brunswick Peneplains.

(Read June 4, 1901).

An important and very suggestive paper, entitled, "The Physiography of Acadia," has recently been published‡ by Dr. Reginald A. Daly, of Harvard University. The author deals chiefly with Nova Scotia, but refers also to New Brunswick, particularly its southern and eastern part. It is the object of the present note to inquire in how far his conclusions apply to New Brunswick as a whole.

* Davis (Science xiv, 779, Nov. 1901), reviews a paper by Sturm on the origin of waterfalls. Two additional classes are recognized by Sturm, of which there are no cases known to me in New Brunswick. (1) Where side streams bring in boulders (as in the canons of Colorado), and (2) where travertine is deposited in a channel as in Bosnia.

† Nineteenth Report, vol. iv, 43–52.

‡ In Bulletin of the Museum of Comparative Zoology, Geological Series, v, 73-104.

As a result of evidence drawn from his personal observations, from a review of the literature of the region, and from a comparison with the well-known districts of New England, the author concludes that the surface of Acadia consists essentially of two great peneplains. The oldest of these, completed in the Cretaceous age, includes all the harder rocks, and hence the greater elevations, the surviving facets of which are the Southern Plateau of Nova Scotia, including all its central and southern parts, the North Mountain, the Cobequid Plateau, the Southern Highlands of New Brunswick, and, presumably, the Central Highlands also. This peneplain must once (according to current theories of the peneplain) have stood at or very near the sea level, to which, with the exception of some harder rocks remaining as monadnocks, hard and soft rocks alike must have been planed down by erosion. Then an elevation began, which, as the progressively greater height northward of the surviving facets shows, was much greater northward, carrying the New Brunswick highlands much higher than those of Nova Scotia, which on the southern coast of that province dip down beneath the sea. This elevation of the land permitted the rivers to begin again their work of erosion, and they proceeded to carve the peneplain. In the harder rocks they slowly cut deep channels, while in the softer rocks this was relatively quickly accomplished, and then lateral erosion began. A long period of stability followed in the Tertiary, during which the rivers (possibly with some tidal co-operation) carved the soft Carboniferous and Triassic rocks down to a new peneplain at sea level, or near it, thus giving origin to the second or Tertiary peneplain,* which includes the Annapolis Valley of Nova Scotia, the Colchester and Cumberland lowlands, and the great Eastern Carboniferous plain of New Brunswick. An elevation followed, permitting the rivers again to cut down deeply into these lowlands, as in many places they have done, and this was succeeded by a period of submergence, drowning many of the

*The fact that neither Cretaceous nor Tertiary formations occur in these provinces is not necessarily a fatal objection to the theory assigning those ages to the peneplains. According to the theory, the highest facets of the entire country would have stood near sea level at the close of the peneplanation in the Cretaceous; but since the newer peneplain is very much lower than the older, any deposits formed in the Cretaceous would necessarily have been eroded away before the erosion could affect the older rocks. Similarly we may suppose that any Tertiary rocks formed during the Tertiary planation of the newer and lower peneplain have since been washed away, or, more probably, lie outside of the limits of this peneplain, which in many places dips beneath the sea.

valleys, which brings us to the present. But the periods of elevation (and, doubtless, of submergence also), were accompanied by warpings of the surface, and this was of two kinds; first, warpings parallel with the Appalachian trend, one of which is responsible, in part at least, for the Bay of Fundy; and second, folding about a hinge line running through Cape Sable, Digby, and east of St. John, the part to the westward having a slight westerly slope.

We pass now to investigate the application of this conception of the two peneplains to New Brunswick. First, we have to consider the Southern Highlands, a range of ancient crystalline ridges and hills extending parallel with the Bay of Fundy from Charlotte to Albert counties. Its extreme elevations reach about 1,400 feet, but the general elevation is very much less. I have not had the opportunity to observe these Highlands with the peneplain idea in mind, but in one position, at least, I recall that a distinct facet of the Cretaceous peneplain of Nova Scotia is finely shown, namely, in the great plateau, some 600 to 800 feet above the sea, extending from near Quaco to Point Wolfe, several miles broad and merging northward with the greater heights which are either monadnocks of the ancient peneplain, or are a result of subsequent warping. Again, another facet probably occurs in Douglas Mountain and the Broke-Neck-Blue-Mountain ridge, over which Mount Champlain (Bald) rises as a monadnock. No doubt other facets will be found.

North of these Highlands lies the great central Carboniferous Basin, which consists, for the most part, of soft sandstones, which have an elevation west of the St. John of 300 or 400 feet above sea level, and slope off gradually, with some local monadnocks and anticlinal warpings, to the eastward, where they dip evenly beneath the sea. The rivers, particularly the St. John, have cut deeply into it. As Daly himself points out, this basin falls in perfectly with his idea of the Tertiary peneplain. It is an extension of this peneplain which forms the great flat area in south-western York County, a typical peneplain from which rise a number of marked monadnocks, Mount Henry, Mount Prospect, Magaguadavic Ridge, Cherry Hill, Wedawamketch, etc, representing remnants of the earlier peneplain.

We pass next to the Central Highlands. This range lies northeast and south-west, entering the Province south of the Aroostook and Tobique, extending between Tobique and Miramichi, and across

the Nepisiguit to Bay Chaleur near Belledune. It is composed of the same ancient crystalline rocks as the Southern Highlands, but rises to extreme heights of 2,600 to 2,700 feet, with a general elevation considerably lower. In two places I have recognized beautiful facets of ancient peneplains. The first is in the level plateau, 1,700 to 1,800 feet above the sea, which exists between the headwaters of the Right Hand Branch of Tobique and the headwaters of the Little Southwest Miramichi (compare Note 55.) As seen from Long Lake on the Tobique, or from the Big Lake on the Miramichi, it presents the aspect of an extensive flat-topped ridge, which is shown upon nearer acquaintance, especially by crossing it, to be a rolling plateau. Fragments of it exist off to the eastward in Mount Braithwaite and ridges along the Little Southwest River, and to the southward of the Crooked Deadwater.* I have no doubt that this is one of the facets of the same great peneplain which Daly describes as the Cretaceous peneplain of Nova Scotia, and further study will unquestionably show that it has a much wider extension in this region. Its height is little greater than required by the angle at which it slopes upward in Nova Scotia and the Southern Highlands. Second, the Governor's Plateau, which I described in an earlier note (No. 29) without at all understanding its significance, appears to be a very typical facet of a true peneplain. It stands, however, at a higher elevation, some 2,400 to 2,500 feet. One at first inclines to consider that it is a fragment of an earlier peneplain, but, recalling the present high elevation of the Silurian plateau, presently to be spoken of, we see that it is doubtless due to the upwarping which this region must have undergone, and which, probably, explains in part the height of the plateau between Tobique and Miramichi, already considered. The mountains centering in Bald Mountain on the South Branch of the Nepisiguit probably represent another facet of the same peneplain similiarly upwarped, but these stand also on the hinge line of the greatest elevation, presently to be referred to.

North and west of these central highlands lies the great Silurian plateau, a fine type of a peneplain, of undulating surface, some 800 to 1,000 feet above the sea, composed of soft Silurian rocks, into which the Tobique, St. John, Restigouche and other rivers have deeply cut. This answers perfectly to Daly's younger or Tertiary peneplain in

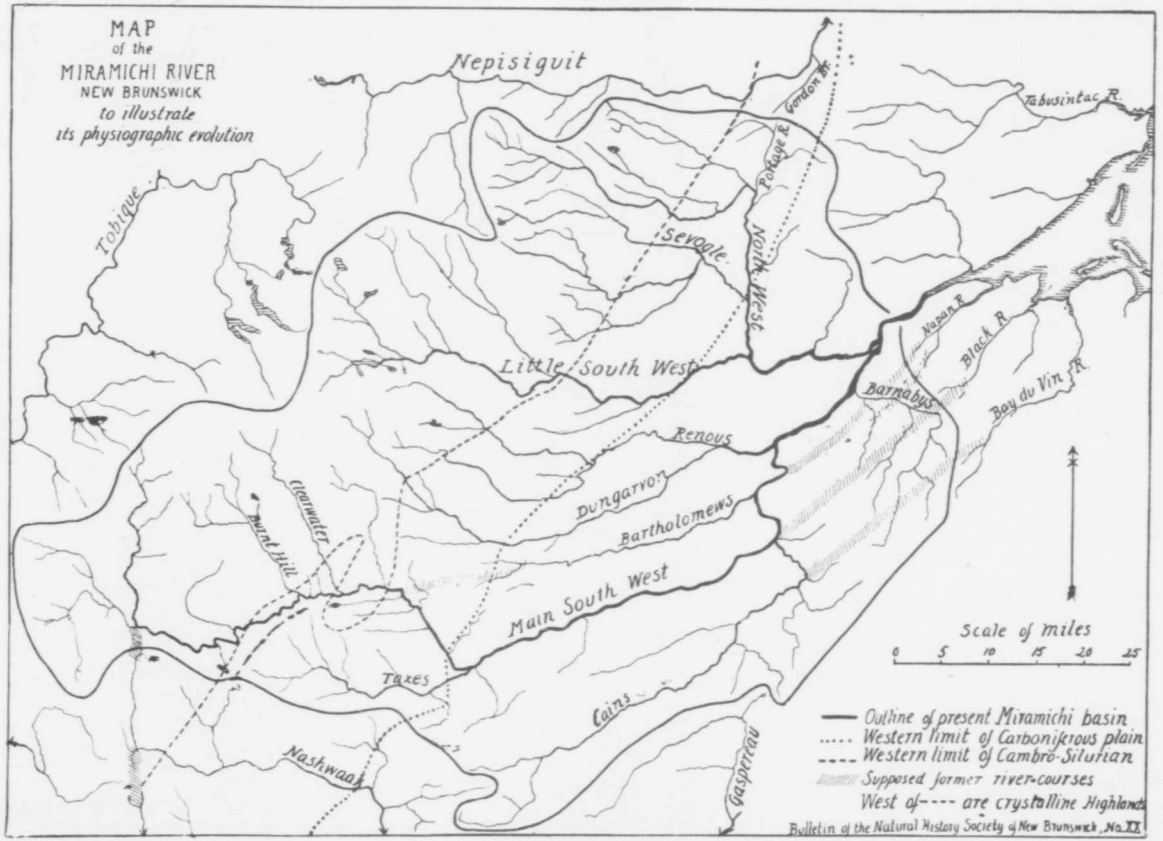
* I expect later to continue the study of this peneplain, and to present a map of it.

