BULLETIN

OF THE

NATURAL HISTORY SOCIETY

OF

NEW BRUNSWICK.

No. XX.

VOLUME IV. PART V.

PUBLISHED BY THE SOCIETY

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ARTICLE I.

ADDITIONAL NOTES ON THE CAMBRIAN OF CAPE BRETON, WITH DESCRIPTIONS OF NEW SPECIES.

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

A visit to the Cambrian areas in Cape Breton during the past summer has enabled the writer to supplement his observations on the range and structure of the Cambrian System in that island.

As a full statement of the results of observations in that island in this and the two previous years will be embodied in a report to the Geological Survey of Canada, only a very brief outline will be given here.

In consequence of the finding of trilobites and Cambrian genera of Brachiopods, etc., in the Etcheminian strata, the writer proposes to revert to the classification of 1889, wherein these deposits are called the Basal Series (of the Cambrian System).*

Further, it has been found that slates with fossils of Cambrian genera are included in the important group of volcanic rocks which lie at the base of the Etcheminian, and that where the dip of the volcanics can be found, as is not infrequently the case, it agrees with that of the Etcheminian. It is thought therefore that those volcanics, (the Coldbrook group) should be included in the Basal Cambrian.

Both in New Brunswick and in Cape Breton the Coldbrook group begins with lavas showing deposition free of pressure, as they are amygdaloidal; or with agglomerates devoid of evidence of marked aqueous wear. The deposition therefore did not begin in deep water, or on exposed sea coasts, or under heavy pressure.

The foundation upon which the volcanics rest shows in several places marks of deep sub-aerial decay at the line of contact. Calcareous bands are dissolved, leaving the silicious portion of the strata. The feldspar of the granitic rocks is kaolinized, and the magnesian

* Trans. Roy. Soc. Can., vol. vii, Sec. iv, p. 135.

silicates are hydrated, impure graphite beds are changed to a black amorphous crumbling shale, and a depression or narrow valley is usually found at the contact of the two terranes. These conditions appear to indicate that the pre-Cambrian complex had long been above the sea-level in these districts when the first Cambrian effusives were thrown out upon it.

Another point worthy of note in this connection is the large amount of feldspathic material in the Etcheminian beds; the very sands are often composed of feldspathic grains, and these largely of unkaolenized feldspar, as though they had not been exposed to sub-aerial decay. Feldspar in this condition is found in two kinds of deposits, those that are the result of glacial wear and those found around volcanic vents, where particles of rock have been torn from the walls and blown out upon the surface of the earth. These if dropped into the sea would soon be covered up by fine mud and preserved in their original crystalline condition. The Etcheminian appears to represent the submarine condition of these effusive rocks.

On the other hand the Coldbrook series, as has been intimated above, represents the preceding sub-aerial phase of the eruptives. It is true that we find in many places conglomerates at the contact of these two series of rocks, so diverse in appearance; but elsewhere there are no beds of rolled fragments at the contact, and the passage is direct from ash-beds or diabases, to the slates and sandstones.

In reports of the Canadian Geological Survey of 1870–71, pp. 57–59, etc, both these groups of rocks have been included in the Huronian System. They may be equivalent in age to the upper part of that series, but unfortunately the absence of fossils in the original Huronian leaves this matter in doubt.

As we contemplate the physical conditions of the initial epochs of Cambrian time in the Maritime Provinces, we seem to see a region long elevated above the sea, now subjected to depression nearly to the sea level, the depression being accompanied with extrusion of lavas and volcanic mud and the ejection of stones and ashes. These at first were cast upon a land surface, but, as the crust of the earth continued to sink, into sounds and bays of a shallow sea, diversified with pre-Cambrian ridges and islands, of greater or less extent.

For the above reasons as well as because the stratified rocks of the underlying complex are markedly unconformable to the Cam-

Base of the Paleozoic Rocks in the Maritime Provinces of Canada.

English Equivalent	Llandilo.	Arenig.	Tremadoc.	Dolgelly.	Ffestiniog and Maenterog.	Menevian.	Solva.	Caerfai.			Pebidian?
Leading Genera of the Several Groups.	e. Harpes, *Trinucleus*, in N. W. New Brunswick.	d. Cyclognathus Parabolinella, *Tetragraptus*, Didymograptus, in S. New Brunswick.	c² *Asaphellus*, Parabolinella, Triarthrus, Bellerophon.	c. *Dictyonema*, Monobolina, Schizambon, Acrotreta. b. *Peltura*, Sphærophthalmus, Leptoplastus, Ctenopyge. a. *Parabolina*, Agnostus, Anomocare, Orthis, in S. New Brunswick.	c. Agnostus, Lingulella. (Place of Olenus).	b. *Paradoxides*, Beyrichian, Lingulepis. a. Obolus, Lingulella, Lingulepis. d e. *Paradoxides*, Solenopleura, Ptychoparia, Microdiscus.	c. *Paradoxides*, Conocoryphe, Liostracus, Agnostus. a-b. *Protolenus*, Ellipsocephalus, Beyrichona, Trematobolus, in S. New Brunswick.	Ptychoparia? Ostracoda. 4 genera. *Acrothele*, Lingulella, Obolus. Acrothyra, Hyolithes.	*Holasaphus*, Paradoxidoid trilobite, Ostracoda, Billingsella, Lingulella, Acrothyra, Obolus, Hyolithes.	Lingulella, Leptobolus, Obolus, Acrothyra, Acrotreta, Hyolithes.	Lingulella, 2 Ostracoda. Acrothyra, Acrotreta.
								3. Upper.	2 and 1, Lower.		
Maritime Provinces.	3. Bretonian Division.				2. Johannian.		1. Acadian.	Etcheminian.			Coldbrookian.
European writers.	Ordovician.		Primordeal Cambrian.					Basal Cambrian. (mihi).			
	Lower Silurian.			(True or) Eu Cambrian.				Sparagmite Formation, Norway.			
Canadian Reports.	St. John Group of Canadian Geological Reports.							Huronian of Geological Reports.			
Groups, and kind of Rocks in Cape Breton.	A capping of volcanic rocks, in one district, to		3. Dark gray, and black carbonaceous shales often changed to slates; a few thin seams and lentiles of dark limestone, and some thin flags.		2. Micaceous gray slates, flagstones and quartzites. Iron bearing in Mira Valley, Cape Breton.	1. Dark gray slates or shales with calcareous lentiles. Gray sandstones. Interraned conglomerates at and near the base.		3. Fine greenish gray argillites, some reddish gray. Horizon of roofing slates, in C. Breton and Newfoundland.	2. Red sandstone and red and gray argillite. Lower iron-bearing horizon of Cape Breton Cambrian.	1. Gray shale or slate with some quartzite and conglomerate, the latter especially at the base.	Co. Dolerites, breccias and amygdaloidal ash rocks. Some gray shales toward the top.

brian, the volcanics are thought to belong to the latter, and to give the natural base of this system.

The accompanying table will then show the classification of the Cambrian System, as seen in the Maritime Provinces of Canada. *(See accompanying sheet.)*

In this table we have been able to present one of the faunas of the European Cambrian, heretofore unrecognized in Eastern Canada, *i. e.*, the Tremadoc fauna of English writers, the Ceratopyge fauna of the Swedes (the Euloma-Niobe fauna of Prof. W. C. Brogger), the Dicellocephalus fauna of Mississippi valley.

This is based on the discovery of examples of Asaphellus, Parabolinella and Triarthrus in soft shale on the upper part of McLeod Brook, in Boisdale district. It happens that at St. John the strata which would carry this fauna is in the channel of the river in the upper part of the harbor of St. John, with the Dictyonema fauna on one shore, and the Tetragraptus fauna on the other, hence it has not been recognized in the St. John Basin.

Also, the strata of Division 2 of the St. John group, the Johannian division, which we have all along spoken of as the probable place of the Olenus, it would seem will have to be assigned largely to the Paradoxides Zone, since Mr. Loper, who has been collecting in Cape Breton for the U. S. Geological Survey, has found a *Paradoxides*, which proves to be a variety of *P. Forchhammeri*, in the middle of this Division. From this it may be inferred that the two lower bands (*a* and *b*) of this division may be assigned to the Paradoxides zone. I had found in the Mira R. Cambrian a cheek of Paradoxides type in this division, but this alone was not sufficient to determine the presence of this genus in the Johannian division.

Another important point made during the past season was, that the strata at Young's Point (or McFee's Point), from which the fossils came, collected by Messrs. Weston and Robert many years ago for the Canadian Geological Survey, and which the author had described, and referred (on account of their resemblance to European forms) to the Ordovician fauna, are in the Etcheminian or basal Cambrian. The more abundant material gathered since Messrs. Weston and Robert's visit, show that the species referred by me to Orthisina is a Billingsella. The Holasaphus does not agree with any other basal Cambrian trilobite so far described; but the Hyolithes may be a form of *H. americanus* of Billings.

The writer has suggested the possibility that from the composition of the Hastings Cove Paradoxides fauna, the genus Olenellus, sens. strict., might occur above Paradoxides. This now seems the less probable from the occurrence in Cape Breton of the latter genus as high up as the middle of the Johannian division, where Olenus would naturally be looked for. It would seem that Olenellus must occur lower down than the Johannian division.

New Species of the Etcheminian or Basal Cambrian.

1.—*Development of the genera Acrothyra, Acrotreta and Acrothele.*

The value of small species of fossils in determining geological horizons is well shown in Tullberg's monograph on the Agnosti, of which genus certain types are peculiar to special horizons of the Cambrian and of the Ordovician. A small fragment of rock only has been found sufficient, when containing certain Agnosti, to determine the age of a group of strata.

I hope it may hereafter be possible to use the three genera above mentioned in a similar way for determining the age of parts of the Etcheminian and the higher Cambrian, where these genera occur. It is as a contribution to this object that the writer presents here descriptions of such species and varieties as have been recognized in the Canadian Cambrian rocks.

It will be seen that so far as our knowledge goes, the first two genera are among the oldest that have been recognized in the Cambrian rocks of Eastern Canada, since they are found among the volcanics that lie at the base of the Palæozoic terranes, as well as higher up in the Cambrian; and they were distinct from each other, even at that early time.

The following table shows the distribution of these early forms of Brachiopods in the basal Cambrian rocks and their relative abundance at Dugald Brook at the several horizons at which they occur:

DISTRIBUTION OF ACROTHYRA AND ACROTRETA IN THE COLDBROOKIAN AND ETCHEMINIAN OF CAPE BRETON.

These species and mutations are described in the following pages.	COLDBROOK.	ETCHEMINIAN.													
		1					2			3					
		a	*b*	*c*	*d*	*e*	*a*	*b*	*c*	*a*	*b*	*c*	*d*	*e*	*f*
Acrothyra signata			**7**												
——— ——— prima	18														
——— ——— sera				59											
——— ——— tarda				6	24			1							
——— ——— orta									3						
A—— proavia													6	**160**	
A—— ——— prima										7					?1
A—— ——— crassa														1	?1
Acrotreta papillata				2	**25**										
A—— ——— prima	1														
A—— sp							1?								

N. B.—The figures in the columns show the number of individual shells examined. The horizons where the types of these species are found are marked by heavy faced numbers. Only the ventral valves are recorded in this table.

ACROTHYRA.

For the characteristics of this genus see this Bulletin, Volume IV, page 303.

ACROTHYRA SIGNATA, n. sp. Plate XIII, figs. 2 *a–e*.

Valves corneous or calcareo-corneous, tumid, rather thick shelled.

Ventral valve—Oval, pointed at the umbo, beak depressed and sides compressed. Hinge area oblique. *Interior.*—There is a strong narrow callus, one-third of the length of the valve, bounded by a raised ridge at the sides and in front; at the front of this callus is an oval pit, from which a groove runs backward nearly to the apex of the shell, where it is supposed to connect with the foramen. Outside the callus, on each side, near the margin of the valve, are lenticular marks of the lateral muscles. About the middle of the valve the position of the anterior adductors is indicated by a faint impression of the lozenge or "heart-shaped" depression. The margin of the valve is thickened.

The *dorsal valve* is orbicular, strongly convex, and has a somewhat triangular appearance, because of the sides being depressed from the umbo, and because the front is strongly bent downward. *Interior.*—This shows a sharp, thin, median septum for half of the length of the valve. This ridge is broader and more distinct at the front; at each side are lateral obscure ridges, diverging from the umbo. Outside of these ridges are the lenticular imprints of the lateral muscles.

Sculpture.—The surface of this shell (which perhaps is not the real outer surface) is shining, and has fine concentric ridges visible only with a lens.

Size.—Length of the ventral valve, 3 mm.; width, 2 mm.; depth, 1 mm. In the dorsal the length and breadth are equal, and the depth is less than that of the ventral.

Horizon and locality.—This species is found in Assise *b* of the lowest Etcheminian Zone at Dugald Brook, a branch of Indian Brook in Escasonie, N. S.

On a cursory examination the ventral valve of this shell might pass for that of a Lingulella, but the closed deltidial area is that of Acrotreta and Acrothyra; the form of the dorsal and the nature of its interior show that the species is closely related to Acrotreta.

ACROTHYRA SIGNATA-PRIMA. Plate XIII, figs. 1 *a–g*.

Test (calcareo-)corneous; valves tumid. *Ventral valve* variable in form, longer than broad, often quite tumid, with the posterior half straighter than the anterior, which in some examples is strongly arched down toward the margin. Hinge area variable in height, beak sometimes overhanging the hinge, sometimes withdrawn from the perpendicular. *Interior*—There is a visceral callus from one-quarter to one-third of the length of the valve, wider in front than behind, bordered by vascular grooves; the central depression is deeper toward the apex than toward the front. Outside of the aforesaid grooves is another and a shorter pair, more widely diverging; traces of the lateral muscle scars are seen outside of this latter pair of grooves.

The *dorsal valve* is more regular in form than the ventral, but also often quite tumid. The umbo is low and close to the margin. *Interior* —This possesses a shallow median septum extending to the middle of the valve; on each side of the septum, at the hinge line, are pits for the cardinal muscle. A pair of diverging grooves in the posterior half of the valve mark the position of the lateral muscles.

Both valves have thickened borders and are flattened along the lateral margins.

Considering the variableness of this form one might be disposed to think it a mutation of *A. signata*, and it is so classed here; but the following differences are apparent: The visceral callus of the ventral valve is broader and not so distinctly impressed, and the groove at the posterior end project farther backward. In *A. signata* the callus does not have the strong bounding ridges that this frequently is seen to have. The cardinal area in this form never has the extreme overhang that marks *A. signata*, and the back part of the ventral valve is not produced.

Sculpture.—The surface is smooth, but a strong lens reveals fine concentric ridges at intervals on the surface of the shell.

Size.—Ventral, length, $2\frac{1}{2}$ mm.; width, $2\frac{1}{4}$ mm.; depth, $1\frac{1}{4}$ mm. Dorsal, length and width, $2\frac{1}{4}$ mm.; depth, $\frac{3}{4}$ mm.

Horizon and locality.—Fine grey shales in the volcanic beds of the Coldbrook Group at Dugald Brook, Escasonie (C. B.), N. S.

ACROTHYRA (SIGNATA) SERA. Pl. XIII, figs. 3 *a–f*.

Valves corneous, thick, especially the ventral. General form orbicular, with the umbo of the ventral projecting.

Ventral valve nearly circular in outline, and with the back either straight, or slightly hollowed near the apex, and rounded down toward the front margin. The margin is somewhat straightened at the hinge, and there is a depressed pseudodeltidium, with a narrow striate area on each side. The area is at right angles to the base of the valve, which, when viewed from the side, has the margin somewhat arched up at the front and back. *Interior.*—This has near the hinge a thick rectangular callus, hollowed at the middle, with a depression that deepens towards the hinge; from this it is divided by a low transverse ridge, behind which is a pit leading to the foramen, which is just behind the umbo. On each side of the callus, two low ridges extend forward at a wide angle, and limit the area occupied by the lateral muscle scars. The position of the central group of muscles in front of the callus is not clearly defined.

The dorsal valve is orbicular and the umbo depressed. Two broad obscure ridges radiate from the umbo to the sides of the valve. When viewed sidewise the valve is seen to be bent down both at the anterior and posterior ends. *Interior.*—The most prominent feature is the median septum, which is usually visible from one-sixth of the length of the valve from the back, to the middle of the valve. A pair of diverging grooves originate at the hinge line, and forward, towards the sides of the valve, divide off the space occupied by the impression made by the lateral muscles. Midway between these grooves and the median septum, are two faint vascular ridges. The margins of both valves are thickened and flattened.

Sculpture.—This consists of fine concentric ridges with smooth intervals between ; the known surface is smooth and shining, but there are fragments of what appears to be an outer layer, with a dull, minutely granulated surface. The surface is cften ridged with growth lines, especially toward the anterior margin.

Size.—Length and width of the valves equal, $2\frac{1}{2}$ mm. The depth of the ventral is $1\frac{1}{2}$ mm.; that of the dorsal, 1 mm.

Horizon and locality.—The Assise 1*c* of the Etcheminian at Dugald Brook, Escasonie (C. B.) N. S.

This differs from the type in the shorter and wider shell, upright hinge area, wider visceral callus, and straighter back of the ventral valve. From *A. signata prima* in the more regularly conical form of the ventral valve.

ACROTHYRA SIGNATA–TARDA. Pl. XIV, figs. 1 *a–d.*

Only the *ventral valve* known. This is tumid, with a broad low umbo, and convex on the median line. *Interior.*—Distinguished by two short prominent grooves that end abruptly, short of the end of the callus ; the callus is narrow and has a low ridge along the middle; it ends $1\frac{1}{4}$ mm. from the hinge, and the two lateral grooves are about 1 mm. apart. Outside of the two grooves above named are low crescentic ridges in front of the lateral extensions of the hinge line, that enclose the scars of the lateral muscles.

The *dorsal valve* has not been separated from that of *Acrotreta papillata*, which occurs with it.

Sculpture.—This, on the lateral slopes of the valve, consists of fine, closely set ridges, visible only with a lens.

Size.—Length, $2\frac{1}{2}$ mm.; width, 3 mm.; depth, $1\frac{1}{2}$ mm.

Horizon and locality.—In the gray shales of E. 1 *c* and *d* at Dugald Brook, Escasonie, (C. B.) N. S. Common in the latter assise.

This mutation is distinguished from *Acrotreta papillata*, with which it is associated, by the form of the callus, etc., and from *Acrothyra signata* (typical) by its flatter callus and deeper and shorter lateral groves; the same characters distinguish it from *A. signata-prima* and *A. signata-sera.*

ACROTHYRA SIGNATA–ORTA. Pl. XIII, figs. 4 *a–f.*

This rather tumid form has an overhanging beak. *Ventral* valve broadly ovate, bluntly pointed, convex along the back, especially toward the front of the valve, where the curve becomes abrupt. *Interior*—A callus about three times as long as its width in front, extending from the beak one-third of the length of the valve, sometimes there is an apophysis in front of it, of equal width, sometimes an apparent extension of the callus, with a median ridge dividing it lengthwise. The callus usually has a transverse raised thread towards the posterior end, and sometimes another near the front. A faint, narrowly triangular hollow, divides the callus from the impression of the lateral muscles.

The dorsal valve is oblately orbicular in form, with inconspicuous umbo. The valve is somewhat depressed in the middle and toward the front. *Interior*—This part of the valve exhibits a median septum in the posterior quarter of the valve, and behind it two lateral septa, that fork from near the umbo; the place of the lateral muscles is faintly marked.

Sculpture.—Of fine concentric ridges, as with other forms of this species.

Size.—Length of ventral, 2 mm.; width, $1\frac{3}{4}$ mm.; height, 1 mm to 2 mm. Dorsal length, $1\frac{3}{4}$ mm.; width, 2 mm.; height, about $\frac{1}{2}$ mm.

Horizon and locality.—Fine, greenish grey calciferous sandstone of E. 2 *c.* at Dugald Brook, Escasonie. Not rare.

This mutation shows a change in the direction of *A. proavia* described below, and of a higher horizon..

The ventral valves lie on their sides on the layers of the rock, but the dorsals are on edge.

ACROTHYRA PROAVIA. Pl. XIV, figs. 2 *a–g* and 3 *a–f*.

Acrotreta proavia, n. sp. Nat. Hist. Soc. N. B. Bull., Vol. iv, p. 203, pl. iii, figs. 2 *a* to *f*.

Shell substance calcareo-corneous. The thin outer crust sometimes wanting from corrosion, abrasion or absorption.

Ventral valve oblique-conical, with a prolonged beak. Cardinal area narrow, as is also the pseudo deltidium; in the pseudo deltidium near the apex is a small oval tubercle, between which and the apex, the foramen is supposed to be situated. The valves slope evenly down from the apex to the anterior and lateral margins. No good examples of the *interior* of this valve have been obtained; imperfect ones show two vascular lines enclosing a narrow visceral callus, and extending as far down from the apex on one side as the hinge area does on the other; the front margin exhibits on the interior a row of about ten radiating vascular ridges. This valve is often undulate with one, sometimes several strong grooves concentric to the umbo, marking periods of rest in the growth of the shell; corresponding ridges are found on the deltidial area.

The dorsal valve is round, and broadly rounded in front; the contour of the surface is varied by a moderate projection of the umbo behind, and by a slight flattening of the valve in front, giving the valve a round, slightly triangular relief. The *interior* has the impression of a pair of muscles in the umbo, whence a low ridge extends forward across the valve. Not infrequently the edges of this valve are flattened, and one or more grooves, concentric to the umbo, marking stages of growth, indent it.

Sculpture.—A strong lens reveals a series of concentric striæ on the surface on some examples of this shell, there being about 20 in the space of a millemetre. Between these ridges a still stronger magnifier (1 inch objective) shows a fine granulated surface with occasional rows of coarser granules, parallel to the concentric striæ. On the inner, chitinous surface there is a similar ornamentation, but less distinct than that on the surface of the outer layer.

Size.— Length of the ventral valve in the largest examples, 3 mm. ; width, 2 mm. The dorsal valves in both diameters is 2 mm. Depth of the ventral valve from the beak $1\frac{1}{2}$ mm. ; that of the dorsal at the middle, $\frac{1}{2}$ mm. A great majority of the valves are smaller and of the size given in the original description.

Horizon and locality.—In the Assise *e*, common (and less common in *d* where it is larger) of the upper Etcheminian, Dugald Brook, Escasonie, Cape Breton. Very thin shells are found in Assise *f.*

There is a good deal of variation in the form of the ventral valves of this species. The majority are of the dimensions given, but sometimes the width of the valve is equal to the longest diameter. Also the concentric furrows of growth are in some examples so profound as to give the ventral valve, when slightly distorted obliquely, the appearance of a minute Raphistoma.

This species differs from all others of the genus known to me, except *L. inflata* of the Protolenus fauna, in the overhanging apex, which in the typical form projects one-quarter beyond the base of the valve, but in the variety from Assise *f*, one-third beyond. As a result of their form, the ventral valves of this species, in place of standing erect like many of those of the genus Acrotreta, rest on the dorsal side, on the layers of the shale in which they are imbedded, and except for their strong convexity might be mistaken for those of a minute Lingulella. As they occur scattered over the layers of the shale they also strongly recall the ordinary aspect of the conical teeth of fishes, brilliant with black enamel.

No described species of Acrotreta is as small as the more abundant valves of this species, though *A. gemmula* of the Protolenus fauna approaches it in that respect.*

Sir William Dawson has called attention to the resemblance in structure between the shells of Hyolithidæ and the Brachiopoda, and has compared the ventral valve of a Brachiopod to the tube of a Hyolithes. Had Sir William been acquainted with this species he would have found it a good example for comparison. This will be seen if the ventral valve be so oriented, as to make the areal side correspond to the ventral side of a tube of Hyolithes. The dorsal valve with its round form and excentric umbo, with radiating lines, also resembles the operculum of a Hyolithes. A detailed comparison of this

* Trans. Roy. Soc. Can. Vol. xi, p 87, pl. xvi, figs 2 *a* to *d*.

species with certain Hyolithidæ has been made in an article contributed to the Royal Society of Canada (Trans. New. Ser. Vol. VII., Sec. IV. p. 93).

A study of layers of the shales of the horizon E. 3 *e.*, studded with the valves of this species, failed to reveal any ventral valves, showing clearly a thickened callus. For the relationship of this species we have therefore to depend on the forms *prima* and *crassa*, both of which possess a narrow thickened callus. These show that these three forms are of the same genus as *A. signata*, but of a different species, and reveal a series in the upper Etcheminian Fauna parallel to the *Signati* of the lower fauna; they are distinguished from the latter by their narrow visceral callus. The absence of a thickened callus in the typical form of *A. proavia* would seem to show that the pedicle in this form was slender and weak, and from the fact that this shell, above all its fellows, shows a perfect orientation in one direction, as imbedded in the shale, there is a presumption that the pedicle was also long, enabling the animal to swing in the currents of the sea in which it lived.

Often the ventral has an even slope along the back, but many old valves, especially long ones, show from two to three heavy concentric ridges, marking stages of growth of the shells.

Interior.—The *ventral valve* of this species has a quite small tubercle in front of the foramen. Two-fifths from the apex of the ventral valve there is a shallow depression on the interior surface, which, by analogy with mut. *prima* should mark the position of the central muscle scars. On each side of the shallow depression a shallow groove runs forward toward the front of the valve. Some examples show a median and two lateral septa in front of the shallow depression. Faint ridges, running forward on each side of the front slope of the ventral valve, may indicate the position of vascular trunks.

Interior.—The *dorsal valve* has inside, a median and two lateral ridges. On some valves the median ridge extends only so far as to divide the pits of the cardinal muscle; in others it extends to the middle of the valve. A pair of median pits are sometimes visible near the end of the median septum, one on each side of it.

ACROTHYRA PROAVIA–PRIMA, n. mut. Pl. XIV, figs. 4 *a–f.*

Ventral valve triangular-ovate, about twice as long as wide, prolonged into a long pointed beak, and rounded and bent down in front. *Interior.*—This exhibits a long narrowly tapering callus originating in the beak at the foramen ; the callus is a third of the length of the valve, or more. In front of the callus is a shallow transverse depression, marking the position of the central group of muscles.

The *dorsal valve* is nearly circular, projecting at the back, where there is a somewhat low beak, and rounded down more at the front than the sides. *Interior.*—A median septum is visible, dividing the pits of the cardinal muscles. A shallow median ridge traverses the middle of the valve, which is flattened at each side near the hinge. The edges of both of the valves are flattened and thickened, also the apical third of the ventral valve is thicker than the middle of that valve.

Sculpture.—This consists of a very fine granulation, with frequent, thread-like, concentric ridges.

Size.—Ventral valve : length, 3 mm.; width, 2 mm. ; height of the cardinal area, 2 mm. Dorsal valve, 2 mm. in each diameter ; depth, $\frac{1}{2}$ mm.

Horizon and locality.—E 3 a = base of the upper Etcheminian shale at Dugald Brook, Escasonie (C. B.), N. S. Frequent. In this rock the ventral valves of Acrothyra lie flat on the layers. Also a valve apparently of this form, 3 × 2 mm., from E. 3 *f.*, occurs at Gillis Brook, a branch of Indian Brook, Escasonie.

This mutation is distinguished from the type by its greater size and by the possession of a thickened callus.

ACROTHYRA PROAVIA–CRASSA, n. mut. Pl. XIV, figs. 5 *a–c.*

Only the *ventral valve* known. This is short, tumid and conical. *Interior.*—This possesses a narrow callus, four or five times as long as wide, and nearly a third of the length of the shell. At the front of the callus are two small oval scars divided by a faint septum. The callus is concave and extends back nearly to the beak.

Sculpture.—Some fragments of the surface which are preserved show fine, close set, concentric ridges.

Size.—Length, $2\frac{1}{2}$ mm.; width, 2 mm.; height, $1\frac{1}{2}$ mm.?

Horizon and locality.—Lower layers of the assise E. 3 *e.* at

Dugald Brook, Escasonie (C. B.), N. S. Also a doubtful ventral from E. 3*f.* at Gillis, Indian Brook, Escasonie. Scarce.

This mutation is distinguished from the type and from mutation *prima* by its robust form, and from *proavia*, the type, also by the possession of a thickened callus. From the mutations and type of *A. signata* by the narrowness of its callus.

Of the two species of Acrothyra herein described, *signata* was found specially to characterize the lower half of the Lower Etcheminian fauna, being found most abundant in the middle measures of this set of beds. It is not, however, limited to these measures, but by mutations is sparingly represented in the upper part of this lower fauna.

Acrothyra proavia, on the contrary, has been found only in the Upper Fauna, and mostly in its higher part, where some layers are crowded with thousands of these little shells.

ACROTRETA. Kutorga.

While this genus appears as a contemporary of Acrothyra in the earliest Basal Cambrian, it seemingly lived on after the latter had passed away. But throughout the Coldbrook and lower Etcheminian measures, it is quite subordinate in numbers to Acrothyra, and we have not found it at all in the upper Etcheminian. Throughout the true Cambrian, in the Acadian Provinces, however, these conditions were reversed, for, with the doubtful exception of *Lingulella* (*Acrothyra ?*) *inflata* of the Protolenus fauna, an undoubted example of the genus Acrothyra is unknown to me above the Etcheminian horizon, and Acrotreta has full possession of the field.

ACROTRETA PAPILLATA, n. sp. Pl. XV, figs. 2 *a–f.*

(Calcareo-)corneous valves moderately arched, nearly orbicular.

Ventral valve with a moderately elevated umbo, one-fifth from the back of the valve; the back of the valve somewhat concave toward the umbo, but convex toward the front margin. There is a concave pseudo-deltidium, and the side slopes of the hinge area are convex. *Interior*—In this the visceral callus is short, sub-circular, and marked at the middle by a deep circular pit; at its sides, obscure, short, straight, diverging grooves are usually seen within the circular groove that surrounds it.

The dorsal valve is moderately arched, the slope being steepest toward the umbo, which is but slightly raised. On each side of the umbo flattened slopes run along the sides of the valve in the posterior half. There is a shallow median sinus on the back of the valve, which widens toward the front. *Interior*—Under the beak is a boss from which a median septum runs forward, that forks about a fifth of the length of the valve from the hinge line; from the space between the forks, at a third of the length of the valve from the hinge, the median septum reappears, widens, and terminates at a point nearly a third from the front of the valve. On each side of umbo are pits of the cardinal muscles, and outside these, in advance of them, and near the margin, are large scars of the lateral muscles.

The margins of both valves are flattened and thickened.

Sculpture.—This shell has a dull, minutely granulated surface, across which run narrow ridges concentric to the umbo, widely spaced in the middle of the shell, more closely arranged toward the margin, and closely crowded and narrow, on each side toward the hinge.

Size,—Ventral, $2\frac{1}{2}$ mm. long, $2\frac{1}{2}$ to 3 mm. wide, and $1\frac{1}{4}$ mm. high. Dorsal, as the ventral, except that the height is about $\frac{3}{4}$ mm.

Horizon and locality.—E. 1 *d*, the Gregwa shale of the Etcheminian at Dugald Brook, Escasonie, (C. B.) N. S. Common. It occurs also in Assise E 1 *c*.

VAR. Pl. XV, figs. 3 *a–c*.

In examples from Boundary Brook the form of the callus in the *interior* of the *ventral valve* varies from a perfectly circular elevation to one that is somewhat squared at the sides; the groove outside of the callus is sometimes indistinct. On each side of the foramen is sometimes a short, sharp furrow directed forward. In the *dorsal valve* the depressed posterior lateral slopes and the somewhat flattened anterior slope gives the valve a triangular appearance. The *interior* shows a pit at the hinge area, which is narrow, and thence a narrow median ridge runs nearly to the middle of the valve. An inconspicuous lateral branch is thrown off on each side of the median ridge.

ACROTRETA PAPELLATA–PRIMA, n. mut. Pl. XV, figs. 1 *a–c*.

Only the *ventral valve* of this form is known. This is wider than long, tumid, with the cardinal area vertical. *Interior.*—In this the visceral callus is of a circular form, and only one-quarter of the length of the valves. Its ridge closely encircles a deep pit, which lies just in front of the foraminal opening, in the direction of which it becomes narrower and shallower. The traces of a pair of straight diverging grooves are discernable at the sides of the callus.

Sculpture.—This consists of minute concentric ridges, visible only with a strong lens.

Size.—Length, 2 mm.; breadth, $2\frac{1}{2}$ mm.; depth, 1 mm.

Horizon and locality.—Fine gray shales in the volcanic beds at Dugald Brook, Escasonie (C. B.), N. S. Scarce.

The short callus distinguishes this species from *A. crothyra signata-prima* with which it occurs. The pit in this callus, though so short, is analogous to that of *A. signata*, so that in this earliest fauna these two types of umbonal muscle scar and groove were already differentiated.

ACROTRETA *c. f.* SOCIALIS. vonSeebach. Pl. XV, figs. 5 *a–k*.

c. f. Acrotreta socialis, v.Seeb., Zeitschr. der Deutsch. geol. Gesellschft., Vol. xvii, 1865, p. 341, pl. viii, *a*, figs. 1–4.

c. f. Acrotreta socialis, v.Seeb., G. Linnarsson, 1896, Brachiopods of Paradoxides Beds of Sweden, Bihang till K. Svenska vet. Akad-Handl. Bd. 3 No. 12, p. 16, Tafl. iii, figs. 32–34.

A small species with coarse surface characters and strong muscle scars.

Ventral valve moderately elevated, sub-circular in outline, somewhat flattened on the cardinal slope, where, in outline, it is slightly convex ; nearly straight on the anterior slope. *Interior*—At the back there are one or two faint grooves on the median part of the cardinal slope ; the foraminal boss is a wedge-shaped one with the point directed forward ; this is enclosed by two sub-parallel, deep, rounded pits, for attachment of muscles. Behind the foramen is the back of a ridge, similar to a crescent, that encloses the apical part of the shell behind, and laterally ; in the front half of the space thus enclosed is a faint outline of a visceral callus of a lozenge shape. The position of the vascular trunks is probably outside of the horns of the crescent, thence extending forward ; about a third or a quarter from the front of the shell is a crescentic row of short vascular grooves. In front of this row of grooves are one or two growth ridges, and the flattened border of the valve.

The *dorsal* valve is orbicular in outline; its height is less than half of that of the ventral. The valve is strongly arched in the posterior half, but somewhat flattened on the posterior lateral slopes. *Interior.*—This is marked by three strong radiating ridges in the posterior half of the valve; at the origin of these ridges are a pair of pits with a small tubercle in each, marking the position of the cardinal muscles. Of the three radiating ridges, the central is a narrow median ridge, with three sharp keels; for half of the length of the valve this ridge is prominent, but fades away in the anterior third of the valve; at the end of this ridge would be the scars of the anterior laterals ("j.") The lateral ridges are broader than the mesian one, but not so long; outside of them are the impressions of the lateral muscles.

Sculpture.—The roughness of the matrix prevent a good presentation of the surface characters of this species. Some examples of the ventral valve show fine concentric ridges, of which there are about ten in half the length of the anterior slope (*i. e.* about 10 to 1 mm.); the surface of these ridges appears to be granular.

Size.—The largest dorsal observed was 3 mm. across, but the greater number are not more than 2 mm. The full-grown ventral is about 2 mm. high, and the dorsal less than one.

Horizon and locality.—In gray flags of Div. 2*c* on the eastern slope of the valley of McNeil Brook, on the road to Trout Brook. Found in various attitudes in the sandy bed. The ventrals are both upright, inclined and lying on their sides in the layers. From this locality Mr. Fletcher has reported Obolella, a genus in which, at the time his report was written, many of these small brachiopods were included.

Linnarsson described very fully a species like this from the Paradoxides beds of Sweden.* He found it to range through the whole of the Paradoxides Zone. Our form belongs somewhat higher up.

From *A. Baileyi* of the (lower) Paradoxides beds in New Brunswick† this species is distinguished by its smaller size, narrow umbonal ridge to the ventral valve, higher cardinal area, and by the enclosing longitudinal pits that enclose the umbonal ridge. It differs from *A.*

* Loc. cit.

† Trans. Roy. Soc. Can., Vol. iii, sec. iv, p. 36, pl. v, figs. 13, 13*a*, *b* and *c*.

gemmula of the Protolenus fauna‡ (see Pl. XV, figs. 1 *a–d*) in the sharp umbonal ridge, and by the strong lateral ridges of the dorsal valve. From *Acrothyra proavia* of the Etcheminian fauna § (see Pl. XIV, figs. 2 *a–g*) it is distinguished by the more central apex of the ventral valve, and by the prominent ridges of the interior of the dorsal valve, as well as by its larger size. From *A. gemma*, Bill. (Walcott)¶ it is distinct by its smaller size, less proportionate height of the ventral valve, its narrow umbonal boss and its more obscure cardinal area, also by a difference in the internal markings of the dorsal valve.