every respect, except in its greater elevation, which, however, is readily explained by an upwarping of this region. Unlike the central Carboniferous plain, it does not slope off to the eastward, but holds its height to near the mouth of the Restigouche (if, indeed, it does not slope slightly thence to the westward), whence it falls off relatively rapidly to Bay Chaleur. Why, now, does this plateau not slope to the eastward when its contemporary, the Carboniferous plain, does so? Here Daly's suggestion as to warping about a hinge line extending through Cape Sable, Digby, and east of St. John, is most important. If, now, that line be continued in a northerly direction, it will pass over the eastern end of Grand Lake (through the highlands occupied by Marr's and Emigrant Settlements),* through the highest part of the Central Highlands, and across the mouth of the Restigouche River.† This would represent an anticlinal uplift from which the old peneplain sloped on the one side to the eastward (thus explaining the slope of the Carboniferous plain), and on the other to the westward (thus explaining the lack of easterly slope in the Silurian plateau). But it explains many other facts as well, of which the most important are these, that the St. John has been turned south from its proper morphological course into Bay Chaleur, and that the Tobique runs southwest instead of northeast (Note 45); and further, that the St. John, after thus reaching the Carboniferous basin, does not follow it to the sea, but continues southward into the Bay of Fundy. It perhaps explains also the turning of the Miramichi southward from its course into the Dungarvon to the Taxes, near Boiestown (Note 50).

Such a syncline usually is accompanied by corresponding anticlines, however, and one of these we doubtless have in the great trough occupied by Nepisiguit Bay, the Lower Nepisiguit, the north and south part of the Northwest Miramichi, and the right-angled bends of the main Southwest Miramichi. East of this appears to come another anticline, followed by a syncline, forming Northumberland Straits, while another anticline forms the higher lands of Prince Edward

* Independently of Daly's suggestion as to the anticlinal hinge line, I had previously come to the conclusion that the ancient watershed east of the lower St. John was at the head of Grand Lake, that most of Salmon River formerly flowed into Richibucto (whose morphological head was Salmon Creek, west of the Gaspereau), and much of the Canaan into the Buctouche (whose morphological head was Prices Brook), a subject to which I shall return in a future note.

† Possibly the south branch of Nepisiguit and the Upsalquitch may occupy the crest of this anticline.


MAP
of the
MIRAMICHI RIVER
NEW BRUNSWICK
to illustrate
its physiographic evolution
Nepisiguit
Tobique
Sevogle
North West
Little South West
Main South West
Renous
Dungarvon
Bartholomews
Clearwater
Burnt Hill Brook
Taxes
Cains
Nashwaak
Gaspereau
Barnabys
Bay du Vin R.
Black R.
Napan R.
Tabusintac R.
Scale of miles
0 5 10 15 20 25
Outline of present Miramichi basin
Western limit of Carboniferous plain
Western limit of Cambro-Silurian
Supposed former river-courses
West of---- are crystalline Highlands
Bulletin of the Natural History Society of New Brunswick. No. XX

MAP NO. 2.

Island. As to the age of this hinge line, we are at present in doubt, but it is likely that further studies will determine it, and tentatively we may assign it to the period of the uplift of the Cretaceous peneplain, though it may be a cycle later.

It remains to notice the warpings parallel with the Appalachian trend.* As already mentioned, one of these probably helped to form the Bay of Fundy; the Southern Highlands owe, probably, a part of their height to an upwarping, while the Carboniferous plain along the Richibucto–Grand–Lake–Oromocto axis, and again in the part occupied by the Miramichi river, represents either one, or, perhaps, more, synclinal downwarpings. An extensive upwarp raised the Central Highlands and the great Silurian plateau, and these Central Highlands perhaps owe their height to the fact that they stand at the intersection of the two great lines of upwarping (the one parallel with the Appalachian trend, and the one at right angles), while on the other hand the great depression of the region where the branches of the Southwest Miramichi come together (and, indeed, the peculiar manner in which they come together), may be due to the fact that that region is at the intersection of two lines of synclinal warping. If the cross warping parallel with the great hinge line followed the elevation of the Cretaceous peneplain, probably the longitudinal warping accompanied the elevation of the Tertiary peneplain, but the reverse may be the case.

In a general way, then, Daly's theory applies well to New Brunswick, and it will form a valuable working hypothesis. Much investigation will, however, be needed before it can be either on the one hand applied in detail, or on the other, disproven.

50.—The Physiographic History of the Miramichi River.

(Read June 4, 1901.)

In earlier notes of this series (Nos. 33, 37, and 45) the attempt has been made to trace the probable physiographic evolution of the Nepisiguit, Restigouche, and Tobique rivers; a similar treatment of the Miramichi here follows. It is, of course, plain that the deductions

* It is of interest to notice that the axes of these warpings and of the crystalline rocks do not coincide. Thus the axis of the crystalline rocks is on a line drawn from Belledune point to the mouth of Eel River, in Carleton County, but the axis of the greatest upwarping is on a line from Mars Hill to Miscou Island. Thus the branches of the Southwest Miramichi are strictly parallel with the warpings, though not with the crystalline rocks.

set forth in these notes often rest upon very scanty data ; and they are to be viewed, therefore, not as matured conclusions, but rather as tentative hypotheses suggested by the known facts and needing the test of further investigation.

The Miramichi is remarkable for the great number and regular radiation of its large branches, which, considering its mouth as at Beaubair's Island, cover at least 260° of a circle. As the geological maps, or the accompanying sketch (Map No. 2) will show, most of its branches rise in the Central Highlands, flow eastward to the Carboniferous plain, uniting as they go, to fall by a single trunk into the sea. This Carboniferous plain is a peneplain of three or four hundred feet elevation in its western part, where the rivers have cut deeply into it, but it dips gradually to sea level towards the east. It is composed of Carboniferous strata which are mostly nearly level, and hence have been little disturbed since their formation.

For physiographic study the river falls naturally into three portions ; (1) the Northwest, (2) the Little Southwest, and (3) the Main Southwest.

We consider first the Northwest. This river shows two parts ; first, the numerous streams rising far back in the wild, uninhabited Highlands amid high felspathic and granitic hills, and flowing eastward in deep valleys over rough beds, converging as they go ;* and second, the trunk stream running from north to south, collecting their waters to pour them into the Little Southwest. As to the origin of the former streams, they must at least go back to the Cretaceous peneplain of which the Highlands are probably remnants (see Note No. 49 preceding), and very probably they are much older and represent streams which helped in the planation of that peneplain before its post-Cretaceous elevation. They run now from their sources

* As laid down on our maps, there is a most astonishing resemblance between the two great western branches, the Main Branch and the Sevogle. Taking the Geological Survey map, for instance, we note that both rivers enter the north and south part at about the same angle. Some miles (though at different distances) up both divide into branches, striking off at similar angles. Taking the north branches, both give off small ones to the south and then fork into approximately equal streams. Taking the south branches, both fork at about the same distance, and these branches are not unlike in the two cases. So remarkable is this resemblance that we must conclude either there is here some extraordinary coincidence, or that the two rivers have been laid down from sketches intended to apply to the same river. The two streams are little more unlike that would readily be explained by two traverse surveys of the same river. The chief difference consists in the greater distance of the first branching of the one than of the other from the main river.

to near their mouths in pre-Carboniferous formations, but no doubt, in the lower parts of their courses at least, they formerly ran over Carboniferous rocks, the removal of which has let them down upon and into the older strata. It is very possible that the most ancient contact line of Carboniferous and earlier strata (in the shore line of the Carboniferous seas) occurred at the places where these branches now unite and abruptly change their direction, somewhat west of the present contact line.* The possibility that some of the Nepisiguit branches once formed a part of this system has been considered in an earlier note (No. 33.)

We pass next to consider the north and south valley of the Northwest, which is very remarkable for the way it cuts across nearly at right angles to the directions of the western branches. Its true morphological head is unquestionably Portage River, from which a low portage leads into Gordon or Portage Brook, a branch of the Nepisiguit. All these streams (Miramichi, Portage River, Gordon Brook and Lower Nepisiguit) are practically nearly in a line, and occupy a single great north and south trough or depression with much higher ground both east and west; and the same influences, therefore, whatever they were, appear to have determined the Lower Nepisiguit and the north and south part of the Miramichi. If now we seek an explanation for this great depression, we at once conclude that it cannot be a great valley of erosion, but must rather represent a synclinal trough due to earth warping. To the eastward the Carboniferous rocks rise to a height of over 500 feet above the sea, in consequence, as Ells states,† of a great anticlinal uplift represented by "the high ridge that extends eastward from the vicinity of Bartibog station on the Intercolonial Railway." As mentioned in the preceding note, this elevation is probably a continuation of the anticline which extends through the New Brunswick highlands, and the question arises: How originated the depression extending right across this anticline? Here, no doubt, the explanation is to be found in a synclinal depression parallel with and corresponding to the anticlinal hinge line extending from St. John to the mouth of the Restigouche, mentioned in the preceding note, forming a trough here well marked, and tending to

* The Carboniferous rocks are here fringed by a narrow band of Lower Carboniferous not included within the boundary drawn on the accompanying map.

† Geological Report, 1882, D. 3.

disappear southward. It is possible that before this trough was formed, all the western branches in question, together with the main Nepisiguit, flowed across the country to empty into the sea where the Pokemouch, Tracadie and Tabusintac now do.

We pass next to consider the Little Southwest Miramichi. The part of this river from Beaubair's Island to Red Bank is commonly called a part of the main Northwest, but it seems plain that it belongs to the Little Southwest physiographically, and we shall so consider it. The general history of this river seems comparatively simple, but it is complicated in detail, as will be shown in a later note. It rises with numerous large branches in the heart of the highlands, and flows with a great fall (1,100 feet and more) in a deep and winding valley over a very rocky bed eastward to the sea. It represents, perhaps, the morphological axial river of the entire system.