Acrotreta bisecta. Pl. xvi, Figs. 2*a* to *g*.

Occurs in the Upper Cambrain of Cape Breton (Dictyonema horizon) and is described in a previous number of this Bulletin (vol. iv., p. 275). It agrees best with *A. Baileyi*, but differs from all the others by the strong median septum of the dorsal valve.

Acrotreta. sp.

A species of this genus occurs in the sandstone of E 2*a* at Young's Point with *Lingulella Selwyni*. It is rare, and only a dorsal valve has been found.

Development of Acrotreta.

This is one of the most conservative of the genera of the Cambrian and Ordovician. Though its species occur at intervals at various horizons in this system, the uniformity of size and sculpturing are remarkable. The latter consists of fine concentric striation, only visible with a strong lens. The size did not increase more than about four-fold in area in the vast space of time included in the Cambrian and Ordovician Systems. Contrast this with Paradoxides, which increased in area an hundred fold in the first two sub-faunas of the Paradoxides Zone.

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‡ Trans. N. York Acad. Sci., xiv, p. 126, pl. v, fig. 5*a* to *d*.
§ Nat, Hist. Soc. N. B. Bull. xviii, Vol. iv, p. 203, pl. iii, figs. 2*a* to *f*.
¶ U. S. Geol. Surv. Bull. 30, p. 98, pl. viii, figs. 1, 1*a* and *b*.

The series of Acrotreta run in size about as follows:

SIZE AND FORM OF THE VENTRAL VALVE IN SPECIES OF ACROTRETA OF THE CAMBRIAN AND ORDOVICIAN.

Horizon or Group.	Name and Reference.	In Millimetres. Length.	Width.	Height.	Proportion of Width to Height
Coldbrook Group,	A. papillata—prima, Pl. xv, figs. 1*a* to *c*	2	2½	1¼	2.
Lower Etchminian,	A. papillata, Pl. xv, figs. 2*a* to *f*......	2½	3	1¼	2.4
Upper ? Etchminian,	A. gemma, (Bill.) Walcott*..........	2½	3	2	1.5
Protolenus Fauna,	A. gemmula,† Pl. xv, figs. 4*a* to *d*....	1½	1½	1	1.5
Lower Paradoxides,	A. Baileyi‡ Pl. xvi, figs. 1*a* to *d*......	3½	4	1 +	3. –
Upper Paradoxides,	A. socialis, v. Seebach,§	3	3	2	1.5
? Dolgelly,	A. gemma, (Bill.), Walcott*,.	3	3½	2½	1.4
Dolgelly,	A. bisecta,¶ Pl. xvi, 2*a* to *g*	3	3¼	2½	1.3
Tremadoc,	A. cf. socialis (Seeb), Brogger**.....	1½	2	1½	1.3
Tremadoc,	A. sipo, n. sp., Pl. xviii, figs. 1 and 2..				
Arenig,	A. gemma, Billings,††...............	1¾	2	2	1.
Llandello,	A. subconica, Kutorga,‡‡	4	4	4¾	.85
do.	A. Nicholsoni, Davidson,§§	4	4	4¼	.94
Etage D,	A. babel, Barrande,‖	2	2½	2¼	1.1

It will be noticed that not only are the later species as a rule larger, but they are proportionately higher. Also we may observe that there were two lines along which there was a divergence in the relative height of the ventral valve. *A. Baileyi* had low umbones and approximated in form to Linnarssonia, a genus which, so far as has been observed, appeared in the Canadian Cambrian a little before it

The other line of development culminated in the high umboned species of the Ordovician faunas.

* Bull, U. S., Geol. Survey No. 30 p. 98.
† Trans. N. York, Acad. Sci.. No. XXVIII, p. 126.
‡ Trans. Roy, Soc , Can.. Vol. III., Sec. IV, p. 36.
§ Brachiopoda Paradox. Beds, Sweden, Linrs. p. 16.
¶ Nat. Hist. Soc., N. B., Bull, No. XIX, p. 275.
** Die Silurisch. Etagen 2und 3, p. 46.
†† Paleozoic Fossils, Vol. I, pt. 1, p. 216.
‡‡ Monog. Br. Brachiopoda. Vol. 1, pl, IX. Fischer, Conchyliologie p. 1266.
§§ Monog. Br. Brachiopoda, Vol I. pl. XVI, Vol. III, p. 338.
‖ Syst. Silur. Bohem, Vol. V, pl. 95.

For information regarding several European species of Acrotrata I am indebted to Mr. Gilbert Van Ingen, of the School of Mines, Columbia College, New York.

ACROTHELE Linnarsson.

ACROTHELE AVIA. Pl. xvi, Figs. 1*a* to *f* and 2*a* and *b*.

Acrothele avia, n. sp. Nat Hist. Soc. Bull., vol iv., p. 202, pl. iii., figs. *a* to *h*.

A rather large species with oblately oval valves and a thick horny shell.

Ventral valve somewhat concave in front of the apex. This valve has a triangular, somewhat convex, high area, including a narrow, slightly convex, pseudo deltidium, divided into two equal parts by an obscure central groove. There appears to be a foraminal opening at the slender pointed apex.

The *interior* of the ventral valve is marked by a shallow circular pit, on each side of the pedicle opening; and behind, at the margin, is a shallow triangular pit, resembling the pedicle groove of an Obolus In front of the pedicle opening is a strong oval tubercle, on each side of which extend the ridges that bound the oval centre of the visceral cavity. Four low vascular ridges extend forward from this oval area to the anterior margin of the valve. The parts of the interior of the shell, above described, are enclosed by an ox-bow shaped groove, resembling the impression of vascular trunks; these trunks have about four anterior branches, and each trunk extends nearly to the front of the valve. On the lateral slopes of the shell are three crescentic grooves, which may be accidental and due to pressure.

The dorsal valve is strongly bent down behind and in front. The umbo is slightly prominent, is appressed, and is close to the posterior margin. The sides of this valve have about a dozen radiating, branching, crenulated ridges, that extend to the margin.

The *interior* of the dorsal valve has a strong median septum, extending to the middle of the valve; at the end of this ridge is the central muscle. Scars of the latter are seen on each side of the broad end of the median ridge, near its end. On each side of the median ridge at the cardinal margin are two larger pairs of muscle scars.

From the posterior part of the shell several faint radiating ridges extend toward the front margin.

Sculpture.—The surface of the valves is marked by irregular, concentric, rounded ridges, that frequently anastomose; and the front of the ventral valve and the sides of the dorsal valve have a number of radiating ribs. The sculpture is very variable; on the central part of the dorsal it shows an irregular network of low, rounded ridges; on the sides of the valve these ridges are more regular in their course; and on the margins, especially of old shells they are stronger and more continuous. There is also much variation in the distinctness of the features of the interior, both of the dorsal and ventral valves, the smoother shells being thinner. There is no trace on the interior of the dorsal valve of the ridges on its lateral slopes.

Size.—Length 9 mm.; width 10 mm. or more. Depth of the two valves together 2 mm. or more. *Horizon and Locality.*—In assises *d* and *e* of the Upper Etcheminian (E. 3 *d* and *e*) Dugald Brook, Escasonie, N. S.

As the outer layer of this shell is thin and fragile, the strong inner layer is the one most commonly exposed, and might be thought the real surface. The outer surface has an ornate sculpturing, while that of the second layer is smoothed.

This species of Acrothele is distinct from all others by the long tubercle or callus in front of the pedicle opening. The ribs of the outer surface of the lateral slopes of the dorsal valve are peculiar to it. *A. Matthewi* and its varieties have no such ribs. *A. Matthewi-prima* has a granulate-latticed surface, but no lateral or anterior ribs. *A. Matthewi-costata* also has a granulated surface, and ribs on the front of the ventral, but none on the sides of the dorsal valve. The varieties of *A. Matthewi* also have the foramen nearer the cardinal margin than is the case with this species.

Examples of this species occurring in the Assise E. 3*d* differ from those of *A. abavia* occurring with it, in the thinner corroded valves, larger size and oblate form; they are doubtfully referred to this species, for the ventral valve is more concave in front of the umbo than are the typical shells occurring in Assise E. 3*e*. It does not flake at the middle layer of the shell as *A. abavia* of the same assise does.

In Assise E. 3*d* valves appear, which, by their oblate form and surface markings, may, without much doubt, be referred to this species. Not only are they broader than the Acrotheles of the lower assises, but they are larger, some valves attaining $9\frac{1}{2}$ mm. in width. An exterior of a ventral which is nearly one-half wider than long, and an interior of a dorsal about a third wider than its length, are figured.

In the examples from this horizon the *ventrals* show surface markings, hinge area and foramen; their interiors show crescentic grooves of the vascular trunks, and at the margin, prints of its branches. Some of the *dorsals* show the surface sculpture; others, which have the *interior* exposed, show median and lateral ridges, vascular lines, etc.

A. AVIA-PUTEIS. n. mut. Pl. xv, figs. 5 *a* and *b*.

This seems to be a variety of *A. avia*. It differs in the possession of a pair of pits, one of which lies on each side of the space between the foramen and the visceral callus, partly overlapping each. The visceral callus is quite short in this form and has but little prominence. The ridges on the surface of the valve are more regularly concentric than in the type, and more sharply cut; about ten are found in the space of one millemetre. The cardinal area is curved forward towards the top, and finely striated. The foramen is about a fifth of the length of the valve from the cardinal line, and the front of the callus about a third. Vascular trunks and branches are visible on the surface of the ventral valve as in the type. The dorsal valve does not sensibly differ from that of *A. avia*.

Size.—The largest valve seen was 8 mm. long, and about the same width.

Horizon and localily.—Found in the Bretonensis shale (E.3*d.*) at Gregwa Brook, Escasonie, Cape Breton. Frequent.

ACROTHELE ABAVIA. n. sp. Pl. xv, figs. 3*a* to *d*, and 4*a* and *b*.

Outlines of the valves nearly circular. Length of the hinge line less than a third of the diameter of the valve.

Ventral valve rather flat, with the umbo slightly raised. The umbo is about one-quarter of the length of the valve from the cardinal line. *Interior.*—In the examples known the horizon E.3*a.*, the interior is smoothly moulded, except along the front slope, where faint vascular grooves may be detected, but in those from E.3*b.* a visceral callus is faintly outlined, with a swelling on the middle; some valves here have faint impressions of vascular trunks on each side of the callus running forward.

The *dorsal valve* has its greatest height near the middle, and has an appressed umbo, close to the hinge line ; the lateral margin, in the pos terior half are revolute. *Interior.*—A median septum starting near the hinge line, extends across the middle of the valve to nearly one-third from its front ; it is widest in the middle and fades away to a point in front. On each side of it is a vascular grove, the pair radi. ating from near the umbo and extending nearly to the front margin they are nearly as far apart at the front as half of the width of the valve. Another pair of such grooves, about half as far apart as these, are faintly impressed on each lateral slope of the valve. The visceral cavity is faintly marked out by striated lines in the posterior half of the valve, and has an irregular arched front, projecting near median septum towards the front of the valve. Faint vascular striæ are visible on the median area towards the front of the valve. Some examples from the horizon E.3*b* have a shorter septum, and show the position of the central and lateral muscles closer to the hinge line. These shells are more oblate.

Sculpture.—This is only known near the side of the valve, where it consists of fine, closely set, more or less tuberculated ridges, parallel to the margin.

Size.—Length and width equal, 7 mm. Depth of the ventral valve about $\frac{3}{4}$ of a millimetre ; that of the dorsal 1 mm.

Horizon and locality.—All the horizons from E. 3*a* to E. 3*e*, except E.3*d*, at Dugald Brook, Escasonie, N. S.

The Acrotheles of E.3*c* are much corroded, and do not show the characters well ; they are mostly moulds from which the shell has been exfoliated. One ventral shows well the hollow behind the hinge area, and the foramen.

Examples from the assises E.3*e*. have in the *ventral* valve quite a small tubercle in front of the foramen ; the visceral callus extends half of the length of the shell, and at each side in front are sometimes seen pits of the adductor muscles ; on each side of the callus a groove runs out toward the front margin. Some examples show a median and two lateral septa in front of the callus. Often the shell has an even surface to the margin, but frequently there are a few strong concentric ridges that mark stages of growth.

The *dorsal* valve of this species (from E.3*e*.) has inside, a median and two lateral ridges ; on some valves the median ridge extends only so far as to divide the cardinal muscles ; in others it extends to the middle of the valve. A strong pair of median pits are sometimes visible near the end of the median septum.

This is the oldest undoubted Acrothele detected in the Eopalæozoic rocks of Eastern Canada. Almost all show only the interior surface, or intermediate layers of the shell. One ventral has a corroded outside, with traces of concentric ridges.

ACROTHELE PROLES. n. sp. Pl. xvi, figs. 3*a* to *e*.

General form lenticular with the umbo of the ventral valve projecting.

The length and breadth of the valves of this species are sometimes equal, though usually the width is somewhat greater.

The *ventral valve* is convex on all the slopes, except close to the umbo, where it is slightly concave in front. The umbo is low, and is about one-seventh of the length of the valve from the hinge line, the area is about 1 mm. high, and the length of the hinge line nearly one-third of the width of the valve. *Interior.*—This has an obscurely lozenge shaped callus in front of the foramen, upon which at the posterior end is a small, more elevated portion. On each side of the callus is a pair of vascular ridges, marks of the advance of the central muscles. A pair of short ridges, near the hinge line, are of the nature of teeth outlining sockets for the articulation of the two valves. Faint curving ridges in the anterior part of the valve appear to be vascular trunks ; these fork toward front, and show eight or nine ridges with corresponding depressions along the anterior margin.

The dorsal valve is more regularly lenticular, but more abruptly bent down behind than elsewhere, the umbo is depressed, and not easily recognized. Flattened valves exhibit costæ radiating from the umbo, but not reaching the margin. *Interior.*—This shows a strong, broad median septum extending nearly half of the length of the valve ; at the front it fades away into fan-like ridges that rapidly sink to the level of the valve. On each side in the cavity of the valve, and extending nearly as far forward as the median septum and, diverging from it, is a pair of sharp vascular ridges. Ontside of these, on the rounded edge of the valve at the ends of the cardinal line, are a pair of elongated, flattened teeth, that articulate with the sockets in the ventral valve. The margins of the dorsal valve are broad and rolled backward at the edges.

Sculpture.—This consists of fine, regular concentric ridges that occasionally anastomose. There are about eight or ten ridges in the space of one millimetre, the ridges being more widely spaced toward the margin.

Size.—The largest valves seen was 12 mm. long; valves of 9 mm. are common, the height of each valve is about 1 mm.

Horizon and locality.—In the shales of E. 3*f*., near the top of the Etcheminian at Dugald and Gillis' Brooks. Frequent.

This interesting species seems best represented in Europe by *A. coriacea* of Linnarsson, but that species is of the Paradoxides Zone, its umbo is further from the hinge line, and the cardinal features are different.

It will be noted that the supposed vascular trunks in this species, *Acrothele avia* and *Obolus (Palæobolus) Bretonensis* are far removed from the margins of the valves.

ACROTHELE, sp.

A species of this genus occurs in the flags of Division 2 (*b* ?) of the St. John Group at a cutting on the Intercolonial R. R. at Long Island passage, St. Andrews Channel. The material is too imperfect to determine the species.

Notes on the following table.

It seems quite probable that when the Acrotheles that have been described from the Lower Paradoxides Beds are compared, some of the names may be found to be synomyms, there being five species accredited to the Band *c*. But it is to be remembered that there are two sub-zones in this band, showing considerable differences in the fauna. To the lower sub-zone of Paradoxides lamellatus (*cf.* Œlandicus) *A. granulata* and *A. cf. coriacea* are to be assigned, and to the higher or sub-zone of *P. eteminicus* and *Conocoryphe Matthewi*, the other three.

As Mr. Walcott's species are referred simply to Lower Cambrian, one cannot compare them closely with the others; but it seems pos-

(*Continued at page 404.*)

DISTRIBUTION OF ACROTHELE IN THE

	Name of Species and Reference.	Upper Etcheminian. Faunal Sub-zones.					
		a	*b*	*c*	*d*	*e*	*f*
1	Acrothele abavia, n. sp..	×	×	×	...	×	....
2	A. ——— avia, mut. puteis, n. m....	...	....	. .	×	....	....
3	A. ——— avia*	. .	....	..	×	×	....
4	A. ——— proles, n. sp..............	....	....	. .	....	....	×
5	A. ——— decipiens, Walcott	....	...	....	L C	....	....
6	A. ——— Matthewi, mut. prima†....	....	....	....	....	....	....
7	A. ——— ——— mut. lata†...	....	..	...	....	....	....
8	A. ——— Gamagei, Hobbs..	.. .	....	....	...	....	....
9	A. ——— intermedia, Linnarsson*...	.. .	....	...	....	...	....
10	A. ——— granulata, Linnarsson÷÷...	....	...	. .	....	....	...
11	A. ——— c. f. coriacea, sp. ined.....	....	...	....	....	.. .	. .
12	A. ——— Bohemica, Barrande	....	....	....	....	....	.. .
13	A. ——— Matthewi, Hartt**	....	...	...	.. .	....	....
14	A. ——— coriacea, Linnarsson††	....	....	....	....	....	...
15	A. ——— subsidua, White‡‡..... .	. .	.. .	....	L C	....	....
16	A. ——— incohans, Barrande‡‡......	....	....	...	...	....	....

* Bull. Nat. Hist. Soc. N. Bruns'k, vol. iv, p. 202, pl. iii, figs. 1*a* to *h*, 1899.
† Trans. Roy. Soc. Can., vol. iii, sec. iv, p. 39, pl. v, figs, 16, 16*a*, 17, 17*a*, 1885.
‡ Palæont. Camb. Terranes, Boston Basin. A. W. Grabau, p. 615, pl. 31, figs. 1*a* to *d*, 1900.
÷÷ Brachiopoda of Paradoxides Beds of Sweden, p. 24, pl. iv, fig. 51, 1876.
Proc. U. S. Nat. Mus. No. xix, p. 716, ld. 60, fig. 2, 1897.

Cambrian Rocks of Eastern Canada, etc.

ST. JOHN GROUP.												
Acadian. Division 1.				Johannian. Division 2.			Bretonian. Division 3.					
Faunal Zones.							Parabolina.	Peltura.	Dictyonema Asaphellus.	Tetragraptus		
Protolenus		Paradoxides.										
a	*b*	*c*	*d*	*a*	*b*	*c*	*a*	*b*	*c*	*d*	*e*	
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* Ibidem, p. 21, pl. iv, figs. 44 to 48.

** Acadian Geology, Dawson, London, p. 644, fig. 221, 1868.

†† Geog. and Geolg. Expl. West 100 Merid., vol iv, pt. 1, p. 34, pl. i. figs. 3*a* to *d*, 1875.

‡‡ Fauna med Conocoryphe exsulens, Stockholm, p. 25, taf. iii, figs. 40–44, 1879,

‡‡ Faune Silur. de Hof, p. 102, figs. 74 and 75, 1868.

(Continued from page 401.)

sible that the one referred to *A. subsidua* may be some other species, as it occurs with a different fauna than that of the original form, and apparently, should be much older.

I have ventured to assign White's *A. subsidua* to the Peltura Zone, because it appears to be the same with a species which occurs in the Mt. Stephen Fauna; this fauna contains an Ogygia and an Olenoides with other forms which appear to indicate this as the lowest horizon to which it should be assigned. White's species is said by Director Walcott to occur with Asaphiscus and Olenoides, which also appear to be Upper Cambrian forms.*

Near the same horizon, or perhaps a little higher would come Barrande's *A. incohans* which occurs in the "Fauna of Hof" equivalent to the Tremadoc Fauna.

Among the Acrotheles there are several types of sculpturing of the surface of the valves. The most characteristic is that of fine, short, irregular wavy ridges, such as are found in *A. Matthewi* and *A. granulata*. Another type is represented in *A. proles*, *A. gamagei* and *A. cf. coriacea* wherein the ridges become more regularly concentric; the valves in this group are larger, and the ventral less selliform than in the preceeding one. White's description of *A. subsidua* would indicate that there is a third style of ornamentation in the latter species, in which the surface is papillose, yet with concentric lines of growth.

From the time of its sudden appearance in the base of the Upper Etcheminian group, Acrothele continues to be common until we pass the Lower Paradoxides beds; from this point upward they are rarely met with in Eastern Canada. It is thus more limited in range than Acrotreta which extends up into the Ordovician. Its range also differs from that of Acrothyra, which is a common genus in the Lower Etcheminian, can be found even as far down as the Coldbrook, and also is present with Acrothele in the Upper Etcheminian, but hardly invades the Protolenus fauna; where, as well as in the Lower Paradoxides beds, shells of Acrothele are common.

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* Bull. U. S. Geol. Surv. No. 30, p. 40.

(B) The Tremadoc Fauna.

In this fauna one enters upon the debatable ground between Cambrian and Ordovician. In the Edition of Dana's Geology, 1875, this group was classed as Silurian (*i. e.* Ordovician). In the later edition (1896) it is transferred to the Cambrian. Prof. Jas. Hall referred species of this fauna from the Sandstones of the Mississippi valley to the Potsdam (therefore Cambrian) in 1863? Director Walcott has referred strata in the west of America and at Saratoga, N. Y., holding this fauna to the Potsdam or Upper Cambrian.

But in Europe the consensus of opinion (omitting Great Britian) places this fauna in the Ordovician or Lower Silurian. Lindstrœm says that in Sweden not one species passes from the Cambrian to the Ceratopyge Fauna (*i. e.* the Tremadoc) while nineteen species pass from the Ordovician to the Silurian (Upper). Four species, however, are recorded as passing in Wales from the Lingula Flags to the Tremadoc Group.* Elsewhere it is stated that 6 out of 37 species of crustacea pass from the Tremadoc to the Arenig in Wales.† So that it is difficult to draw a line of absolute division between Cambrian and Ordovician either above or below the Tremadoc.

On the whole it seems better to hold to the prevalent English opinion which places the line of the division above the Tremadoc, notwithstanding the conditions that prevailed in Northern Europe, and notwithstanding the fact that new and important genera of crustaceans appeared in the Tremadoc slates.

To adopt the line drawn by the palæontologists of Scandinavia and Germany would make necessary a revision of the Cambrian geology of America, whereby large areas and extensive faunas that have been classed as Cambrian would of necessity be transferred to the Ordovician, or Lower Silurian.

Further, it may be inferred that this hiatus in the faunas will be bridged over by the discovery of connecting faunas in the strata of some other region than that of Europe. The Mount Stephen fauna, for instance, in British Columbia, associates genera of Ffestiniog, Dolgelly and Arenig types, and generally in the Rocky Mountain region there is a blending of Cambrian and Ordovician types. For these reasons it seems undesirable to abandon the old classification which drew the

* Mem. Geol. Surv. G. B., vol. iii, p. 365, etc.

† Ibid. p. 353.

dividing line at the base of the Arenig, and made the appearance of the Arenig graptolites the starting point of a new system.

The beds from which this fauna was taken appear in outcrops along the left bank of McLeod Brook, in Boisdale, Cape Breton, N. S., the best locality being about an eighth of a mile below the bridge that crosses that stream in McMullin Settlement. The rock is a soft, fine-grained, dark gray shale, not very different in appearance from that which, on the opposite side of the valley of McLeod Brook, carries the Dictyonema fauna. The rock easily softens when exposed to the weather, but is compact and firm lower down. No reference is given to "locality" in the following descriptions, as all come from McLeod Brook. The classes represented here are Brachiopoda, Lamellibranchiata, Gasteropoda, Vermes and Crustacea.

ACROTRETA SIPO. n. sp. Pl. XVIII, figs. 1 and 2.

A small species with somewhat overhanging umbo.

Ventral valves nearly as high as long. Umbo projecting behind the cardinal line, somewhat bluntly pointed, (some valves are trumpet shaped toward the margin) and a little broader than long. *Interior.* The foramen passes outward through a short siphon which is attached to the dorsal side of the valve; on each side of it are traces of lateral septa; in front of it is the faint impression of a callus which extends one-third of the distance to the anterior margin.

The *dorsal valve* is transversely oval, and arched from hinge to front, more strongly near the hinge; the lateral edges are flattened, especially toward the hinge. *Interior*—This shows traces of scars of lateral (?) muscles on each side of the umbo, and of a pair of central muscles near the middle of the valve. A distinct, though low, median septum crosses the valve nearly to the front margin.

Sculpture.—No concentric striæ were observed on this species, but the surface of the valves is minutely granulated.

Size.—The largest ventral observed had a size at the orifice of 3 x 3 mm., and others a height of $2\frac{1}{2}$ mm. A dorsal was $2\frac{3}{4}$ x $3\frac{1}{2}$ mm.; height $\frac{3}{4}$ of a mm.

The siphon is seldom preserved.

Three quarters of the ventral valves collected stand vertically in the mud in which they were entombed.

This curious little shell seems to throw light on the function of the callus in Acrothyra and Acrotreta. In ordinary species of Acrotreta the strong thickened ring around the foramen, within the shell, only needs to be raised still further to produce a siphon. And the siphon in this species, attached as it is to the dorsal side, holds the position of the callus in Acrothyra.

This must be near in age to *Acrotreta gemma* of Billing's, than which it is a little larger, but as we do not know anything of the interior of Billing's species (which belongs to the Arenig horizon) we do not use his name.

LEPTOBOLUS cf. LINGULOIDES.

A small linguloid shell is not rare in this shale. As in others of this genus, the umbo of the ventral is weak and short, and so the two valves are not easily distinguishable. Owing to the thinness of the valves the internal features are only faintly indicated. The ventral shows two lateral ridges diverging from the umbo, and a callus is obscurely indicated; one example shows a trace of a vascular trunk on one side. The dorsal has an obscure medium septum extending to the middle of the valve.

Sculpture.—A very fine concentric striation is visible on some valves.

Size.—Usual length, 3 mm.; (largest, $3\frac{1}{2}$ mm.); width, $2\frac{1}{4}$ mm.; (largest, $2\frac{3}{4}$ mm.)

This species is nearly as large as *Lingulella linguloides* of the Lower Paradoxides beds near St. John, a species which we would also refer to Leptobolus. The outline also is similar, but the umbo of the ventral is weaker; this and the smaller size may be due to a more pelagic habitat.

LINGULELLA cf. DAVISII, McCoy.

Examples of a Linguella, which though smaller than the above species of the Lingula Flags and Tremadoc slates of Britain, has the same general form, are found in the Cape Breton beds. It has the nearly straight base and sub-parallel sides of McCoy's species. The dorsal valve has on the interior a median septum two-fifths of its length, and the whole interior, especially towards the umbo, is marked with scattered pits.

Sculpture.—Externally this shell has fine concentric ridges, which are crossed by very fine radiating striæ. The middle third is marked by numerous fine radiating vascular lines, and the lateral borders are flattened at the sides.

Size.—Length $10\frac{1}{2}$ mm.; width 9 mm. Infrequent.

Lingulella cf. lepis.

Another Lingulella, a smaller species, occurs with preceding. It has a similar but proportionately coarser concentric striation; between the ridges it is marked with a fine granulation; the outline is more regularly rounded than that of the preceding species. It appears to agree with Salter's species as regards the form and striation, though it is smaller, being only half the length. The interior markings are not known.

Size.—Length, 6 mm.; width, 5 mm.

Modiolopsis (?) cf. Solvensis, Hicks.

Long-ovate, elevated toward the umbo and carrying its fullness towards the lower posterior end of the valves.

The umbo is near the anterior end, and there is a small, transversely elongated scar just in front of it.

Sculpture.—The bad condition of the surface leaves this doubtful for most of the surface, but there are faint concentric striations toward the lower margin and the posterior end. Only two examples known.

Size.—Length $4\frac{1}{4}$ mm.; width $2\frac{1}{2}$ mm.

This species resembles that above cited, but lacks the strong ridge extending backward from the umbo. It is also only half of its length.

Bellerophon insulæ, n. sp. Pl. XVIII, fig. 3.

A small thin species, having about three whorls, of which outer is enlarged and more than twice the height of the others; it is emarginate on the ventral side, and shows no keel ; it has from two to three concentric growth ridges in the outer half of the last whorl.

Sculpture.—The outer whorl shows a very fine concentric striation, visible only with a strong lens.

Size.—Height across the whorls, 7 mm.; width across the shell from the emargination of the aperture at the ventral side, to the dorsum opposite, 4 mm.; width across the aperture from ventral to dorsal, 4½ mm.

Dr. Henry Hicks' species (*B. Ramsayensis*), which is about the size of this one, may be con-specific with it, but the Welsh specimens are too much distorted to be used for satisfactory comparison, and his description is brief.*

Prof. W. C. Brœgger figures a species (*Bellerophon Norvegicus*), from a corresponding horizon in Norway.† It is a little smaller, the outer whorl expands more rapidly and is free for half of its length ; it is not deeply notched like our species ; though differing in these respects, it has a striation similar to the Canadian species, only in place of being sharply curved back at the dorsum, the striæ curve forward in crossing that line.

BELLEROPHON BRETONENSIS, n. sp. Pl. XVIII, 4*a–d*.

Shell of about two or more whorls, the outer whorl large and moderately expanded. Orifice somewhat enlarged and strongly emarginate on the dorsal side by a sharp V-shaped sinus. Sides of the opening strongly arched upward between the dorsal and ventral sides. No distinct keel.

Sculpture.— The surface is diversified with numerous rounded ridges concentric to the umbo, with flat spaces between ; there is a sharp, narrow furrow along the crest of each ridge ; the ridges near the orifice are sharper and more crowded than farther back on the whorl ; here there are about three in the space of 2 mm., but towards the mouth about four. The fine sculpturing of the surface appears to be a minute granulation.

Size.—Length from the inner part of the last whorl to the lateral edge of the lip, 20 mm. Width across the shell from the dorsum to the inner part of the last whorl, 12 mm.

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* Quart. Jour. Geol. Soc., London, vol. xxix, No. 113, p. 50, pl. iii, figs. 30-32.

† Memoir cited, p. 53, pl. x, figs. 15, 15*a*, 15*b*.

The characters of this shell are obscured by flattening in the shale The umbo appears to be excentric, and it resembles *B. Œlerti*, Bergeron, of the Lower Ordovician of the Montaigne Noir in Southern France,* but has fewer whorls. Similarly to that species, the ridges on the shell are more distant from each other on the upper part of the main whorl than towards the aperture. I could not detect any flattened ridge along the keel of the dorsum.

This shell is distinct from *B. arfonensis* Salter by the sharp angulation at the dorsal line, and the striæ that cross it are angulated, not arched.

BELLEROPHON SEMISCULPTUS, n. sp. Pl. XVIII, figs. 5.

Only the last whorl known. This is free from the inner part of the coil. The proximal part is smooth with faint concentric undulations of growth.

The lines of growth arch backward toward both ventral and dorsal side, and at the dorsum there is an elevated flattened keel, separated from the lateral slopes by a slight furrow ; the striæ that run backwards to this keel traverse it at right angles.

Sculpture.—The outer two-thirds of the whorl is marked by sharp-edged, concentric ridges of growth ; at first there are about four in the space of a millimetre, then they become more distant with flattened spaces between, and toward the orifice of the shell there are about two ridges in the same space. Between the ridges, and on the smooth part of the whorl, the surface of the shell is minutely granulated.

Size.—Only one example is known, which is 7 mm. across from the back of the whorl to the mouth, and 6 mm. across from the ventral side of the mouth to the dorsal keel.

This species resembles *B. hippopus*, Salter, of the Arenig horizon in Wales. It differs in its smaller size and in the very regular ridges of growth ; there being no alternation of weak and strong ridges. From *B. arfonensis*, of the same author, it differs in the raised keel in place of a depressed band along the dorsum.

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*Etude geologique du Massif Ancien situe au sud du Plateau Central, J. Bergeron, Paris, 1889, p. 343, pl. iv, figs. 10 and 11.

UROTHECA, sp., Pl. XVIII. fig. 6.

A thin chitinous tube seemingly of this genus occurs sparingly. It is thickened along one side and is marked by very minute longitudinal striæ.

PARABOLINELLA QUADRATA, n. sp. Pl. XVIII, fig. 7.

Middle piece of the head shield subtrapezoidal in outline. Anterior marginal fold narrow; width of the front area of the cheek, one-fourth of the length of the glabella. Glabella quadrate in front, and as wide there as its length, but considerably narrower at the posterior furrow. Posterior and second furrow directed backward, and deeply impressed in the outer third, but not reaching the margin of the glabella. Eyelobe slightly elevated, extending opposite the two anterior furrows of the glabella; ocular fillet broad and indistinct. Fixed cheek triangular, about as wide behind as the length of the dorsal suture behind the eyelobe. The posterior marginal furrow is faintly marked. The dorsal suture arches outward in front of the eyelobe, and behind it goes direct backward and outward to the posterior margin, and in that part is nearly half as long again as the chord of the eyelobe and anterior part of the suture together.

The pleuræ are long and narrow, and have a sharp, deep furrow, which is nearest the posterior margin; they are sharply bent, and pointed at the ends. The ring is pushed up in the middle into a pseudo-tubercle, such as is common on the occipital ring of species of this genus.

Sculpture.—A row of faintly marked tubercle-like swellings are found along the bottom of the anterior marginal furrow. The middle piece of the head-shield in all its parts appears smooth, except for a minute punctation.

Size.—Middle piece of the head-shield 25 mm. long. It is 25 mm wide at the anterior and about 40 at the posterior end.

This species is near *Parabolinella limitis* of Brœgger. It differs in its longer and more quadrate glabella. The fixed cheek also is longer and the eyelobe less prominent. Apparently also it is a larger species.

From *P. rugosa* of the same author it is distinguished by its more quadrate glabella and by a different arrangement of the glabellar furrows. It resembles this species in the possession of a comparatively wide area in front of the glabella. The glabella, so wide in front (one-seventh wider than at the posterior lobe), recalls that of *Ceratopyge forficula*, Sars., of a similar horizon in Sweden.*

PARABOLINELLA cf. LIMITIS, Brœg.

The middle piece of the head-shield of a young individual which, by its form, agrees with the figures of this species, given by Professor Brœgger,† was found in these beds. Only one example was met with. The size of the shield is $2\frac{1}{2} \times 4+$ mm. The interior of the shield shows three pairs of furrows, a strong ocular fillet, and a well-marked eyelobe.

TRIARTHRUS BELLI, n. sp. Pl. XVIII, fig. 8.

Only the middle piece of the head-shield is known; this is subquadrate, with narrow cheeks and anterior margin.

There are traces of a very narrow anterior marginal fold, and behind it a narrow convex anterior area of the cheeks. The *glabella* is quadrate, rounded in front, and bears three pairs of furrows, which are progressively less bent backward from the back to the front pair, though the two posterior pairs are already parallel; the anterior pair are quite faint, and more strongly arched than the others. The glabella is somewhat keeled along the axial line. The *fixed cheek* is long and quite narrow, and is separated from the front area by a shallow furrow; at the eyelobe it is about one-third of the width of the glabella, and at the back about one-half. The eyelobe is long, narrow and obscure. The posterior marginal fold is narrow but prominent. The occipital ring is bent forward at the ends, and has a tubercle on the axial line.

Sculpture.—This species has a smooth test, but under a small lens shows a somewhat uneven surface.

Size.—Only one example known; in this the middle piece of the head is 6 mm. long and 10 mm. wide at the back. Scarce.

This species is clearly distinct from *T. Beckii* Green by its narrower cheek and wider space between the sutures in front. It resembles more closely *T. Angelini* Linrs, but it differs from the type of that

* Die Silurischen Etagen, 2 und 3, p. 14, tab. iii, fig. 3.

† Die Silur. Etag. 2 und 3, p. 102, tab. iii, figs. 2 and 4.

species as figured by Linnarrsson in the wider frontal area of the cheeks and its convex front margin; also in possessing three pairs of furrows, etc. From the Norwegian form, referred to this species by Brœgger, it differs in its narrower glabella, rounded front, and in having three pairs of furrows, though the third one is faint; the anterior area of the fixed cheek is wider, and is separated from the rest of that cheek by a shallow furrow; it is, however, nearer this form than to any other known to me.