We consider next the Main Southwest and its branches, excluding at first the part above the Taxes, the latter river being no doubt the morphological head of the main river. This part of the Miramichi consists of a series of nearly equal rivers running nearly parallel with one another, but brought into one stream by a remarkable series of right-angled bends (compare Map No. 2). Examining these rivers more closely, and passing upward from its mouth, it is quite plain that the Renous (perhaps including its branch, the Dungarvon) forms the true morphological head of the part of the river below it, while what is now the main river comes into it as a side branch. Passing up the main river, it swings again to the west, and here plainly the Bartholomew is its morphological head, while again the main river is morphologically but a branch. Passing farther up the main stream, it again swings to the west, and soon after Cains river comes into it precisely in the same manner as it fell into the Bartholomews and the combined streams into the Renous. Small branches of Cains river appear almost to attempt to continue still farther the remarkable arrangement,* while it is very probable the upper Gaspereau emptied by the west branch of Sabbies River into Cains River. Were the part of the main river above the Taxes wanting, it is plain that Cains would be the main and largest stream. All of these branches, except Cains

* Indeed, one is inclined to think it possible that the Upper Nashwaak above Cross Creek may once have flowed by Cains River into the Miramichi, a theory by no means without facts in its support.

river, rise in the Pre-Carboniferous highlands, and all show a change of direction near the line of contact between Carboniferous and Pre-Carboniferous, which must have some physiographic meaning; and the parts of these rivers flowing over the Carboniferous plain have cut well into that great peneplain, which rapidly falls in elevation to the eastward. What, now, is the explanation of the remarkable right-angled bends which thus throw these several independent streams into one trunk? We notice, first of all, that the general line of these bends is nearly that of the trunk valley of the Northwest, and this suggests that they lie in the same synclinal depression, which is probably the case. Moreover, it is likely this part of the Miramichi occupies a great trough parallel with the Appalachian trend (see preceding note), so that another influence has aided in throwing them together. In any case, however, their direction and parallelism suggests that they formerly (*i. e.* on the Tertiary peneplain) emptied independently into the sea to the eastward, following an even slope of the little disturbed Carboniferous strata. Indeed, it is possible that traces of such an arrangement still exist, for our maps* show a remarkable arrangement of rivers to the eastward. Barnabys River cuts straight back from the lower Miramichi and has long branches from the westward, which are approximately in line with the Miramichi branches, while still farther to the eastward the Napan, Black and Bay du Vin rivers continue the same lines. It seems possible, therefore, that the Bartholomew, the main Miramichi and Cains river formerly flowed along the present branches of Barnabys River, and along the Napan, the Black and the Bay du Vin rivers independently into the sea, but that the synclinal warping of the Tertiary peneplain (aided perhaps by fault lines) threw them into one another, while Barnabys River, flowing down the slope of the trough of Appalachian trend, has cut back and bisected their lower courses.

We consider next the part above the Taxes. That the Taxes is the morphological head of the lower river, there is, I believe, no doubt. This part of the Miramichi is the most puzzling of all. Proceeding first to its head, we notice that its upper course runs nearly south, until, at the junction with the western branch, it turns abruptly to the eastward. But exactly in line with this upper part of the

* Unhappily, the lack of accurate maps is a well-nigh insuperable obstacle to more than speculative conclusions in such studies as these.

river, and separated from it by only a short interval, lies the upper part of the Nashwaak Valley,* while still further south in the same line lies the low land at the head of the Becaguimec and Keswick rivers. I believe, therefore, that there existed here an ancient river valley which emptied southward, and which has been beheaded by both the Miramichi and the Nashwaak. The remainder of the part of the river above the Taxes flows at first in a rather open country, but soon cuts deeper into it; the valley becomes winding, narrow and with a very rocky bed, until below Rocky Brook it bends nearly at right angles to flow into the main river. We notice, however, that this part of the river is in line with the Bartholomews (or possibly the Dungarvon), and it seems most probable that it formerly was the continuation of one of those rivers, thus preserving the parallelism of the entire series. The change of direction, as we have seen, may be connected with the hinge line passing north and south just to the eastward. All this part of the country was, probably, once covered by the Carboniferous sediments presenting their regular slope to the eastward, and their removal has let down the river into the underlying older formations, explaining its present course across them.

So much for the more ancient history of the river; what effect upon it had the glacial period? Aside from several minor gorges and falls (of which a particularly fine one is described by Ells upon the Main Northwest, above Stony Brook†), the filling of valleys with drift and the formation of some small lakes, I have not been able to trace any important influence, though field study will, doubtless, reveal other glacial influences. The river has no great waterfalls anywhere upon its main branches, though it has innumerable rapids.

The Miramichi, therefore, has had a comparatively uneventful development. The great Cretaceous peneplain must here have had an even easterly slope, explaining the parallelism of the numerous branches, which, by warpings during the peneplanation of the Tertiary peneplain, were considerably altered in direction and thrown together. The river has lost some of its old waters, perhaps to the Nepisiguit, to the Gaspereau, and possibly to the Nashwaak; it has gained from the ancient Keswick; its upper part has been transferred from one of its branches to another, and some of its lower branches have been changed from independent courses into a single trunk.

* The Nashwaak Mountain placed at this angle on the Geological Survey Map is out of place.

† Report 1881, 29 D.

51.—On a Lunar Rainbow Seen on Trowsers Lake.

(Read Nov. 5, 1901.)

The lunar rainbow is a not infrequent phenomenon, but a remarkably perfect example, seen by Mr. M. I. Furbish and myself at Trowsers Lake on the evening of August 3rd, 1901, may be worth mention. About ten o'clock, a light shower with fleecy clouds came up opposite to the waning but bright moon, and against the clouds appeared a very perfect bow with the arch complete. No colors were visible, but instead the bow was of grayish light, not unlike the northern streamers.

52.—On an Unusual Frost-effect of 1901 on the Tobique.

(Read Nov. 5, 1901.)

In the valley of the Tobique and elsewhere in central New Brunswick the firs and spruces in August last (1901) arrested attention by the remarkable appearance of the tips of all their branches. The new growth of the year, from two to four inches in length, hung downward, brown, withered and dead. I was informed, no doubt correctly, that the destruction was caused by a severe frost during the first week in June. I noticed that many of them were sprouting again behind the dead part, and usually by two buds on opposite flanks of the branch. The growth of these trees for 1901, therefore, is likely to be marked for the future, both by its shortness, and also by the unusual amount of bifurcation in the branches, features which may puzzle the student unless he knows the true cause.

53.—On a Hypsometric Section Across Central New Brunswick.

(Read Nov. 5, 1901.)

In August last, in company with Mr. M. I. Furbish, I crossed New Brunswick from the Tobique River to the mouth of the Miramichi, by way of Trowsers, Long, Milnagek (Island), Little Southwest (Tuadook) Lakes, and the Little Southwest Miramichi River. Careful aneroid measurements were made throughout the trip, after the methods and with the results described below. The great majority of the places mentioned have not hitherto been measured for elevation.

INSTRUMENTS.—We had with us, and read constantly, three aneroids, a small one belonging to Mr. Furbish, another of my own which has been used in making the measurements communicated in previous years to the Society, and a new Watkin Mountaineering Aneroid made by Hicks of London (No. 117, $4\frac{1}{2}$ inches in diameter.) This instrument, possessing a new device which entirely overcomes the "creeping" error inseparable from the older forms, is the best aneroid now manufactured. It was tested for me just before the trip by Dr. Harrison at Fredericton, and, although at first it seemed to give a considerable error, it was later found that this was due to an improper mode of reading it, and when correctly read it gave no measureable error. After the trip it was compared by Mr. Hutchinson with his standard instrument at St. John, and found to be without appreciable error. Moreover, it has since been examined by its maker, Hicks, who reports it in perfect order. It was found to be more sensitive than either of the other instruments, and hence its readings alone have been used in making the following calculations, though the readings of the others have been used as a check.

COMPARISON BASE.—For this I have used the Fredericton station from the beginning of the trip until Little Southwest Lake was reached, *i. e.* August 2nd to 19th, and the Chatham station from August 14th to September 2nd. For lists of readings from the two stations, I wish to express my thanks to Dr. Harrison and to Mr. J. F. Connors, the dominion observers at the two stations. Both stations are too distant to form satisfactory bases (both being about sixty to seventy miles from the principal places measured), this distance allowing of considerable error due to difference of weather conditions between the places measured and the stations. To lessen this error (or indeed to eliminate it), I have devised the following method, which applies, however, only where several measurements are made of the same locality: The station readings were plotted as polygons (curves), in which the abscissæ were the dates and times of reading, and the ordinates (made long to bring out slight variations) were the barometric readings. Over these my own readings were plotted upon the same scale, but with the first reading superposed over the first base-station reading. It is now obvious that, if the weather conditions at base-station and the places measured are identical, and the barometers read alike, the curves should be coincident throughout, and that the

deviation from coincidence will afford a measure of the variation in weather conditions between base-station and place of observation. Local weather-changes are thus brought out with great clearness. One can therefore eliminate all readings showing a marked deviation from this coincidence and retain only those in which the base-station reading gives a correct index of the weather changes. This method is, of course, only applicable where several measurements are made of the same locality, and in such cases I have applied it in the calculations yielding the results below, selecting from my total number of readings only those which are thus shown to be the best.

METHOD.—The readings were in nearly every case made at the exact minute when the barometer was being read at the Fredericton station, and the temperature was recorded at the same time. The results have been worked out by Airy's tables and with his formula for allowance for temperature. In the case of the readings compared with Chatham, however, owing to a misunderstanding of the time at which they were to be taken, our readings are some minutes earlier (Chatham taken at 7.50, 2.50 and 7.50, ours at 7.24, 2.24. and 7.24, standard), and hence they are, theoretically, less accurate than the series compared with Fredericton, though the error would be very slight, especially where several readings are averaged.

PROBABLE ACCURACY.—The instruments and methods used, and the care exercised in all observations and calculations are such as to make me feel confident that the following measurements are as accurate as aneroid measurements can be made with Fredericton and Chatham as base-stations.

RESULTS.—The following figures express heights above mean-tide level at St. John. Unless otherwise specified, the places have not been measured before.