Billings does not describe *T. Fischeri*, except by contrast with other species (Upper Ordovician chiefly), but from his figure of that species, the Cape Breton form differs in the posterior marginal fold, which is not turned forward, like *T. Fischeri*. It also differs from that species in having an anterior buccal area and in the absence of pits on the front of the glabella.*

I refer this species to Triarthrus rather than Parabolinella because of the narrow fixed cheeks, the long, backward-turned eyelobes and the regular, straight furrows on the glabella.

Angelina ? sp. ? Pl. XVIII, fig. 9.

While we have no adult of this genus from the Tremadoc of Cape Breton, there is a young larval shield which seems to agree reasonably well with the characters of this genus by its suture and general outline. Only the head-shield has been preserved. This is narrow, as are all its parts. The eyelobes are curved and linear, starting from near the front of the glabella in a heavy ocular fillet, the eyelobes are placed about the middle of the cheek. The movable cheeks have extended spines, and are cut off in front by the curving suture. The glabella is ridged along the middle, and has traces of three pairs of faintly marked furrows. The occipital ring is narrow and weak.

Sculpture.—The surface appears smooth.

Size.—Length of this larval headshield, 5 mm. (or to the end of the spines 8 mm.); width, 7 mm.

Asaphellus Homfrayi, var. Pl. XVIII, figs. 10*a–e*.

Salter's description of this species is as follows:

"Asaphus (Isotelus) long-oval, gently convex, having the head subangulate in front, and having short [genal] spines. Facial suture

* Palæoz. Fossils, vol. i, p. 291, fig. 280.

within the margin. Eyes submedian [near the mid-length of the shield], small. Pygidial axis long, somewhat prominent at the apex. It is three inches long and one and a half broad."

The addition to this description in Salter's trilobites is as follows:

"The head is more than a third of the whole length, and longer than the thorax, which in its turn, is *longer** than the caudal shield. The head is semi-oval, rather pointed in front, and has *very short* posterior spines; it is broadly depressed around the margin. The glabella portion is scarcely marked out; the eyes are placed nearly half-way up the head; they are small (two lines long), the facial sutures curving out boldly beneath them, and cutting the posterior margin more than half way out from the axis.

Above the eye they form a narrow ogive, and nearly follow the front margin. On the underside of the head the vertical furrow on the epistome shows distinctly through the cast. The labrum [hypostome] is imperfect, but exhibits a strong marginal groove, and two small lateral furrows.

The body rings have the axis as broad as the sides, and moderately convex. The pleuræ are flat as far as the fulcrum, truncate at their ends, and have but a slight groove, which reaches two-thirds of the length. The fulcrum is at one-third in front, and less than half way out in the middle pleuræ.

The caudal axis extends three-fourths down the smooth tail, very indistinctly marked above, but in some specimens crossed by several faint rings, and is always prominent at the tip."

The Cape Breton form, by its hypostome, is clearly within Callaway's genus Asaphellus. Allowing for the distortion of the type species, figured by Salter, it is quite as large.

Certain features, not mentioned by Salter, are characteristic of the Cape Breton form. The glabella is somewhat ridged along the axial line, and its margins more distinct. About one-fifth of the length of the head shield from the back there is a slight but distant prominence (scarcely a tubercle) on the axial line; a fairly marked tubercle is also found on the median line of the axis of the pygidium, at the back of the first ring, and faint traces of similar prominences on succeeding rings.

* The italics are inserted to mark points of difference from the Canadian variety.

The genal spines are not as short as Salter's description indicates, for the points are opposite the fourth segment of the throax; the length of the movable cheek and spine, behind the facial suture, is just equal in length to the part of the latter behind the eyelobe.

The eyelobes are variable in position; in the type figured they are just half way between the front and back of the shield; in examples of the narrow form they are, proportionately, further back; and in both forms the width of the middle piece in front is considerably less than at the eyelobes.

In the broad form, the headshield, thorax and pygidium are each of about equal length; others have the pygidium shorter than the thorax by the width of one joint. In the narrow form examples occur in which the pygidium is longer than the thorax. The pygidium has more numerous somites than *A. Homfrayi* as figured by Salter.* From *A. affinis* McCoy (Ibid) it differs in having the middle piece narrower in front, and the glabella and axis of the pygidium more markedly elevated.

Young individuals have the pygidium proportionately shorter and wider; one of about 15 mm. in length has a pygidium equal in length to only six rings of the thorax. The thoracic ring is narrow, for one is equal in length to the breadth five rings.

Hypostome.

This for *A. Homfrayi* seems very imperfectly known. A good example of the Cape Breton variety has the following characters:

Hypostome 16 x 17 mm. main lobe 11 x 11. No anterior wing or doubleur attachment was observed.

Nearly circular, though wider towards the back than the front. It has a moderately arched oval body, with a broad convex border, wider towards the back. The main body of the hypostome is divided by a pair of diagonal furrows that impress each outward third about two-thirds from the front. Immediately behind these furrows are the maculæ, sharp, narrow ridges, raised above the general level of the hypostome; no ocular facets are visible, but there are several small, obscure pits along the ridge. The macula of the hypostome is opposite the eyelobe of the cephalic shield, but is nearer the axial line of the body. The furrow within the border is depressed at the back and

* Monograph British Trilobites, p. 165, pl. 24, figs. 6-12.

bordered by a narrow upturned flange, but there is no emargination, nor does the border project backward in a fork. The hypostome is highest in the middle of the main lobe, and the convex border is bent down in the middle, where it is broadest.

Development.—Young, $2 \times 1\frac{1}{2}$ mm.

This form is interesting as a connecting link between several genera of the Asaphidæ. It may be said to antedate the development of the generic characters.

At this stage the carapace had no flattened borders, and the head shield especially was strongly bent down in front and at the sides. The back of the glabella is very distinctly marked out, and here the head-shield is strongly trilobed. About the middle, on the inside of the shield, a flaring ridge runs out on each side from the glabella, and fades away on the surface of the test, that appears to be the back part of the eyelobe. At this stage no movable cheek had been detached, but the genal corner of the shield is somewhat extended into a short point. There are indications of several somites in the head shield; first the neck ring and posterior marginal fold, then a pair of somites indicated by incipient furrows on the sides of the glabella, then the ocular segment.

The thorax, at this stage, possessed two joints, with rounded rings and pleuræ.

In the pygidium, the neopygidium and protopygidium* are distinct; the former has three rings as strongly marked off as those of the thorax, the protopygidium has the same number of obscure somites.

In this larval form, which in development is close to the unsegmented larva, the outline of the headshield distinctly recalls the adult in Illænus and Dysplanus, but the strongly segmented pygidium has an even more generalized meaning.

Young 6 x 5 mm.

This moult already possesses many features of the adult.

The flattened borders are obvious on both shells, and the head-shield is broken up into the three principal pieces. The movable cheeks have heavy genal spines, and the course of the suture is functionally that of the adult. The slipping of the cheeks in this example has obscured the eyelobe, which, however, appears to be not far from

* Trans. Roy. Soc. Can. 2nd Ser., vol. iv, sec. iv, p. 145., lines 24, 27.

the glabella. The glabella, though slightly marked elsewhere, is marked off in front by a slope to the flattened margin.

The thorax now has five joints, and the pleuræ has grooves and facets like the adult.

The pygidium has about the same number of segment as in the younger shield, but those of the neopygidium are less prominent than in the younger moult; they are, however, still discernable on the side-lobes, as well as on the rachis. In this, while not agreeing with the genus Asaphellus, they recall many others of the Asaphidæ.

Note on the Young of Asaphellus Homfrayi.

Since writing the above in regard to the young of *Asaphellus Homfrayi* the writer has consulted Dr. Callaway's article on the fauna of the Shinton Shales,* and was at once struck with the resemblance between the youngest form here described, and *Conophrys Salopiensis*, and it is clear that the latter is a later stage or development of the former.

There is no question that in the Canadian form three rings, of the five that are strongly marked, are still a part of the pygidium; but if they were *free* rings there would be a remarkably close assimilation to Conophrys, the difference being only in the greater number of rings in the thorax of this genius. Looked upon as a developmental stage of Asaphellus this difference is to be expected, as our form is smaller than *Conophrys Salopiensis.*

The differences in the headshield are also of a kind that naturally follow from the two being different stages of development. Dr. Callaway shows the front lobe of the glabella as much more distinct than that of the Canadian form, though he speaks of it as being "hardly distinguishable from the front of the head;" in the Canadian form this lobe is barely discernable, except at the sides of the glabella. Again he speaks of the neck furrow being "deep," whereas in the Canadian form it cannot be discerned, and the lateral furrows are fainter and more embryo-like. *Conophrys Salopiensis* therefore may very well stand as a developmental stage of *A. Homfrayi*, somewhat more advanced than the youngest form ascribed to this species from the

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*Quart. Jour. Geol. Soc. London, vol. xxxiii, p. 652.

Canadian beds. The development of one genus from another in the earliest larval stages is shown in the observations on the development of *Anomocare stenotoides* from an Olenus-like (Acantholenus) larva.*

On the other hand, those studies show that Conophrys or rather Shumardia may be a valid genus, arrested in the phylum from which Asaphellus and Asaphus were elaborated; if so, however, we should be able to find it in faunas from which these genera are absent. Nevertheless it is quite possible that it might be absent from faunas which have the later Asaphi, if the Shumardia stage were passed over in the development of the later forms of this family. Such a case of arrested development, and fixation of larval as specific characters, seems to be presented to us in the species *Bathyuriscus pupa* of the Mt. Stephen fauna,† as well as in *Acantholenus spiniger*.

That the form which we have described as an early moult of *Asaphellus Homfrayi* is Asaphoid, though so far removed from the adult in form, I think is shown by its peculiar glabella, fading away at the front into the frontal area of the cheeks, so that the line of demarkation between the two is not clearly traceable, a very common character in the Asaphoid trilobites. In this form it appears to the writer that the faint cresentic lobe in the front of the glabella is homologous with the front lobe of the glabella and the eyelobes collectively, and that the flaring anterior ends of the dorsal furrows represent the posterior half of the eyelobes. The obscurity of the occipital furrow is also an Asaphoid character.

If Conophrys is a valid genus Mr. E. Billings' genus Shumardia has precedence of it by five years. *S. granulosa* (Billings) of the Quebec group is evidently a diminutive trilobite of the same type and from near the same horizon.‡ *S. glacialis*, of the same author, probably belongs to another genus.†

The late Dr. Henry Hicks, described from the Tremadoc group in South Wales, two species of "Niobe," which Prof. W. C. Brøgger refers to Asaphellus§; one of these, *N. Menapiensis*, is too large to compare with the Cape Breton species; the other, *N. Solvensis*, differs in the form of the movable cheek, and of the hypostome.

* Bull. Nat. Hist. Soc. N B. St. John, 1898, No. xvi, p. 40.

† Trans. Roy. Soc. Can. 2nd Ser., vol. v, sec. iv, p. 51, pl. ii, fig. 5.

‡ Palæozoic Roy. Soc. Can. 2nd Ser., vol. v., sec. iv, p 51, pl. ii, fig. 5.

§ Euloma Niobe Fauna, Christiania, '96, 47. p.

Asaphellus (?) planus, n. sp. Pl. XVIII, fig. 11.

A broad oval species with smooth shield and prominent eyelobes.

The head shield is semicirclar, with strong cheek spines. It is about twice as wide as long, and has a broad flat margin.

The middle piece of the head shield is narrowed in the middle by the eyelobes being placed close to the side of the glabella.

The facial sutures are strongly arched out in front of the eyelobe and turning meet along the front margin; the front area of the cheek thus left, is wider than the middle piece at the eyelobe, and three-fifths of the width at the back of the middle piece. The suture curves out boldly behind the eyes, turning inward again near the posterior margin, which it cuts about a third of the distance from the outer margin of the head shield.

The glabella is level with the cheeks, except at the front, where it slopes down to the flattened anterior margin. The eyelobes are strongly elevated, short, and placed about half way from the front of the shield. There is a minute tubercle on the axial line one-quarter from the back of the head. The posterior marginal furrow is short and shallow, and the occipital ring narrow and obscure.

The movable cheek behind the eyelobe is nearly as wide as the glabella; the front runs beneath the front margin of the middle piece in a wide semi-doubleur what extends to the axial line. Posteriorly, it is lengthened into a genal spine, which, from the facial suture to the point, is as long as the posterior extension of the suture.

The movable cheek, under the eyelobe, carries a convex band of several rows of minute ocular facets arranged diagonally; those in front of the middle of the band run diagonally upward and forward, those behind the middle run diagonally upward and backward.

The thorax of eight joints has long, narrow segments, terminating in rounded points, strongly facetted; the ring of the middle segment is about as long as the pleuræ; the pleuræ are bent (but scarcely geniculate) at one-half of the length of the first segment; they bear a quite shallow furrow directed backward; each ring of the thorax has a narrow articulating band.

A thorax and pygidium of smaller size, supposed to belong to this species, has the following characters: The pygidium is broadly semicircular and no axis is visible; a slight broad protuberance one-third from the posterior end indicates the termination of the rachis; the sides lobes are sloped down to a somewhat flattened margin. On each side lobe there is a shallow groove near the front.

The hypostome in this species is unknown, therefore the reference to Asaphellus is provisional.

Sculpture.—The surface of the shell of this trilobite is smooth or minutely punctate. The underside of the movable cheek has a rugulose surface on the upper part, and a finely concentrically striated band on the slope outside of this; the flattened band is covered with widely spaced anastomosing raised lines, parallel to the margin of the shield.

The composition of the test in this species is different from that of *A. Homfrayi* which has a shining and polished surface as preserved in the shale; this, on the contrary, had a dull surface, and appears to be more calcareous, as there is little but a film of the shell substance left, where the containing shale has been exposed to weathering.

Size.— Length, about 70 mm.; width, about 55 mm.; length of head shield about 26 mm.; of the thorax, 20 mm.; of the pygidium, about 24 mm. The pleuræ are about 45 mm, long, and the pygidium of about the same width. Scarce.

A. (?) *planus* is distinguished from *A. Homfrayi*, var. by its broader glabella, more prominent and more distant eyes, broader and less pointed front to the middle piece of the head shield, more obscure neck furrow, narrower thoracic rings, and the smooth and obscure axis of the pygidium.

This form might be referred to Niobe, but for the obscurity of the glabella (and the almost entire absence of rachis to the pygidium, if we are right in referring the smooth pygidium to this head and thorax). This form cannot belong to *Platypeltis*, Cal., because it has eight segments, and no frontal enlargement of the glabella is traceable; on the contrary, the glabella is conically rounded, as in Asaphus.

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Issued, St. John, N. B., January, 1902.

Explanation of the Plates.

Plate XIII.

Fig. 1. *Acrothyra signata* mut. *prima* n. mut. $2\frac{1}{2}$ x $2\frac{1}{4}$ x $1\frac{1}{4}$ m. Mag. $\frac{8}{1}$; —*a* Ventral valve; —*b* Mould of interior of same; —*c* Ventral from the side; —*d* Another ventral with low umbo; —*e* Dorsal valve; —*f* Mould of the interior; —*g* Dorsal from the side. From Coldbrook Group at Dugald Brook, Escasonie, N. S. See p. 382.

Fig. 2. *Acrothyra signata* n. sp. 3 x 2 x 1 mm. Mag. $\frac{10}{1}$; —*a* Ventral valve; —*b* Mould of the interior; —*c* Ventral valve from the side; —*d* Dorsal valve; —*e* Mould of interior of same. From Assise E.1*b* (Lower Etcheminian), Dugald Brook, Escasonie. See p. 381.

Fig. 3. *A. signata* mut. *sera*, n. mut., $2\frac{1}{2}$ x $2\frac{1}{2}$ x $1\frac{1}{2}$. Mag. $\frac{10}{1}$; —*a* Ventral valve; —*b* Mould of interior of same; —*c* Ventral from the side; —*d* Dorsal valve; —*e* Mould of interior; —*f* Dorsal from the side. From Assise E.1*c* (Lower Etchemin.) at Dugald Brook, Escasonie, N. S. See p. 383.

Fig. 4. *A. signata*, mut. *orta*, n. mut., 2 x $1\frac{3}{4}$ x 1 mm. Mag. $\frac{10}{1}$; —*a* Ventral valve, mould of interior showing visceral callus; —*b* Another narrower, showing traces of extension of the callus; —*c* Ventral from the side; —*d* Dorsal valve; —*e* Mould of interior of the dorsal; —*f* Dorsal from the side. From Assise E.2*c* (Lower Etchemin.) at Dugald Brook, Escasonie, N. S. See p. 385.

Plate XIV.

Fig. 1. *Acrothyra signata* mut. *tarda*, n. mut., $2\frac{1}{2}$ x 3 x $1\frac{1}{2}$ mm. Mag. $\frac{10}{1}$; —*a* Ventral valve from above; —*b* Mould of interior of a ventral; —*c* Same seen from behind; —*d* Ventral valve from the side. From Assise E.1*d* (Lower Etchemin.) at Dugald Brook, Escasonie, N. S. See p. 384.

FIG. 2. *Acrothyra proavia*, 2 x $1\frac{1}{2}$ x $\frac{3}{4}$ mm. Mag. $\frac{10}{1}$; —*a* Ventral valve; —*b* Same from behind; —*c* Same from the side; —*d* Dorsal valve; —*e* Mould of the inside of this valve; —*f* Dorsal from the side; —*g* Outline of the two valves, from the side. From Assise E.3*c* (Upper Etchemin.) at Dugald Brook, Escasonie, N. S. See p. 386.

FIG. 3. *A. proavia*, large valves, 3 x $2\frac{3}{4}$ x $\frac{3}{4}$ mm. Mag. $\frac{10}{1}$; —*a* Ventral valve; —*b* Another ventral with corrugated front; —*c* Ventral from the side; —*d* Dorsal; —*e* Mould of interior of the dorsal; —*f* Dorsal valve in profile. From Assise E 3*e*, lower part, (Upper Etchemin.) at Dugald Brook, Escasonie, N. S. See p. 387.

FIG. 4. *A. proavia*, mut. *prima*, n. mut., 3 x 2 x $1\frac{1}{2}$ mm. Mag. $\frac{10}{1}$; —*a* Ventral valve; —*b* Mould of interior; —*c* Ventral, from the side; —*d* Dorsal valve; —*e* Mould of interior; —*f* Dorsal from the side. From Assise E.3*a* (Upper Etchemin.) at Dugald Brook, Escasonie, N. S. See p. 389.

FIG. 5. *A. proavia*, mut. *crassa*, n. mut., $2\frac{1}{2}$ x 2 x $1\frac{1}{2}$ mm. Mag. $\frac{10}{1}$; —*a* Ventral valve; —*b* Mould of same; —*c* Ventral from the side. From Assise E.3*e*, lower part, (Upper Etchemin.) Dugald Brook, Escasonie, N. S. See p. 389.

PLATE XV.

FIG. 1. *Acrotreta papillata*, n. sp., $2\frac{1}{2}$ x $2\frac{1}{2}$ x $1\frac{1}{4}$ mm. Mag. $\frac{10}{1}$; —*a* A narrow ventral valve; —*b* Same from the side; —*c* Mould of interior of a ventral valve; —*d* Dorsal valve; —*e* Same from the side; —*f* Mould of interior. From Assise E.1*d* (Lower Etchemin.) at Boundary Brook, Escasonie, N. S. See p. 390.

FIG. 2. *A. papillata*, mut. *prima*, 2 x $2\frac{1}{2}$ x $1\frac{1}{4}$ mm. Mag. $\frac{8}{1}$; —*a* Ventral valve; —*b* Same, side view; —*c* Mould of ventral. From the Coldbrook Group, Dugald Brook, Escasonie, N. S. See p. 391.

FIG. 3. *A. papillata* var. *lata*, n. var., 2 x $2\frac{1}{2}$ x $1\frac{1}{4}$ mm. Mag. $\frac{10}{1}$; —*a* Ventral mould of interior; —*b* Same from the side; —*c* Same from behind. From Assise E.1*d* (Lower Etchemin.) at Boundary Brook, Escasonie, N. S. See p. 391.

FIG. 4. *Acrotreta gemmula*, $1\frac{1}{2}$ x $1\frac{1}{2}$ x 1 mm. Mag. $\frac{10}{1}$; —*a* Ventral from behind ; —*b* Same from the side ; —*c* Ventral, mould of interior ; —*d* Dorsal, interior. From Protolenus Beds, Hanford Brook, N. B. See p. 395.

FIG. 5. *Acrotreta cf. socialis*, v. Seebach 3 x 3 x 2 mm. Mag. $\frac{6}{1}$ (except *e.* and *k.*) ; —*a* Ventral valve ; —*b* Same from the side ; —*c* Mould of interior ; —*d* Same from the side ; —*e* Apex of the mould, mag. $\frac{8}{1}$; —*f* Dorsal valve ; —*g* Same from the side ; —*h* Mould of interior ; —*i* Same from the side ; —*k* Enlargement of surface sculpturing, mag. $\frac{15}{1}$. From Lingulella radula Zone, (St. John Gr : C.2*c*), McNeill Brook, Mira, N. S. See p. 392.

PLATE XVI.

FIG. 1. *Acrotreta Baileyi*, $3\frac{1}{2}$ x 4 x 1 mm. Mag. $\frac{4}{1}$; —*a* Ventral, mould of interior ; —*b* Same from the side ; —*c* Dorsal, mould of interior ; —*d* Same from the side. (C.1*d*) Lower Paradoxides Beds, King's Co., N. B. See p. 395.

FIG. 2. *Acrotreta bisecta* 3 x $3\frac{1}{4}$ x $3\frac{1}{2}$ mm. Mag. $\frac{6}{1}$; —*a* Ventral valve ; —*b* Mould of interior from the side ; —*c* Same seen from above ; —*d* Dorsal valve ; —*e* Mould of interior from behind ; —*f* Same from the side ; —*g* Same from above. From the Dictyonema Beds, (C.3*c*) McLeod Brook, Boisdale, N. S. See p. 394.

FIG. 3. *Acrothele abavia* n. sp., $6\frac{1}{2}$ x $6\frac{1}{2}$ x $\frac{3}{4}$ mm. Mag. $\frac{4}{1}$; —*a* Ventral valve, interior, the umbo is filled with a plug of fine sand ; —*b* Same from the side ; —*c* Dorsal valve, interior, the shell is broken away at the umbo ; —*d* Same from the side. From Assise E.3*a* (Upper Etchemin.) at Dugald Brook, Escasonie, N. S. See p. 398, 402.

FIG. 4. *Acrothele abavia* n. sp., $5\frac{1}{2}$ x 6 x 1mm. Mag. $\frac{4}{1}$; —*a* Ventral valve, interior ; —*b* Dorsal valve, interior. From Assise E.3*b* (Upper Etchemin.) at Dugald Brook, Escasonie, N. S. See p. 398.

FIG. 5. *Acrothele avia*, mut. *puteis*, n. mut. 6 x 6½ x 1 mm. Mag. $\frac{4}{1}$; —*a* Ventral valve, mould of interior; —*b* Dorsal valve, interior. From Assise E.3*d* (Upper Etchemin.), Dugald Brook, Escasonie, N. S. See p. 398, 402.

FIG. 6. *Acrothele Matthewi* var. *costata*, 5 x 6 mm. Mag. $\frac{4}{1}$. From the Protolenus Beds, Hanford Brook, St. John Co., N. B. See p. 397.

FIG. 7. *Acrothele avia* — Enlarged sculpture. See Plate XVII.

PLATE XVII.

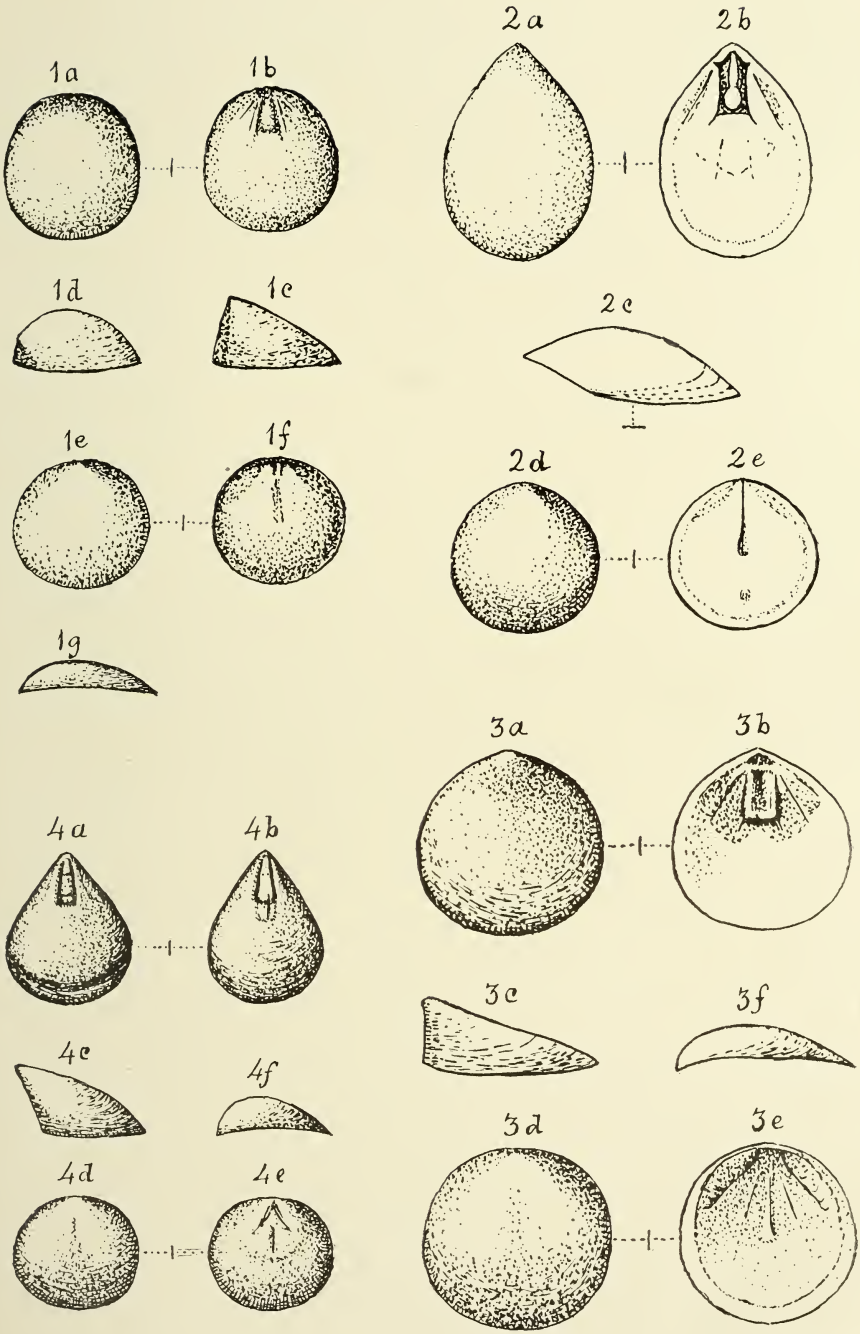
FIG. 1. *Acrothele avia* 9 x 10 x 1 mm. Mag. $\frac{6}{1}$ (except *c.* to *f.*); —*a* Ventral valve, central part; —*b* Same seen from the side; —*c* Ventral, interior of; —*d* Dorsal valve; —*e* Same in outline; —*f* Dorsal, interior—*c.* to *f.* mag. $\frac{3}{1}$. Fig. 7 of Plate XVI; —*a* Surface sculpture on lateral slope of ventral; —*b* Sculpture on middle part of ventral. Both mag. $\frac{10}{1}$. All from Assise E.3*e* (Upper Etchemin.) at Dugald Brook, Escasonie, N. S. See p. 396, 402.

FIG. 2. *Acrothele avia*, broad form, ventral, 7 x 9½ x 1 mm. Mag. $\frac{4}{1}$, Dorsal 5½ x 7 mm., mag. $\frac{5}{1}$; —*a* Ventral valve; —*b* Dorsal valve, mould of interior. From Assise E.3*d* (Upper Etchemin.) at Dougald Brook, Escasonie, N. S. See p. 397.

FIG. 3. *Acrothele proles* 8½ x 9 x 1 mm. Mag. $\frac{4}{1}$; —*a* Ventral valve; —*b* Interior of same; —*c* A smaller dorsal valve; —*d* Interior of same; —*e* Outline of the valves from the side. From Assise E.3*f* (Upper Etchemin.) at Gillis', Indian Brook, Escasonie, N. S. See p. 400, 402.

FIG. 4. *Acrothele Matthewi* mut. *prima*. Mag. $\frac{2}{1}$; —*a* Ventral valve, showing the umbo close to the posterior margin; —*b* Same in profile. From Protolenus Beds (C.1*b*), Hanford Brook, N. B. See p. 397, 402.