Trowsers Lake. Mean of two measurements, 1,286 feet. Chalmers gives (Summary Report for 1900) 1,350, and McInnes (Geological Map) 1,360 feet, both, in my opinion, impossibly high. Concerning my own lower result of last year (viz.: 1,243) some observations will be given below.

Long Lake.—A single measurement, 1,302 feet, probably too high. Mr. Chalmers makes Long 30 feet lower than Trowsers, which seems to me incorrect. McInnes made it 10 feet higher, and I made it 13 feet higher last year, and 16 feet higher this year.

Milnagek (Island) Lake.—Mean of seventeen good measurements 1,584 feet. The only previous measurement of this charming lake is my own of last year, 1,510 feet, concerning which remarks are made below. I made this lake by direct measurement this year 260 feet above Long, which seems to imply that 1,584 feet is somewhat too high.

Just east of Milnagek lies *Squaw Lake*, a small shallow lake 175 feet higher by direct measurement, and hence 1,659 feet, the highest lake yet measured in New Brunswick.

Watershed Plateau—(a remarkable facet of the ancient "Cretaceous" peneplain) between Island and Little South West Lakes. Mean of four measurements with Fredericton as a base, gave 1,725 feet with 1,768 feet as the highest point reached by us. With Chatham as a base, the average of four measurements is 1,667 feet, with 1,697 feet as the highest point. The discrepancy in these results will be discussed below.

A small lake on this plateau must be between 1,725 and 1,750 feet, the highest noted in the Province.

Little Southwest Miramichi, or *Tuadook Lake*, also known as *Big Lake.*—Mean of five measurements, with Fredericton as a base, gave 1,161 feet; with Chatham as a base the same five measurements gave 1,126 feet. The mean, however, of thirteen measurements compared with Chatham is 1,136 feet. Ells measured this lake some years ago, and gave its height as about 1,200 feet.*

The Crooked Deadwater at the head of the Little Southwest Miramichi River is by direct measurement about 175 feet above the Big Lake, and hence about 1,311 feet.

Pocket Lake is about 10 feet above Big Lake, and hence 1,146 above the sea.

Holmes Lake is about the same height as Big Lake.

Jacks Lake is by estimation (based upon the small drop from it to its junction with the main river in comparison with the large drop in the main river from the lake to the junction) about 1,100 feet.

Junction of the West Branch with the main stream. Mean of three measurements, 1,052 feet. This makes the drop from the lake only 84 feet, which appears rather small.

Big Deadwater at junction with the Main North Branch. About 30 feet above the latter, and hence 1,082 feet.

* Report 1881, 32 D.

River at beginning of bad rapids above Indian Brook. Mean of two measurements, 1,045 feet.

River two miles above Mains Brook. Mean of two measurements 828 feet.

River in the principal gorge below Mains Ledges and above Libbys Brook. Mean of two measurements, 566 feet. At this place the river has cut deeply into a great peneplain, which by direct measurement here lies from 230 to 250 feet above the river, and hence about 800 feet above the sea.

River just above Devils Brook. Mean of two measurements, 328 feet.

River just above Red Stone, a single measurement, 180 feet.

River ten miles above Red Bank. Mean of two measurements, 94 feet.

Sea level is reached about two miles above the junction with the Northwest Miramichi.

The general physiographic significance of these results will be discussed in later notes to be offered to the Society. I shall here refer only to two points connected with the measurements themselves. First, my own measurements for Trowsers, Long and Milnagek Lakes are higher this year than last. I am convinced that those of this year are more accurate. My smaller aneroid, I am pleased to find, runs remarkably well with the new Watkin, but it lingers a little behind it on the changes. Moreover, I find that in previous calculations I have not made a sufficient allowance for air-temperature, the introduction of which in summer measurements always gives greater heights. I believe, however, that all of my earlier measurements, if absolutely a few feet too low, are yet correct relatively to one another. Second, where calculations have been made with both Fredericton and Chatham as bases, the heights obtained with Fredericton as the base are considerably higher than those from the Chatham base. I had a similar experience some years ago in comparing readings from the Fredericton and St. John stations (see this Bulletin, XVI, 63), and I then suggested that the height of 164 feet assigned to the Fredericton station might be somewhat too great. This appears to me to be the most probable explanation of the discrepancy shown by the results of this summer. It would be a satisfaction if the height of the Fredericton station could be re-determined, since, if in error, it not only vitiates all past measurements, but will continue to vitiate measurements to be made for many years to come.

54.— On the Physiographic History of the Little Southwest Miramichi River.

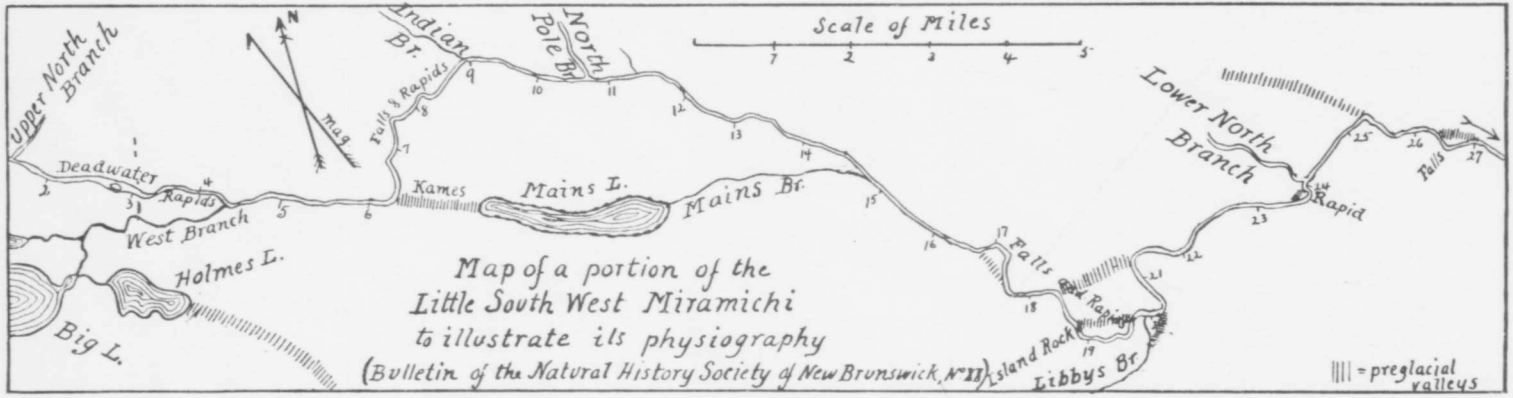
(Read November 5, 1901.)

The Little Southwest Miramichi is noted among guides and lumbermen as the roughest river in all New Brunswick. It is consequently one of the least visited and least known, although it has some of the wildest scenery, and is one of the richest in game and fish, in the province. I have been along its entire length from the Crooked Deadwater to its mouth,* and have made the following observations upon its physiography :

Its general physiographic origin and earlier history have been traced in brief in an earlier note (No. 50). It is one of that series of branches of the Miramichi, all having a history in common, rising in the ancient crystalline highlands of the province and flowing eastward across various formations, cutting deeply into all of them. It is its later quaternary, especially glacial, history which is now to be considered. The subject is illustrated by the accompanying map, No. 3.

There is no question, I believe, that the group of lakes which we are accustomed to consider as the source of this river (viz., the Little Southwest Lakes) belong morphologically to the Renous system, and have only a post-glacial (or, at all events, very late pre-glacial) connection with the Little Southwest Miramichi, by the very rough stream between the lakes and the main river (West Branch), a conclusion reached as a result of evidence to be presented in the next note of this series. The true morphological head of the Little Southwest Miramichi lies eastward of Long Lake, of the Negoot group, and the Upper North Branch is a true morphological branch, even though it exceeds the main stream in size. Possibly, like some other branches larger than their main streams, its headwaters have been captured from some other river, a subject still to be investigated. I have myself been only a mile above the junction of the Upper North Branch and the Main River ; here the river, 1,082 feet above the sea, is a deadwater for three miles or more, below which, to the junction with the West Branch, it falls some twenty-five to thirty feet through a series of boulder trains across its course, evidently the remains of old glacial dams. From the West Branch, 1,052 feet above the sea, down to the six and one-half mile turn, and somewhat beyond, the river

* In company with Mr. M. I. Furbish, in August, 1901.


Upper North Branch
Deadwater
Rapids
West Branch
Holmes L.
Big L.
Kames
Mains L.
Mains Br.
Indian Br.
North Pole Br.
Falls & Rapids
Scale of Miles
Lower North Branch
Rapid
Falls
Rapid
Island Rock
Libbys Br
= preglacial valleys
Map of a portion of the
Little South West Miramichi
to illustrate its physiography
(Bulletin of the Natural History Society of New Brunswick, N°II)

MAP No 3.

flows swiftly, but smoothly, and the whole aspect of this part of the valley from above the Upper North Branch is that of an ancient ripened, though drift-bottomed valley. At the six and one-half mile turn the river bends abruptly northward; the country happens to be burnt, affording an excellent view of the surroundings, and here, extending off to the southeastward, in the line of the course of the river above, is a series of unmistakeable kame-hills of the typical form and appearance. Less than a mile below this turn, at an elevation of 1,045 feet or less, begin the bad rapids and falls which have made this river famous. Here the river narrows and falls over granite ledges and through small gorges with vertical granite walls. The whole aspect of this stretch to Indian Brook is typically post-Glacial. Below Indian Brook, to the North Pole Branch, the river continues rough, though not in so marked a degree as above. At the North Pole Branch the character of the river changes, and it becomes broader, more open, comparatively easy and pleasant for canoeing, with a continuous slope, but no bad rapids and no falls. This character continues to the mouth of Mains Brook, and beyond it to near seventeen mile bend. Evidently all the river from the North Pole Branch to the seventeen mile bend runs in an ancient well-ripened valley, and the part between Indian Brook and the North Pole Branch seems somewhat older than the obviously post-Glacial part above Indian Brook. The interpretation of these facts might be difficult enough were it not for another brought out by the maps,* namely, that in a line between the six and one-half mile bend and the mouth of Mains Brook lies the valley occupied by Mains Lake and Brook. All these facts taken together seem to point to but one conclusion, namely, that in pre-Glacial times the main river flowed through the present valley of Mains Lake and Brook. The kame hills at the six and one half mile bend constitute the great glacial dam which turned the river aside and sent it over a low part of its valley to fall by a post-Glacial channel into the valley of Indian Brook, then a small branch of the North Pole Branch. It followed this valley, which it is now enlarging, to its junction with the North Pole Branch, then a large stream which fell into the old main river at the mouth of the present Mains Brook. It

* For all the facts of topography referred to in this paper, the original very detailed survey map of 1838, by Berton, is much more valuable than the modern imperfect compilations from it.

will be noticed, further, that the directions in which all these streams flow, and in which they enter one another, are fully consistent with this interpretation.*

Down to the North Pole Branch there are few hills near the river, and the first lofty hills appear just below that branch, on both sides of the river. They appear to be well up towards 1,000 feet above the water and to form part of a ridge crossing the river and separating the North Pole from the Lower North Branch. This range is exactly on the hinge line described in the preceding note. Eastward of this ridge the country appears to fall away to a great plateau, a true peneplain, which slopes off to the sea.