FIG. 5. *Acrothele Matthewi*. Mag. $\frac{2}{1}$; —*a* Dorsal valve, interior, showing median septem and its branches, and fine striæ on the valve radiating to the anterior and lateral margins; —*b* This valve in profile. From Lower Paradoxides Beds (C. 1*c*), Hanford Brook, N. B. See p. 397, 402.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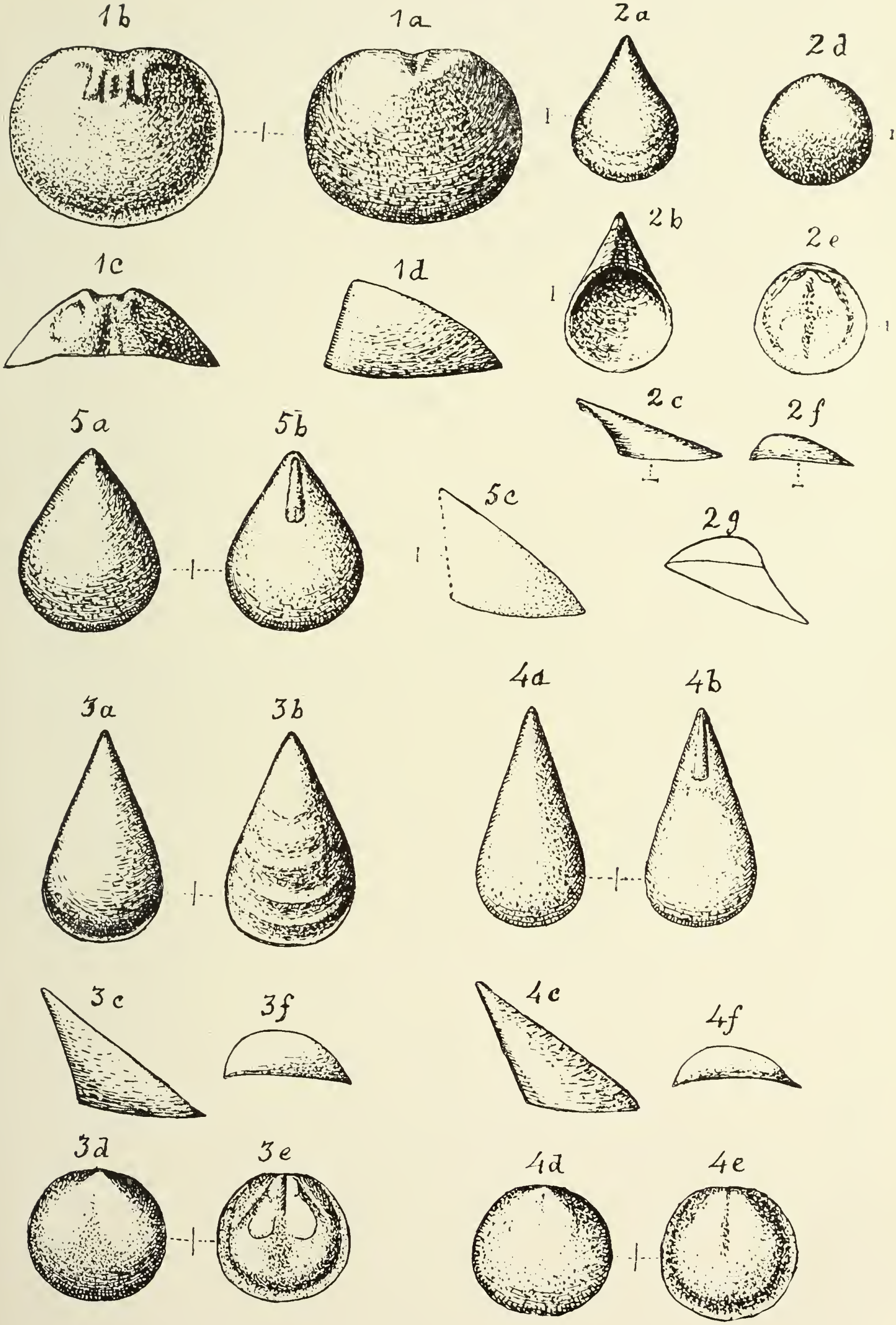
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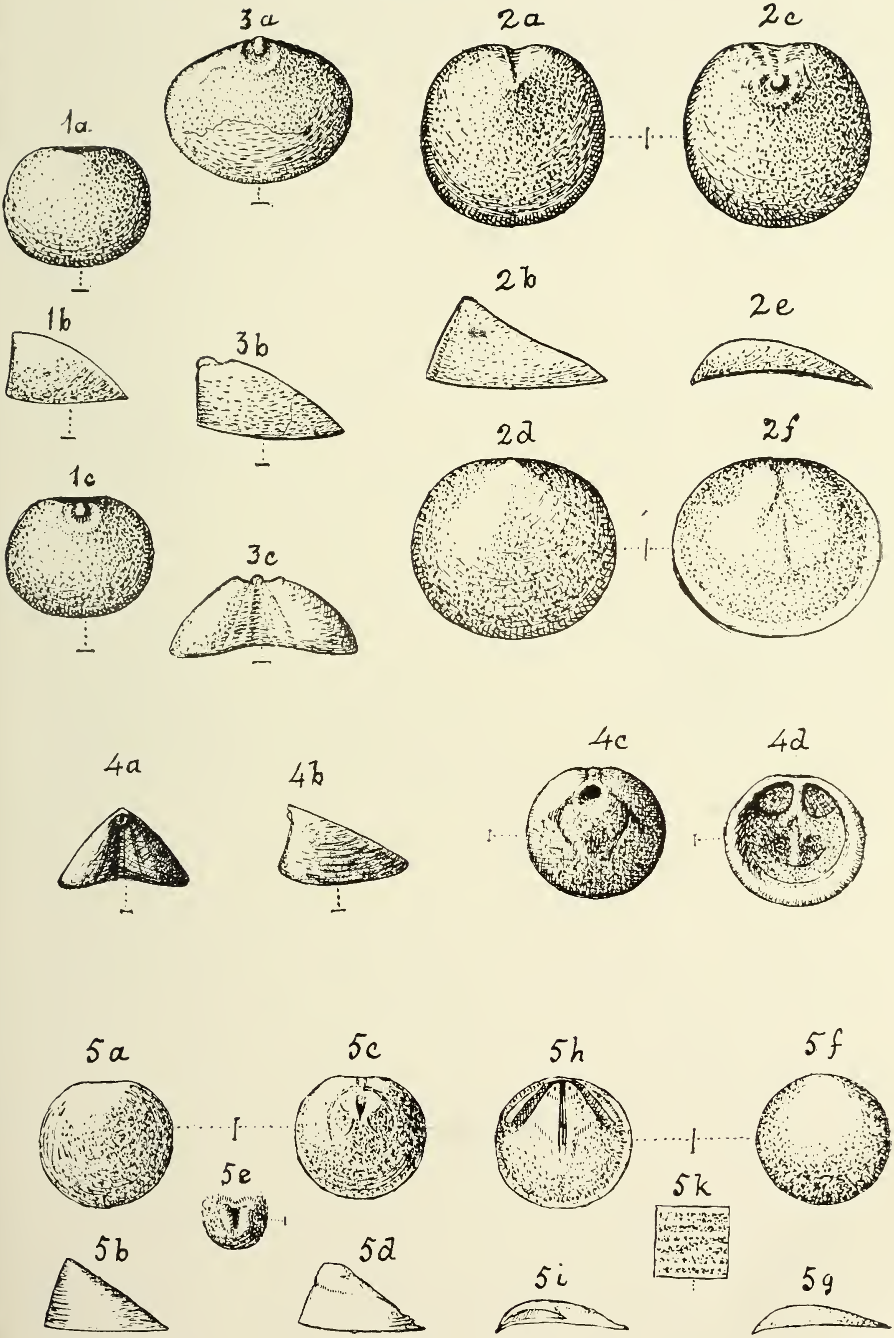
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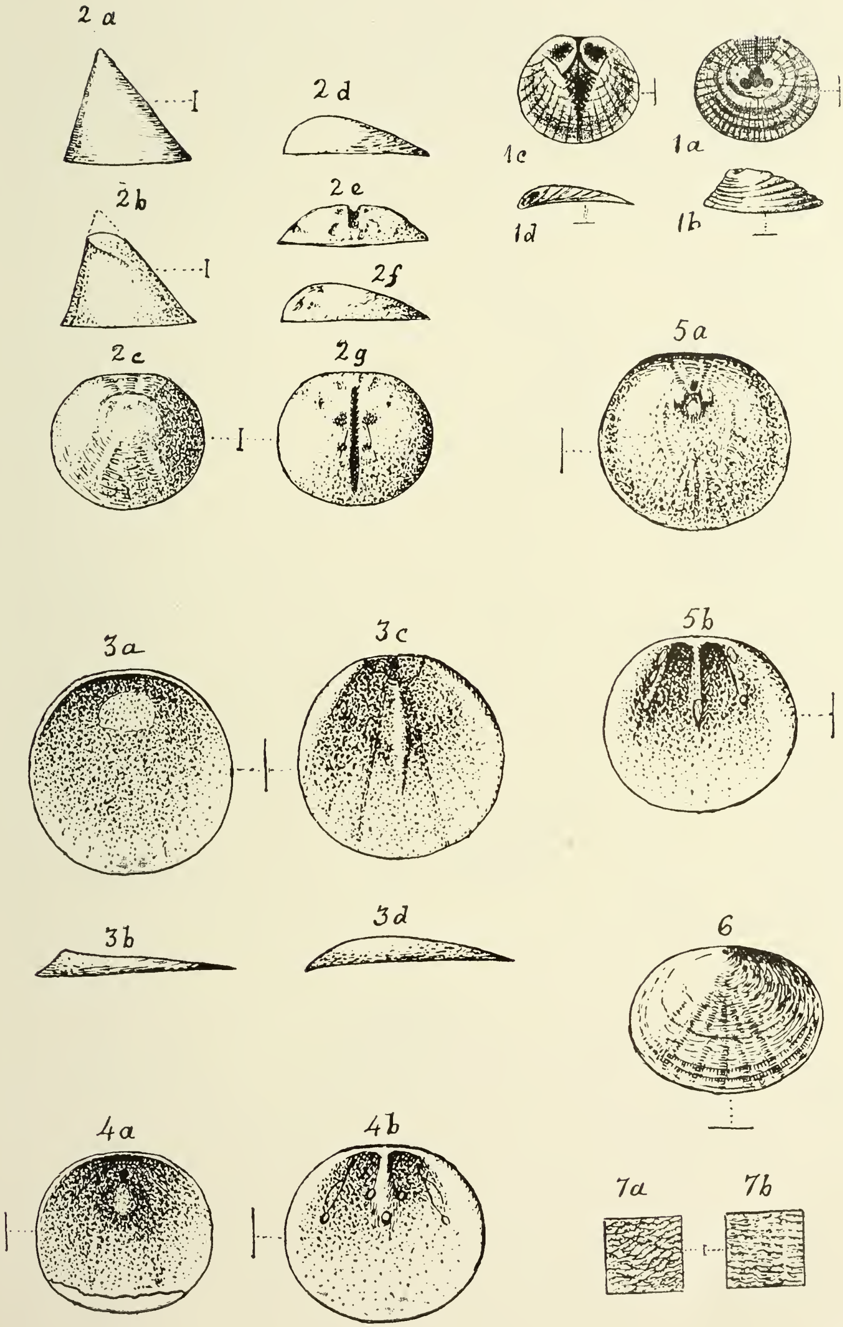
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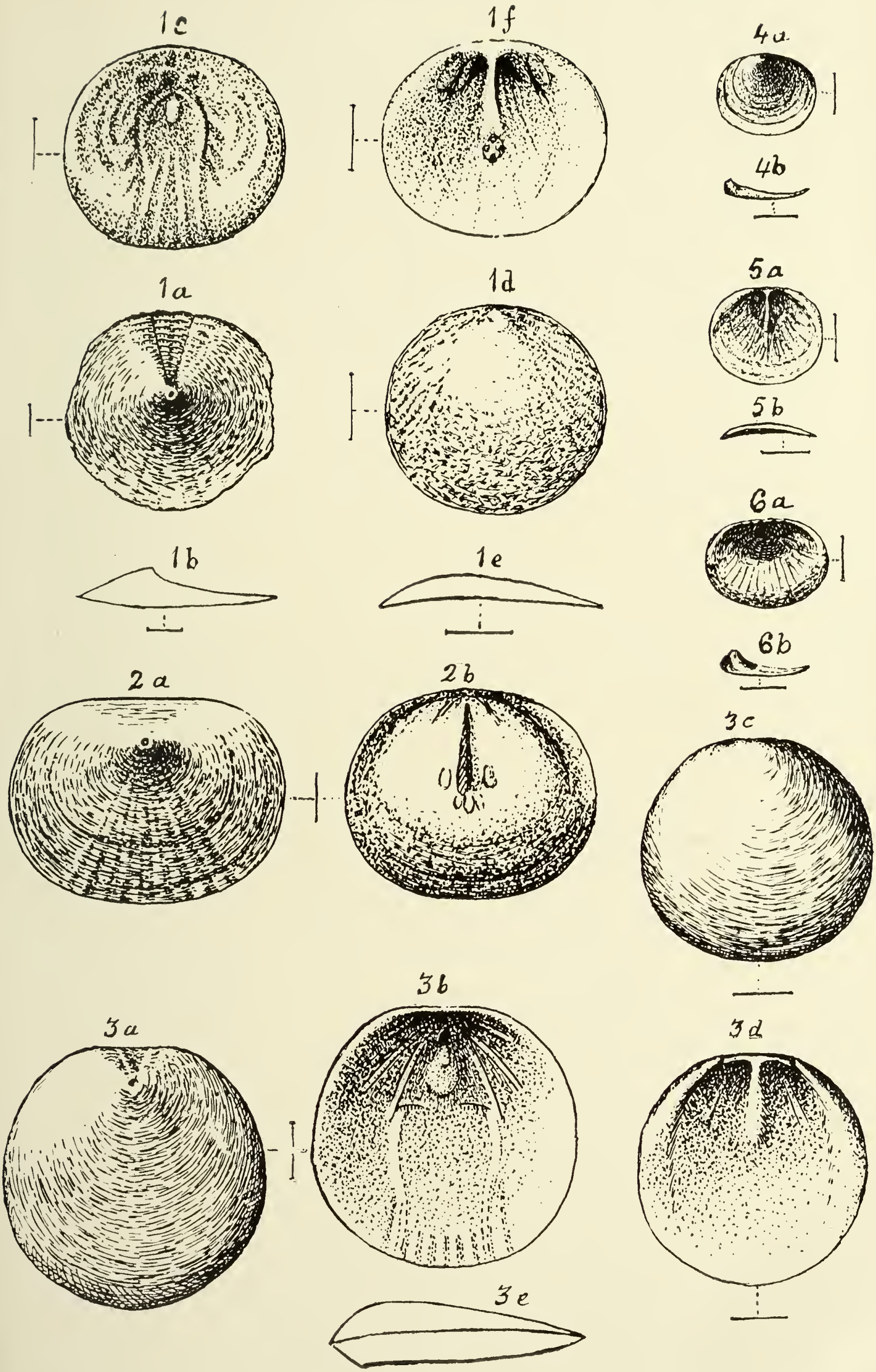
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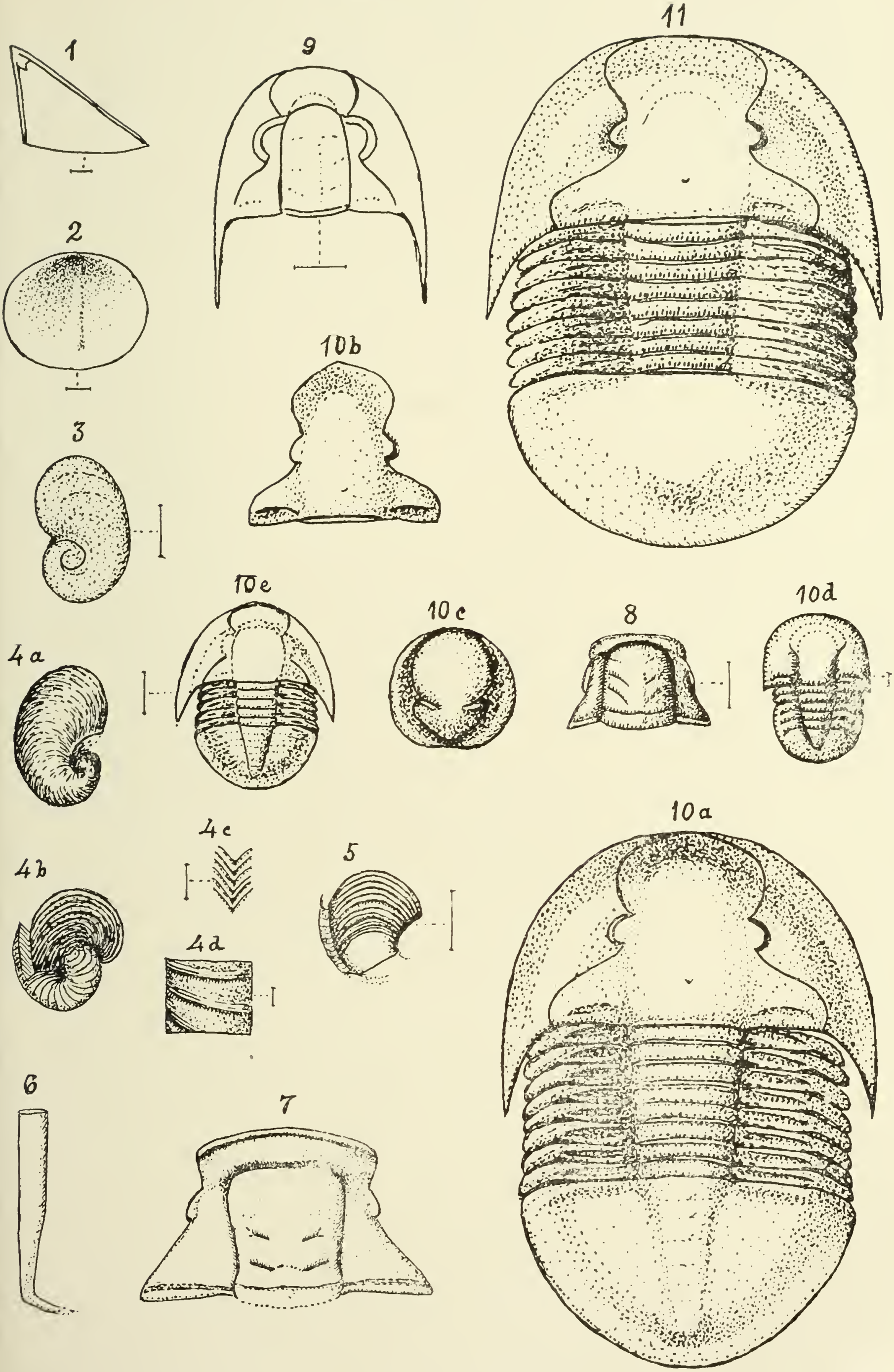
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FIG. 6. . *Acrothele Matthewi* mut. *lata.* Mag. $\frac{2}{1}$; —*a* Ventral valve, interior; has two pits in front of the foramen, diverging-arched ridges on each side of the foramen, and a low ridge on each side of the foramen extending to the hinge line; —*b* A dorsal in profile, showing the position of the hinge-line. From Protolenus Beds (C.1*b*), Hanford Brook, N. B. See p. 402.

PLATE XVIII.

FIG. 1. *Acrotreta sipo* n. sp.—Section of ventral valve. Mag. $\frac{6}{1}$. See p. 406.

FIG. 2. *Acrotreta sipo.*—Interior of dorsal valve. Mag. $\frac{6}{1}$. See p. 406.

FIG. 3. *Bellerophon insulæ* n. sp.—Sinistral side. Mag. $\frac{3}{1}$. See p. 408.

FIG. 4. *Bellerophon Bretonensis* n. sp.; —*a* Dextral side; —*b* Broken valve, showing interior, etc., both natural size; —*c* Dorsum, showing the angle of the growth lines. Mag. $\frac{2}{1}$; —*d* Part of surface of body whorl. Mag. $\frac{4}{1}$. See p. 409

FIG. 5. *Bellerophon semisculptus* n. p.—Showing the outer whorl. Mag. $\frac{2}{1}$. See p. 410.

FIG. 6. *Urotheca* sp.—Tube showing the larval part and the living chamber. See p. 411.

FIG. 7. *Parabolinella quadrata* n. sp.—Middle piece of the head-shield; Natural size. See p. 411.

FIG. 8. *Triarthus Belli* n. sp.—Middle piece of the headshield, left side and occipital ring restored. Mag. $\frac{2}{1}$. See p. 412.

FIG. 9. *Angelina* ? sp. ?—Larval cephalic shield. Mag. $\frac{4}{1}$. See p. 413.

FIG. 10. *Asaphellus Homfrayi*, Salter, var.; —*a* Adult, broad form partly restored; *b* Middle piece of the head shield of the narrow form;—*c* The hyposteme. All natural size; —*d* Early larval form, mag. $\frac{10}{1}$; —*e* A later larval form, mag. $\frac{4}{1}$. See p. 413.

FIG. 11. *Asaphellus* (?) *planus.* Adult. Natural size—the pygidium enlarged from another example supposed to be of this species. See p. 419.

ERRATA.

Page 319, line 21, after "Mr." insert, S. Ward.
" 380, " 10, before "New," insert (A)
" 381, in the table two heavy bars should be replaced by light ones.
" 387, line 8, for "in Assise *f*," read, on the highway at V. McPhee's, in Assise *e*?
" " " 15, for "genus," read, Acrotretinæ
" " " 18, for "the" read, one; and for "*f*" read *e*
" 391, " 23, after "VAR" insert LATA
" " " 34, for PAPELLATA, read PAPILLATA
" 393, " 33, after "size," insert, and as to its interior by its
" " " 35, for "It," read, its interior; and for "A.," read, that of A.
" 395, " 22, In the columns to the right of "A. sipo" insert 3, 3, 2½, 1.2.
" 397, last line, erase "larger"
" 398, lines 10 and 27, for "XV," read, XVI.
" 400, line 10, for "XVI," read, XVII.
" 401, 3rd line from the bottom, for "*Conocoryphe*" read *Ctenocephalus*.

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.

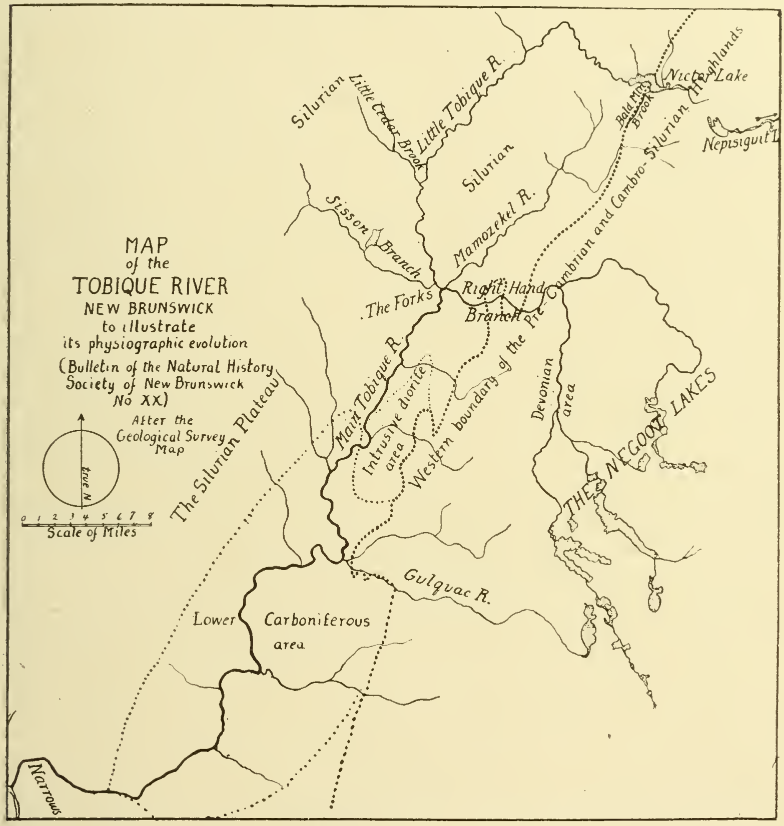
(Read February 5, 1901; re-written January, 1902.)

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.*

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*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

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* 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 1881, 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

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*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

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* 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.