Just above the seventeen-mile bend, the falls and rapids suddenly begin again, and the river falls over crystalline ledges for half a mile, at the foot of which is a typical small gorge and pool. Here again the valley seems typically post-Glacial, and although I did not trace out a pre-Glacial valley, I suspect that one exists in the direction shown by the shading on the map. Below this the river is not so rough for a mile, this part being, doubtless, the ancient valley; but at Island Rock begins the worst series of rapids and falls on the entire river. Here the river falls over rocky ledges, into which it has cut small gorges, a very typical example of which occurs at the foot of the series. The whole aspect of this part of the river bed is typically post-Glacial, but yet it is very difficult to interpret it in that way. The valley here is V-shaped, with the walls of great irregular angular masses of rock, cut by actual measurement about 250 feet below the surface of the great rolling plateau, or peneplain, of which this region is constituted. There appears to be no room in the valley for a pre-Glacial channel around these present ledges and falls, and yet it is equally difficult to imagine that it lies outside of the present valley; for the amount of work required to cut down the present valley to such a depth in such hard rocks appears too great to have been accomplished in post-Glacial times. If, however, this has happened, the pre-Glacial channels would have run in one of the directions indicated by the shading on the map. More detailed study than I could give the question will, no doubt, settle it. At Libbys Brook (566 feet above the sea), which enters the main valley by a lofty post-Glacial fall, the character of the

* It is quite possible that the North Pole Branch emptied earlier at the angle to the eastward of its present mouth, where a small brook now is.

river changes again, and, especially at the twenty and one-half mile bend, it assumes the gentle slope and drift-bottomed character of an old valley. This matured character becomes yet better marked below the twenty-one and one-half mile bend. At the twenty and one-half mile bend there appears to be an old valley entering the main river in the line of the stretch between twenty and one-half and twenty-one miles, and this, I believe, was the pre-Glacial mouth of Libby's Brook. If now, the pre-Glacial channel ran as shown on the map, the part of the valley from the twenty and one-half mile bend to the twenty-one and one-half mile bend must have been in pre-Glacial times a part of Libbys Brook. At these falls the ancient peneplain character of the country is very marked. The line between plain and river valley (viz., the rim of the valley) is sharp and level. By actual aneroid measurement this plain here lies about 250 feet above the river, and hence 800 feet above the sea.

From the twenty-one and one-half mile bend to the Lower North Branch the river is pleasant and more open, with a steady slope, but no bad rapids nor falls. Just above the Lower North Branch is a small rocky rapid, evidently post-Glacial, and the pre-Glacial valley is beautifully clear on the north bank. The Lower North Branch enters with rocky falls, also evidently post-Glacial, and the original survey map by Berton has on this branch this legend, "very rocky and broken for three miles up." At the twenty-five and one-half mile bend, however, a broad, low valley extends northwestward, and no doubt represents the pre-Glacial mouth and lower course of the Lower North Branch.

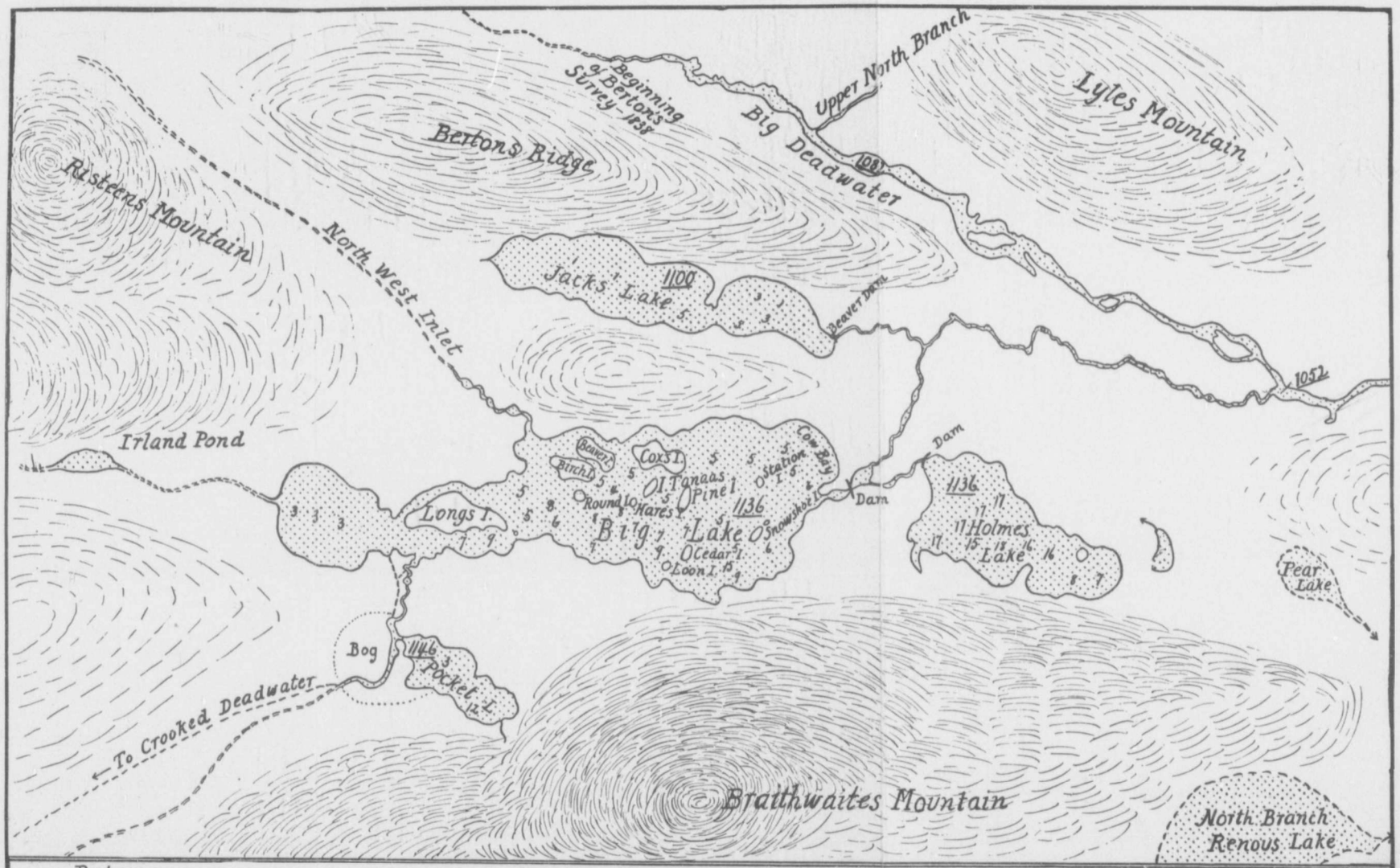
The scenery at the mouth of the Lower North Branch is altogether charming, as indeed it is at many points along this remarkable river.

For a mile below the Lower North Branch the river is drift-bottomed, open, and of ancient aspect; but at the twenty-five and one-half mile bend it narrows somewhat, here passing, according to our geological maps, from the pre-Cambrian to the Cambro-Silurian formation. Below twenty-six miles, begins another short series of falls over rocky ledges, extending to twenty-seven miles. These are also typically post-Glacial, and both ends of the pre-Glacial valley are clearly visible on the North Bank. This is the lowest series of bad rapids on the river.

Below twenty-seven miles, and down to Devil's Brook, the river runs swiftly with continuous drop, but with no falls nor bad rapids. Throughout all this part, however, the valley is very narrow and the walls steep, at times forming almost true cliffs. The edge between the valley and the peneplain into which it has cut is very sharp and level, and apparently somewhat under 200 feet above the bed. This part of the river in places recalls that part of the Nepisiguit between Nine Mile Brook and the Narrows, although on the geological map it is given as of a different formation. Despite its narrowness, however, it is probably a part of the ancient valley, for its bed is drift-filled. Probably its narrowness and the steepness of the banks is a characteristic determined by the hardness of the rocks.

From Devils Brook to Catamaran Brook the valley is more open, the peneplain lower, the river bed broader and drift-filled, and terraces appear, of a height estimated from thirty to forty feet. Higher up the river low terraces of coarse materials had been seen at the mouth of the Lower North Branch, and at twenty-six miles. Below Catamaran Brook the river bed becomes yet broader and more shallow, the walls of the valley farther back and the peneplain yet lower, and terraces become more frequent and higher, and of finer materials. At Otter Brook the first settlement is met with, and soon after the river breaks up among many islands and flows through a broad, well-matured and charming valley until it reaches the head of tide, a mile or two above the junction with the Northwest Miramichi.

In summary, the chief characteristic of the Little Southwest Miramichi River, from the physiographic point of view, consists in the many changes in its course due to the Glacial period. In this respect no other of our rivers, excepting the lower twenty-two miles of the Nepisiguit, can compare with it. As to why this river in particular shows this character in so marked a degree, I can only suggest that there may be some connection between this fact and the position of the river on the southeast, and therefore in the lee, of the Glacial movement over the highest land in New Brunswick. The leward position would be that in which glacial debris would most accumulate, and glacial debris is the indirect cause of the roughness of this river.



--- Portages
=== Streams not surveyed
Sketched contours

Scale of Miles

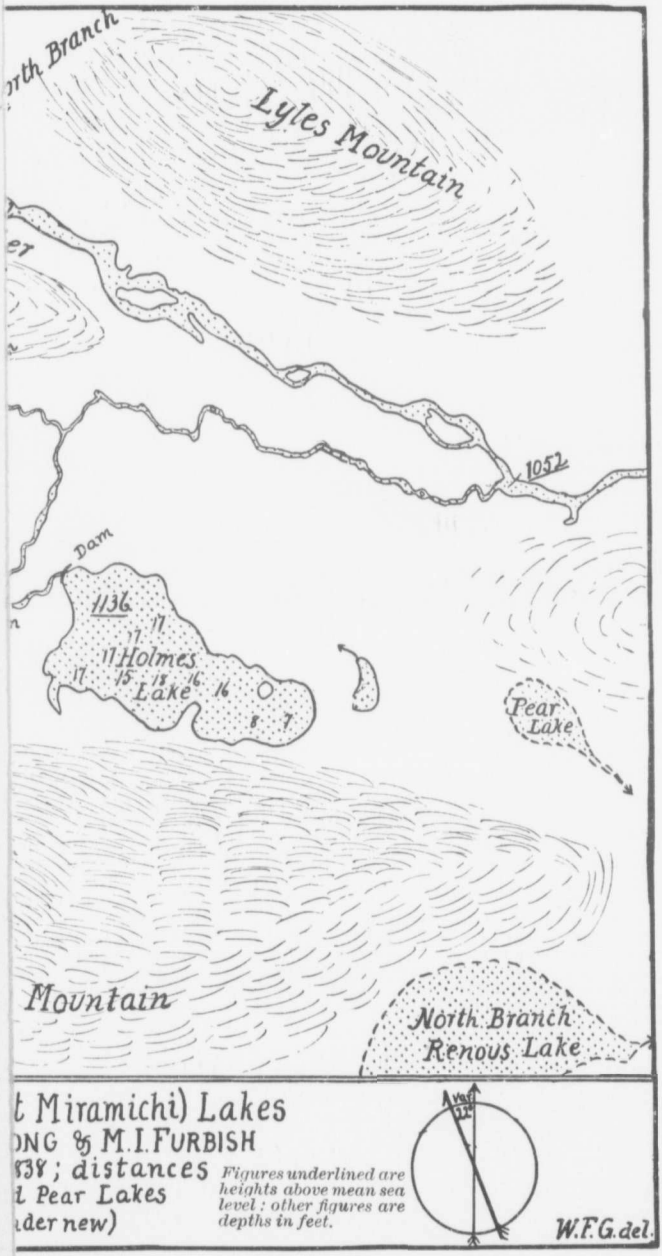
0 1/4 1/2 3/4 1 2

MAP OF THE TUADOOK (Little South West Miramichi) Lakes
After an amateur plane-table survey by W.F.GANONG & M.I.FURBISH
August, 1901. (Big Deadwater from Berton's plan of 1838; distances checked from Lyle's plan of 1884: Renous and Pear Lakes from plans in Crown Land Office; remainder new)

Figures underlined are heights above mean sea level: other figures are depths in feet.

W.F.G. del.

MAP NO. 5.



t Miramichi) Lakes
ONG & M.I. FURBISH
838; distances
t Pear Lakes
der new)

Figures underlined are heights above mean sea level; other figures are depths in feet.

W.F.G. del.

55.—On the Physiography of the Tuadook (Little Southwest Miramichi) Lake Region.

(Read December 3, 1901.)

Near the head of the West Branch of the Little Southwest Miramichi River lies a group of attractive lakes, still in a state of well-nigh primeval wilderness, extremely difficult of access, hitherto unsurveyed and unstudied by the physiographer. In August last I spent eight days there in company with Mr. Furbish, and, favored by good weather, we surveyed them and made such other observations as follow.

History.—The first appearance of these lakes in any record is upon the remarkable Franquelin-DeMeulles map of 1686, where, though but a single lake is shown, it is unquestionably the Big Lake of this group.* They do not re-appear until they were visited by Hind in 1864.† In his well-known report,‡ he gives an account of his portage from Long Lake to Big Lake, which he briefly describes. He made no map, however, and the first map after that of Franquelin was made by Edward Jack, who visited the lakes in connection with explorations of timber-lands in 1873. Jack's map was, however, not based upon a survey, but was a simple sketch, and it formed the foundation of the first published map of the lakes, that on the "Map of the Principal Timber Lands of New Brunswick," 1875. A short note by Mr. Jack upon the geology and mineralogy of the region was published in the report of the Geological Survey for 1870–71, page 251. The lakes and river were visited by Ells in 1879 or 1880, though the references to the lakes in his report are very scanty.§ Aside from the very hasty visits of Hind and of Ells, no geologist had been in this section. In 1884 Mr. R. H. Lyle, a deputy surveyor, ran certain timber lines through the region, two or three of which crossed these lakes. From these lines the lakes were sketched by Lyle, forming the

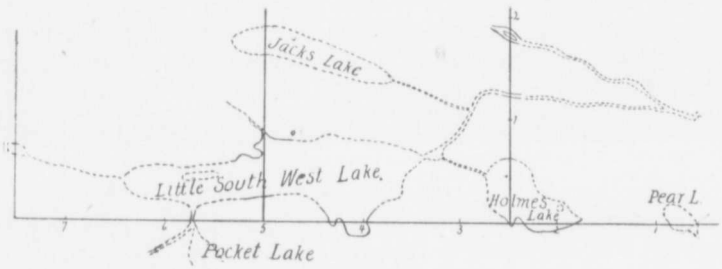
* This map is mentioned in earlier notes, 29 and 39; it is reproduced for the first time from the original MSS. in Trans. Royal Society of Canada, new series, III, section ii, 364.

† They should have re-appeared in 1838, for in March of that year Deputy Surveyor Berton was sent to survey the Little Southwest from its head. He missed the West Branch altogether, and began his survey at the head of the Big Deadwater, at the point marked on the accompanying map. This explains the appearance of the river and absence of the lakes on Wilkinson's map of 1859, and others.

‡ Preliminary Report on the Geology of New Brunswick, Fredericton, 1865, 152.

§ Report of the Geological Survey, 1879–80, D.

map shown in the accompanying cut (Map No. 4), and this sketch has formed the original for all published maps of the lakes, from Loggie's of that year down to the present. The Geological Survey map has, however, certain additions at the western end, of which I do not know the origin, and which are incorrect. In 1890 Mr. W. J. Long and Dr. Philip Cox ascended the river with Indian guides and spent several weeks upon the Big Lake, and it was there that Mr. Long made many of the observations upon animal life, which he describes with matchless charm in his well-known books.* Dr. Cox, however, has published no account of his observations. Both of these gentlemen made sketch-maps of the Big Lake, of which they gave us copies, and from which we have adopted many of the names upon our own accompanying map. More recently this region has been visited



MAP NO. 4.

repeatedly by another charming writer, Mr. Frederic Irland, who, in his beautifully-illustrated articles in "Scribner's Magazine,"† has given delightful, even if somewhat exuberant, accounts of his trips, though he has not many references to these lakes in particular. The late Frank Risteen has also described in his pleasing style a trip to this region.‡

These include all of the published references to these lakes which I have been able to find, and I believe I have missed nothing of importance. As to unwritten history, two points should be mentioned. The lakes were first lumbered about 1866 (for pine only), were later

* Wilderness Ways; Ways of Wood Folk; Secrets of the Woods (Ginn & Co., Boston); recently re-published under the titles, Beasts of the Field; Fowls of the Air.

† Sport in an Untouched American Wilderness, Vol. xx, 350; The Coming of the Snow, Vol. xxvii, 87; The Beguiling of the Bears, Vol. xxx, 313. See, also, Forest and Stream, Feb. 1, 8, 15. 1902.

‡ Forest and Stream, Dec. 22, 1894, 530.

abandoned, and within the past five years lumber operations have again been commenced, and are now being actively carried on at the Crooked Deadwater. About 1866 a lumber road, still called the old MacDougal pine road, was cut from Big Lake to Milnagek, and thence to Trowsers Lake for hauling out pine timber, but it has now almost entirely vanished. A winter portage road connects the Big Lake with Boiestown, over forty miles away. Again, this entire region is notable as the hunting and trapping ground of that prince of hunters, Mr. Henry Braithwaite, who knows it intimately, and who takes to it a number of sportsmen each autumn. It is a pity that Mr. Braithwaite's knowledge of its topography and natural history cannot, through publication, be made available to others and safe from loss.

PLACE-NOMENCLATURE.—There is no name in use for the group, as a whole, and, therefore, I have revived the Indian name for the Little Southwest Miramichi River, namely, *Tu-a-dook*, universally used by the Micmac Indians, but of unknown meaning. *Jacks Lake* was given by Mr. R. H. Lyle during his survey of 1884, as he tells me in a letter, in honor of the late Edward Jack, of the Crown Land office. *Holmes Lake* appears to have been named by Mr. Lyle for a lumberman. *Irland Pond* was named by Mr. Braithwaite, as he has told me, for Mr. Frederic Irland above mentioned, who shot here his first moose. *Big Lake* and *Pocket Lake* are descriptive, and self-explanatory, and probably originated with the lumbermen. The names of the Islands are mostly adopted from those given by Long and Cox in 1891, as shown on their sketch maps. *Longs* and *Coxs* are for themselves; *Tanaas* and *Hares* for their guides, while the others are descriptive and self-explanatory. *Station* (of our survey), *Beaver*, *Birch* and *Big Deadwater* have been given by us, and are descriptive. South of the lake is a fine mountain which has no recognized name, and we propose that it be called henceforth *Braithwaites Mountain*, in honor of Mr. Henry Braithwaite above mentioned. Another rounded mountain is named *Risteens Mountain* for the late Frank Risteen, well-known to all lovers of the New Brunswick woods, who has hunted in this region, while *Lyles Mountain* is for R. H. Lyle who surveyed the region in 1884, and *Bertons Ridge* is for Deputy Surveyor Berton who surveyed the Little Southwest Miramichi River in 1838.

ALTITUDES.—The heights of the lakes above sea level have been discussed in a preceding note (No. 53), and are recorded upon the accom-

panying map* (Map No. 5). Big Lake is made by us 1,136 feet above the sea. The only previous measurement was by Ells, who says :† "The general elevation of the lake at the head of the Little Southwest Miramichi is, by aneroid, about 1,200 feet above sea level," an estimate which our measurements make somewhat too high.

GEOLOGY.—On this I have nothing to add to what is given by Hind, Jack and Ells in the notes earlier mentioned, and incorporated on the geological map. The whole country is covered with granitic and schistose boulders, the former in great majority, but Jack is not correct in stating that from Devils Book to Gulquac and Serpentine no rock in place is to be seen, for Hind records schistose ledges below the outlet of Big Lake, and I found some fine, large ledges of schist south of the old MacDougal road, over a mile west of the Big Lake on the line of a recent timber line, and ledges occur also on Milnagek Lake, as will be shown in a later note.

NATURAL HISTORY.—On this subject no publications exist aside from the notes by Long already mentioned. Doubtless, few animals or plants occur here that are not found elsewhere in the province. For studies upon the habits of the larger animals, the region is, however, unsurpassed. Beaver are now building their houses in Big Lake ; moose and caribou wander in abundance and tamely around its shores, and other animal life is there in great display.

ECONOMICS.—The region abounds in fine spruce timber, the principal game and fur-bearing animals, and big trout. It is, on the other hand, utterly useless for agriculture and settlement. It is, therefore, a part of that central wilderness of New Brunswick, marked out by nature for a great timber and game preserve, and needing only good management to make it a perpetual source of revenue to the province, and an enduring natural recreation ground for her citizens.

THE LAKES INDIVIDUALLY.—This region, as a whole, has the features characteristic of so much of the interior of New Brunswick. Its shallow lakes, with margins and islands of boulders and bog, are connected by swift boulder-strewn streams, and lie amongst low domed hills and ridges clothed with unbroken forest.

---

* All of this map, except the Big Deadwater, taken from Berton's plan, and the Pear and Renous Lakes, taken from the Crown Land office plants, is based upon our own plane-table and traverse surveys.

† Report of the Geological Survey, 1879-80, D. 32.

The Tuadook lakes by no means lie, as our printed maps imply, at the head of this branch of the Little Southwest. Flowing into Big Lake is a large stream of constant volume, large enough to be navigable for canoes at low water were it not for its excessive roughness. This flows from the Crooked Deadwater five miles to the westward, where it receives several branches of considerable size heading in lakes. I hope later to present a fair map of this region, but my own observation of it in a single hurried visit was insufficient to give me any knowledge of it. It lies some 175 feet above Big Lake in the same deep valley, which here has cut down deeply below the great central peneplain. The curious directions and the close approximation of the streams about the Crooked Deadwater suggest some remarkable physiographic relationships for investigation by the future student. A mile above Big Lake this stream becomes a deadwater winding amid bog, and is on the same level with Pocket Lake. Evidently Pocket Lake and this deadwater are the remnants of a much larger lake which once filled this basin. Pocket Lake is mostly but a foot or two deep, with a bottom of the whitish mud, though it is deeper in its southeast corner. The stream from it to Big Lake falls several feet over boulders, evidently a moraine between the two lakes. The water pouring out of this stream is markedly colder than that of the Big Lake, which is easily explained by the great shallowness of the latter.

Big Lake is sufficiently described as to its shape and size by the accompanying map (Map No. 5). Its immediate shores are nearly everywhere low, it is very shallow and is rapidly filling up with organic mud and by the growth of bog in places from its shores. Like Pocket and Jacks Lakes, it is deepest on its south-eastern side. It is permanently held nearly two feet above its natural level by the lumber dam built a few years ago, and the further raising of the water when the gates are closed has destroyed all the trees around its margin, making the shores most unsightly. The lake abounds in islands of all sizes, from single isolated boulders up to one nearly half a mile in length, but in every case they are composed of boulders, to which, in some cases, is added considerable bog. It is the presence of this bog which appears to make the long axes of the larger islands lie at right angles to those of the smaller. In fact, however, the long axes of the rocky parts of all of the islands is in the same general direction, namely, north-east and south-west, showing that they are really parts

of terminal moraines. Some of the points of the main shore are also rocky islands connected with the shore by bog. The greater abundance of islands and the greater shallowness of the water on the northwestern side of the lake, and the greater depths of all of these lakes at their south-eastern angles, is no doubt correlated with the general south-easterly movement of the glacial ice, and is to be explained by the tendency of the drift to accumulate in the immediate lee of the bounding ridges or walls of the old valley. This entire lake is very typical of the sort formed by the partial filling rather than the damming of a valley by drift. Immediately to the southward of this lake rises Braithwaites Mountain, a fine mountain of some 500 to 600 feet above the lake. Off to the westward the edge of the great central peneplain can be seen resembling a flat-topped ridge, and to the northeastward runs the ridge of Lyles Mountain, while, from some points, other hills are to be seen in the distance, including Cow Mountain, Big Bald, and others. These hill views give a considerable charm to the scenery of the lake.

Jacks Lake, separated by a low ridge from Big Lake, is very shallow, and a typical mud lake, having almost no water, but much new bog at its upper end, where it is rapidly filling up. It is quite possible that the stream now emptying near its head into Big Lake was in pre-glacial times an inlet to it.

The lake is held permanently some fifteen inches above its natural level by an old beaver dam. The organic mud must, therefore, have formed in the lake to the depth of over a foot since this dam was built; and since its sticks are still undecayed, we have evidence that the formation of this mud can be comparatively rapid. On the northeast this lake is bounded by an abrupt ridge (Berton's Ridge) some three hundred feet high which separates it from the Big Deadwater.

Holmes Lake is very pretty, the deepest of the group, and is not a mud lake. I do not understand at all the conditions which determine the formation of this organic mud* in some lakes and its absence from others apparently as favorable. Pocket and Jacks Lakes contain it abundantly, while Holmes does not, although the physical conditions appear to be about the same in both cases. Between Holmes and

* The nature of this mud in our lakes is discussed in an earlier note [No. 17, Bulletin No 17, 126]. Its presence does not appear to depend, as might be supposed, upon the absence of lime from the water.

Big Lakes there is only a few feet of elevation obviously composed of boulders, while just to the east of Holmes, is another small lake, and east of that comes Pear Lake emptying into Renous, all with insignificant elevations, apparently solely of drift, between.

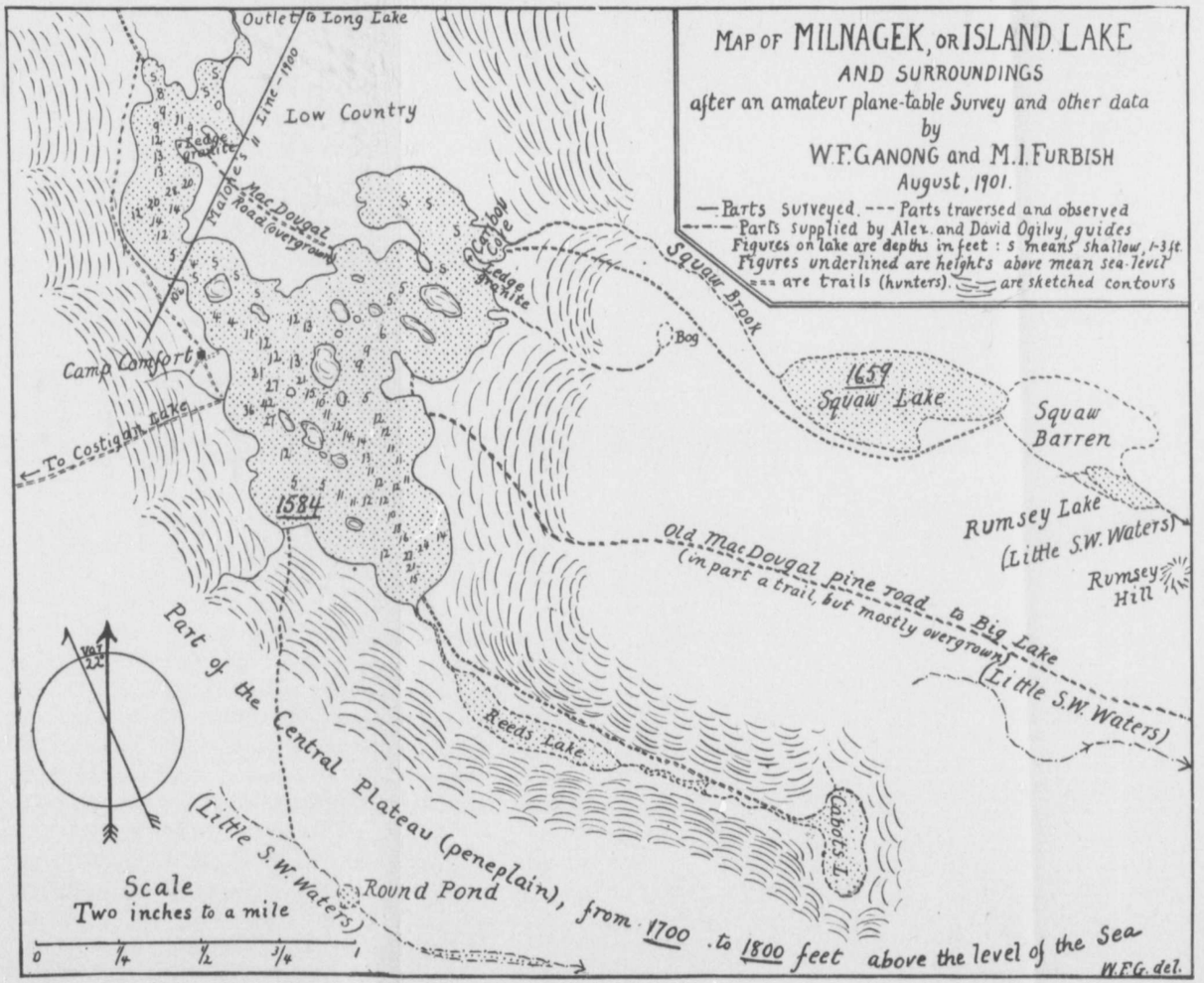
The outlet from Big Lake is a very rough stream flowing over trains of immense boulders (and according to Hind, over schistose ledges), with occasional quiet pools to the junction with the outlet of Jacks Lake, below which it continues, though with more frequent pools, but with many bad boulder rips, to the junction with the main stream. Just above the junction it breaks up among islands, and enters the main stream by two or three inconspicuous mouths, even the principal one of which is so small that it resembles a small brook. It is, no doubt, for this reason that Berton missed it in 1838, as would anyone unaccompanied by guides acquainted with this peculiarity. This part of the river is so narrow and shut in by woods that views of the hills are impossible, though the actual banks are everywhere low. It appears to me to be a new valley made across great beds of glacial drift, and prevented from cutting deeper by the great size and hardness of the boulders of which that drift is largely composed.

Physiographic Origin.—We turn now to the very interesting question as to the mode of origin of these lakes. First, as to the origin of the valleys in which they lie. It is plain that the Big Deadwater, Jacks Lake, Big Lake and Renous valleys, all approximately parallel, have been cut deeply (at least more than 500 to 600 feet) into the surface of an ancient peneplain, which still exists in great perfection immediately to the westward of them, and of which facets are found in Braithwaites Mountain, and in the range running eastward from Lyles Mountain. The lesser elevations between the other valleys are due, of course, in part to the greater proximity of those valleys to one another, leading to the interference of their rims and the more rapid erosion of the intervening ridges. Their general northwest and southeast direction was, no doubt, determined by the slope of the peneplain at the beginning of the present cycle of elevation and erosion. The valley from the Crooked Deadwater to the Big Lake has a different direction, but its consideration must await further knowledge.

We consider next the recent changes due to the Glacial period. The most striking fact about the lakes, from this point of view, is the perfection with which Big Lake, Holmes Lake, the little lake east of it, and Pear Lake, separated only by low banks of boulders, lie in a line with one another, and with the branch of the Renous emptying Pear Lake. Taking into account, also, the parallelism of valleys in this region, and their general directions, it seems to me clear that these lakes belong, morphologically and originally, with the Renous system, and that their connection with the Little Southwest is very recent, if not post-glacial. This is further confirmed by the character of the stream from Big Lake to the main river, which falls continuously over glacial boulders, and, according to Hind, at first over ledges. The somewhat more riotous course of the stream from the Big Lake to the outlet of Jacks Lake, and the direction taken below this by the river, might suggest that the Big Lake had been turned into an older valley occupied by Jacks Lake, but it probably means that the stream here keeps near the same ridge which bounds Jacks Lake on the northeast. I believe, therefore, that in pre-glacial times all these valleys from Jacks southward emptied into the Renous; that the valleys were filled with glacial drift which dammed up the old Renous outlet, reversed the direction of flow of Holmes Lake, and sent the waters to find their way out of the valley by the lowest point, which happened to be a low place existing in the range formerly separating Little Southwest from Renous waters. This is further confirmed by the great contrast between the valley of the stream from the Big Lake and the old broad ripe valley of the main stream into which in falls, a point emphasized in the preceding note.

56.—On the Physiography of the Milnagek (Island) Lake Basin.

In an earlier note (No. 39), reference was made to the interest attaching to Milnagek, or Island Lake, as shown by the visit made to it in July, 1900, by Dr. G. U. Hay, Mr. M. I. Furbish, and myself. In August, 1901, Mr. Furbish and I spent eight days upon the lake and in its vicinity, and made further observations, together with surveys whose results are embodied in the accompanying map (Map No 6).


MAP OF MILNAGEK, OR ISLAND LAKE
AND SURROUNDINGS
after an amateur plane-table Survey and other data
by
W.F.GANONG and M.I.FURBISH
August, 1901.
— Parts surveyed. --- Parts traversed and observed
-·-·- Parts supplied by Alex. and David Ogilvy, guides
Figures on lake are depths in feet: s means shallow, 1-3 ft.
Figures underlined are heights above mean sea-level
=== are trails (hunters). ~~~ are sketched contours
Outlet to Long Lake
Low Country
Ledge granite
MacDougal Road (overgrown)
Malotte's Line - 1900
Carlow Lake
Ledge granite
Squaw Brook
Bog
Camp Comfort
To Costigan Lake
1584
1659
Squaw Lake
Squaw Barren
Rumsey Lake
(Little S.W. Waters)
Rumsey Hill
Old MacDougal pine road to Big Lake
(in part a trail, but mostly overgrown)
(Little S.W. Waters)
Reeds Lake
Cabot's I.
Part of the Central Plateau (peneplain), from 1700 to 1800 feet above the level of the Sea
Var 22°
Scale
Two inches to a mile
0 1/4 1/2 3/4 1
Round Pond
(Little S.W. Waters)
W.F.G. del.

MAP NO. 6.

The first known reference to the lake occurs in Hind's Report on the Geology of New Brunswick (Fredericton, 1865, 152), where its position and size, as reported by the Indians, are mentioned. It first appears upon a map, but very erroneously, upon the Geological Survey sheet of this region of about 1888, where it seems to be laid down from Hind's description. The first map of it made from observation is that contained on our map of the Negoot Lakes accompanying the above-mentioned note, on which, however, it is shown too far to the westward. After our visit in 1900, a surveyor running timber lines in this region for the New Brunswick Railway Company ran a line across it (see the map), and made a crude sketch of the lake, which is in the Company's office at Fredericton.* Two or three scattered references to the lake occur in sportsmen's notes in "Forest and Stream." These, with my own reference in Note 39 of this series, seem to include the entire documentary history of the basin down to the present time. It has never before been visited by any naturalist, and, as implied above, has never been mapped. As to its unwritten history, there appears to be very little. Some thirty-five years ago some of the excellent pine was hauled from this lake into Trowsers by the "MacDougal pine road," but it has otherwise never been lumbered. A few sportsmen have visited it, guided by Messrs. Alexander and David Ogilvy, who know this region thoroughly, and who have a small hunting camp on the shore of the lake (Camp Comfort on the map).

The name Milnagek (*g* hard and accent on last syllable), is Maliseet Indian, and signifies, very appropriately, lake with many islands. It is the same word as Milnocket, occurring several times in Maine. The other names upon the accompanying map have been given mostly by the Ogilvys, either descriptively or, in the case of the proper names for sportsmen who have been taken there by them.

A chief point of interest about Milnagek is that it appears to be the most elevated lake of any importance in New Brunswick. Our single measurement of 1900 gave it as 1,510 feet; but the average of our seventeen good measurements (see Note 53) gave it as 1,584 feet, which, I believe, is very nearly correct. Squaw Lake, to the eastward, and lying very nearly on the top of the plateau, is 175 feet higher, and hence 1,659 feet, but it is little more than a shallow pond. The other lakes, Reeds and Cabots, are not much higher than Milnagek.

* I am indebted for a sketch of it, and of the Company's map of the region, to Mr. W. T. Whitehead, the Company's agent at Fredericton.

The scenery of Milnagek is beautiful. On the east, south and west the hills rise 200 to 300 feet near the lake, and are densely wooded with a fine, mixed forest, above which towers often the stately pine. The lake is studded with islands, all heavily forested, and between them and into the coves are many most charming vistas. The immediate shores are the more pleasing in that the forest comes to the very water, and the unsightly bog is wanting.

The physiographic origin of the lake basin is quite plain. The apparent ridges, nearly surrounding it, are really the sides of a valley cut from 200 to 300 feet below a great rolling plateau, a part of that great central peneplain of the province which has been described in an earlier note (No. 49.)* Southward towards its head the valley rises, and Cabots Lake, the very head of this branch of Tobique, lies about 150 to 200 feet below the plateau beyond it. Squaw Lake, on the other hand, lies upon the very surface of the plateau in one of its less elevated parts, and is one of the innumerable small and very shallow lakes which dot the surface of that peneplain. The valley where Milnagek lies was no doubt once much deeper, for it is evidently bottomed with glacial drift, which forms the most of the points and all of the islands. It is such drift which plainly dams back the lake, though the dam which does it is only a few feet above the water; that is sufficient, however, to turn the outlet from its natural and pre-Glacial course into the eastern branch of Trowsers Lake, and send it by a post-Glacial torrent-channel into Long Lake over a series of beautiful cascades. My supposition of last year (Note 39), that the Milnagek valley is morphologically the continuation of that of the eastern branch (the "left-hand leg" of the lumbermen) is fully confirmed by the observation of this year. After the outlet turns into Long Lake, this valley slopes away rapidly to Trowsers Lake, and indeed is occupied by a small stream for most of its length.

The islands and points of Milnagek are composed of granite boulders, somewhat angular, as a rule, and hence from no great distance. The long axis of both points and islands, as the map shows, is nearly northwest and southeast, suggesting an origin as lateral moraines of a glacier pushing up the valley. In two places shown upon the map there appears to be bed granite in place; in the most easterly locality it encloses masses of stratified rock, confirming the

*Rumsey's Hill is a fine example of a monadnock rising 150 to 200 feet above it.

intrusive origin assigned to this granite by the geologists of the province.

The lake is very irregular in depth, as is to be expected from its mode of origin, with a maximum of forty-two feet. The places of greatest depth mark clearly enough the course of the original channel or valley, which evidently lay near to the western side.

A very remarkable feature of this basin is the way its inlets interlock with those of the Little Southwest Miramichi system, as is shown by the map. This interlocking takes place upon the surface of the plateau, and shows how nearly level the latter is. It is most remarkable of all, however, at the Squaw Barren. This is an opened bog of the raised or "Hochmoor" type. On the west it drains into Squaw Lake, an affluent of Tobique, and on the southeast into Rumsey Lake, a beaver pond draining into the Little Southwest Miramichi. It cannot often be that such a bog forms the watershed between two systems so important.

These lakes abound in moose, caribou, deer and smaller game, with some beaver and abundant trout. Gulls nest on the islands, but otherwise we noted nothing remarkable in the natural history of these lakes.

Finally we consider the economics of the region. It contains some pine and spruce of value which will of course in time be removed, and its big game will make it increasingly attractive to sportsmen. It is of no value for agriculture, and its chief use is marked out by nature, as a part of that great forest and game reserve for which central New Brunswick is so admirably fitted. There is, however, another use for it suggested by its elevation and general attractiveness, namely, as a sanitarium for lung troubles, for which it should be better adapted than any place I have met with in New Brunswick. At present it is very difficult of access, but this will not always be the case.