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* 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 north-east 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

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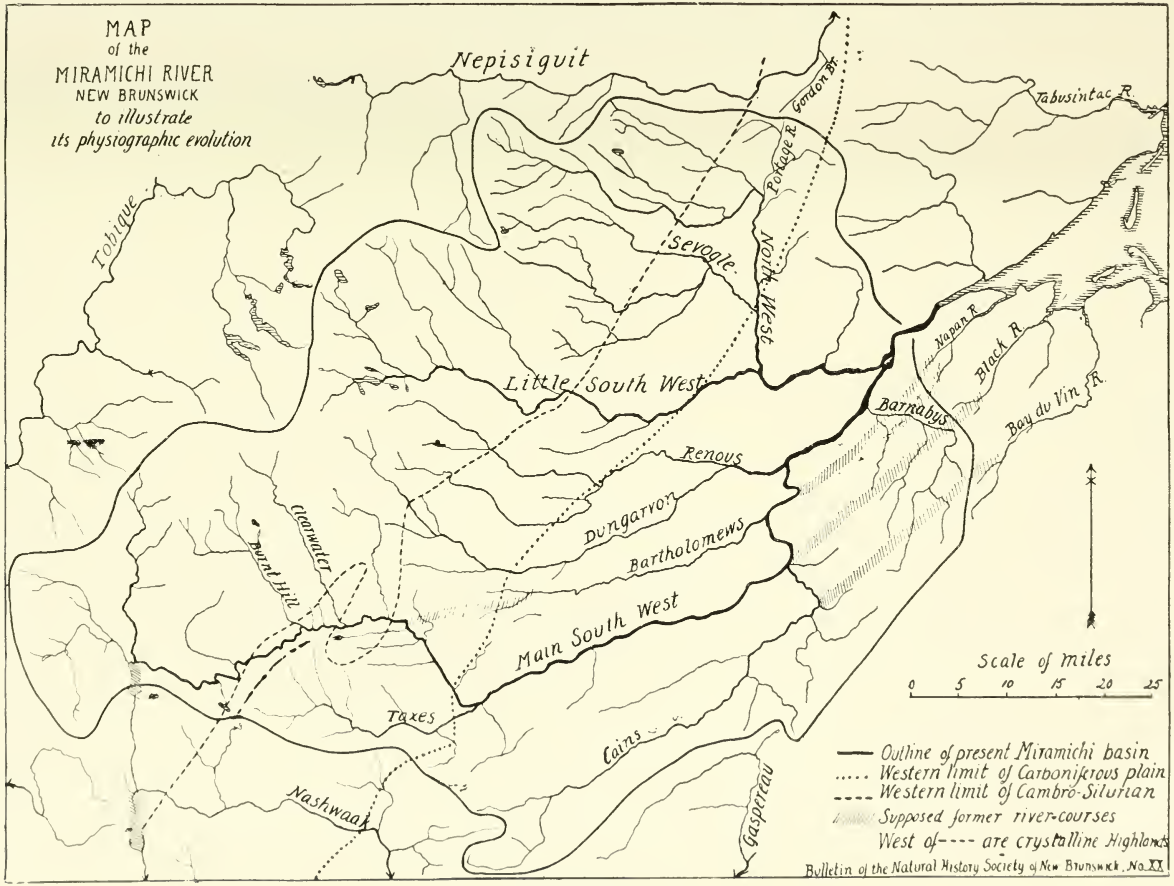
* Independently of Daly's suggestion as to the anticlinal hinge line, I had previously come to the conclusion that the ancient watershed east of the lower St. John was at the head of Grand Lake, that most of Salmon River formerly flowed into Richibucto (whose morphological head was Salmon Creek, west 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
Tabusintac R.
Gordon Br.
Portage R.
Tobique
Sevogle
North West
Little South West
Napan R.
Black R.
Bay du Vin R.
Barnabys
Renous
Dungarvon
Bartholomews
Clearwater
Burnt Hill
Main South West
Taxes
Cains
Nashwaak
Gaspereau
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.

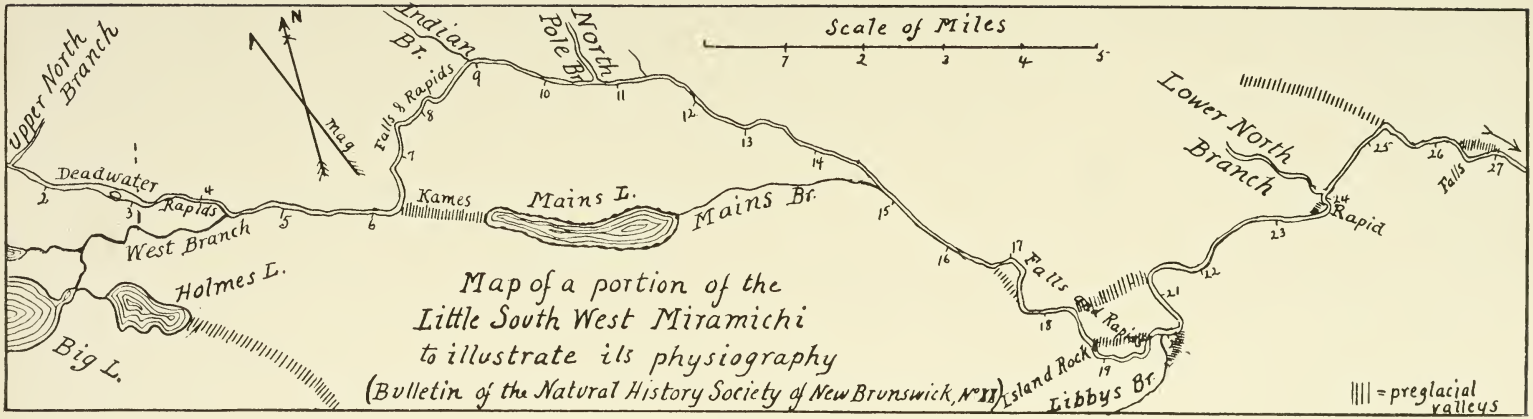
(Read November 5, 1901.)

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.


Scale of Miles
1
2
3
4
5
N
Mag
Upper North Branch
Deadwater
Rapids
West Branch
Holmes L.
Big L.
Falls & Rapids
Indian Br.
North Pole Br.
Kames
Mains L.
Mains Br.
Falls
Rapids
Island Rock
Libbys Br.
Lower North Branch
Rapid
Falls
Map of a portion of the
Little South West Miramichi
to illustrate its physiography
(Bulletin of the Natural History Society of New Brunswick, No. XI)
|||| = preglacial valleys

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.

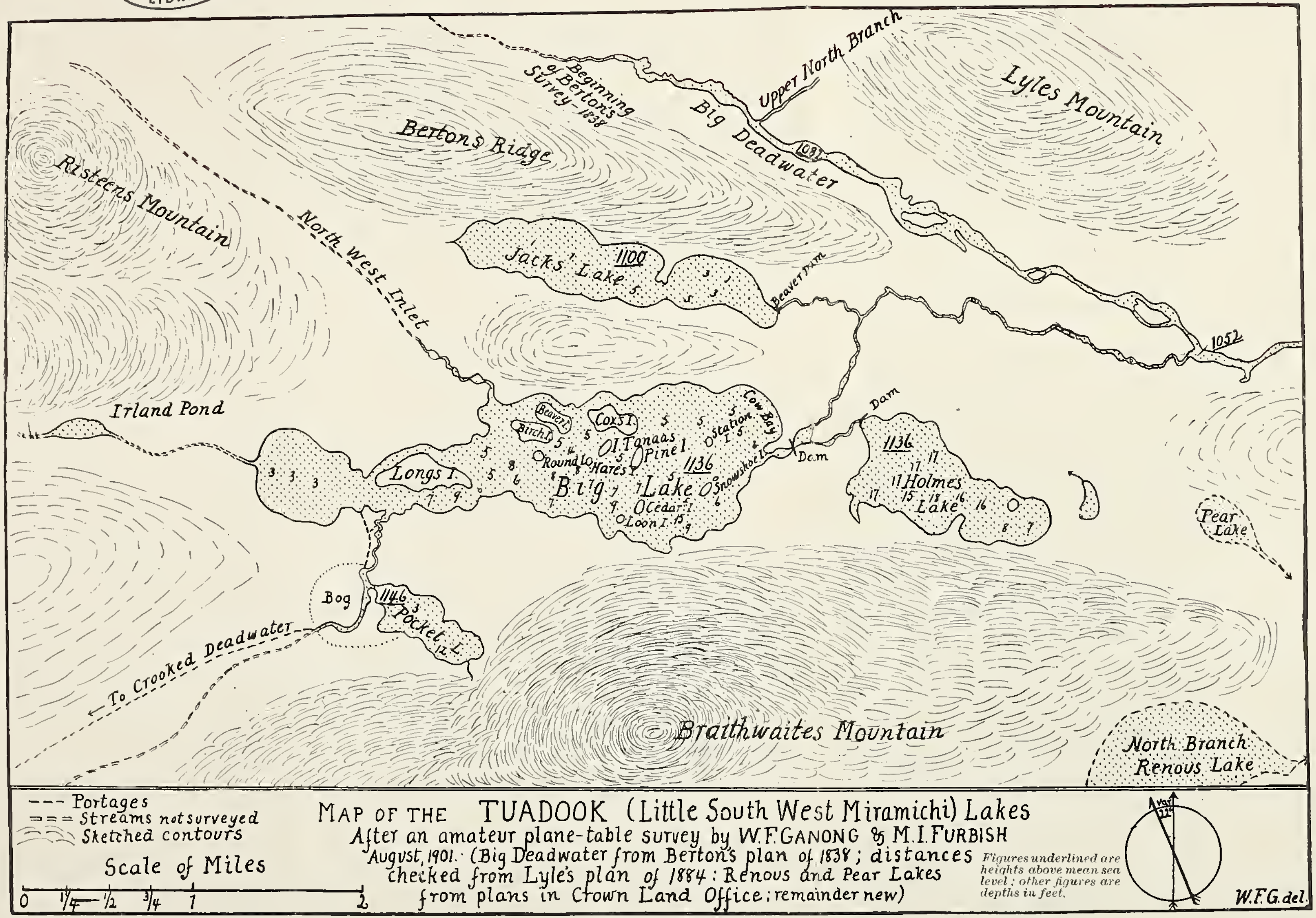
The scenery at the mouth of the Lower North Branch is altogether charming, as indeed it is at many points along this remarkable river.

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.


Beginning of Bertons Survey - 1838
Upper North Branch
Lyles Mountain
Big Deadwater
1081
Bertons Ridge
Risteens Mountain
North West Inlet
Jacks' Lake
1100
Beaver Dam
1052
Irland Pond
Longs I.
Beaver I.
Birch I.
Coxs I.
I. Tanaas
Pine I.
Round I.
Hares I.
Station I.
Cow Bay
Snowshoe I.
Big Lake
1136
Cedar I.
Loon I.
Dam
Dam
1136
Holmes Lake
Pear Lake
Bog
1146
Pocket L.
To Crooked Deadwater
Braithwaites Mountain
North Branch Renous Lake
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.
Var. 22°
W.F.G. del.

MAP No. 5.

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

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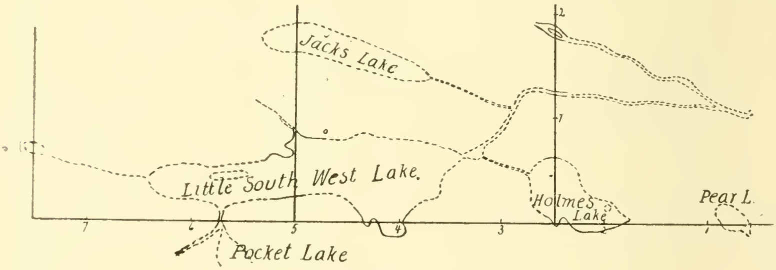
* This map is mentioned in earlier notes, 29 and 39; it is reproduced for the first time from the original MSS. in Trans. Royal Society of Canada, new series, III, section ii, 364.

† 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 accompanying 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.

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* 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 north-western 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 north-eastward 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 north-east this lake is bounded by an abrupt ridge (Berton's Ridge) some three hundred feet high which separates it from the Big Deadwater.

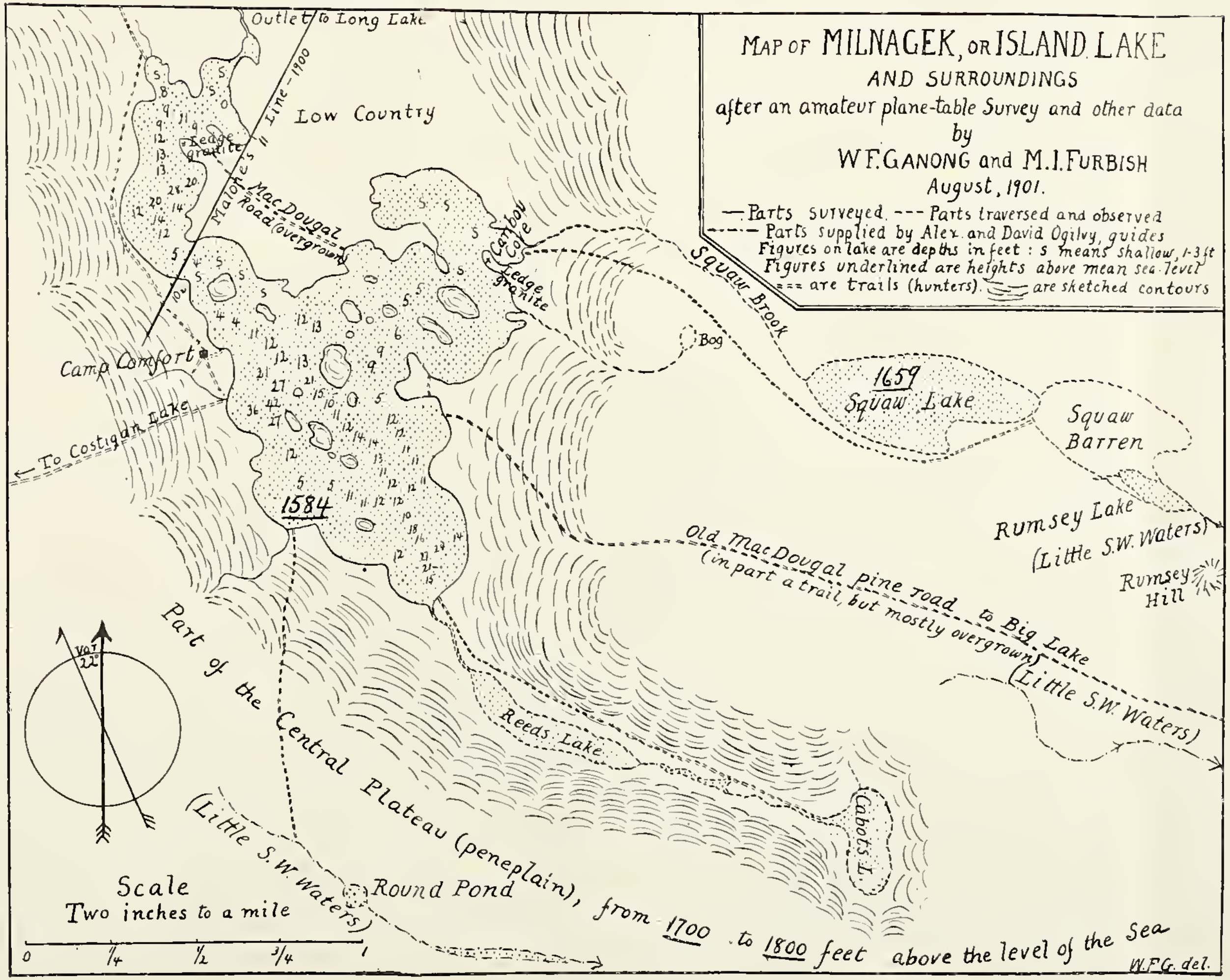
Holmes Lake is very pretty, the deepest of the group, and is not a mud lake. I do not understand at all the conditions which determine the formation of this organic mud* in some lakes and its absence from others apparently as favorable. Pocket and Jacks Lakes contain it abundantly, while Holmes does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


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
Malone's " Line-1900
Ledge granite
MacDougal Road (overgrown)
Caribou Cove
Ledge granite
Squaw Brook
Bog
1659
Squaw Lake
Squaw Barren
Rumsey Lake
(Little S.W. Waters)
Rumsey Hill
Camp Comfort
← To Costigan Lake
1584
Old MacDougal pine road to Big Lake
(in part a trail, but mostly overgrown)
(Little S.W. Waters)
Reeds Lake
Cabots L.
Part of the Central Plateau (peneplain), from 1700 to 1800 feet above the level of the Sea
(Little S.W. Waters)
Round Pond
Var. 22°
Scale
Two inches to a mile
0 1/4 1/2 3/4 1
W.F.G. del.

MAP No. 6.

8179

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.

ARTICLE III.

THE SOUTH TOBIQUE LAKES.

By G. U. Hay, D. Sc.

Before the end of the twentieth century there will probably be few unexplored regions in this province, or lakes where the tell-tale dotted line marks them as unsurveyed, or lakes that have no existence on our maps. But that is the case now. There are some eighteen lakes — large and small — that form the sources of the rivers and streams that enter the Tobique river from the south side. A third of these are either not marked at all or are imperfectly outlined on the maps of New Brunswick in common use. These lie close to the watershed that separates the sources of the Tobique and Miramichi water systems.

In this region Prof. Ganong and I spent nearly four weeks during the summer of 1900, going in to Trowsers Lake from the Tobique river over a portage road twenty miles long, camping nearly a week at the upper extremity of that lake, whence we made short daily excursions to the lakes and streams adjacent. From Trowsers Lake we made a portage to Long Lake, the largest of the system. Here there is also within easy reach of either extremity a number of small lakes. From Long Lake we visited in succession, "carrying" over intervening portages, Portage, Adder and Serpentine Lakes. The outlet of the last named lake is Serpentine River, which, after a swift run of thirty miles, brought us to the Forks of the Tobique, nearly thirty miles above the point where we started in. While Prof. Ganong attended to the physiographic features of the country and took measurements, I examined and collected plants, and took views by means of a camera.

The country traversed is a wilderness, the low lying portions of which are thickly wooded with spruces, firs and other evergreens, giving a somewhat sombre aspect to the country. The ridges are clothed with a more diversified growth of deciduous and evergreen trees. All the smaller lakes are shallow, and the low-lying shores adjacent are the resorts of moose, deer, caribou, beaver, and many of the small fur-bearing animals. Trout abound in great numbers in the streams and thoroughfares adjacent to the lakes, while the togue or namaycush, a fine species of lake trout, is found in at least one lake of the series — Long Lake.

Owing to the remoteness of this district, the difficulties of transportation, and the fact that the waters do not contain salmon, the lakes are seldom visited by fishermen. But in the fall of the year they are a great resort for moose and deer hunters, and in winter trappers visit the region. The "deadfalls" and other cunningly devised traps met with in every direction during the summer show the elaborate plans made for the capture of the small but valuable fur-bearing animals. The distance from the main waterways of the province is also an obstacle to lumber operations, but in proportion as lumber has become scarce in the more easily reached areas, this region has been penetrated to quite a considerable extent by lumbermen who have erected dams at the outlet of Trowsers, Serpentine, and some of the smaller lakes to hoard up an adequate supply of water for artificial freshets in the small streams that flow from these lakes. As a result, the water has risen five or six feet in the lakes, drowning the plants and roots of trees along the shores, which now present a desolate appearance from the dead trunks leaning out over the waters.

Our two day's journey over that portage road which brought us to Trowsers Lake gave plenty of opportunity to study the general features of the country and the plants by the wayside. The road, for the first three or four miles after leaving the Tobique river, led through bogs and low grounds with the vegetation usually found in such situations. The Labrador Tea (Ledum latifolium) exists in profusion ; and should our tea-drinkers ever turn to the brewing of the home product there will be an abundant supply in this South Tobique Lake region. Viburnums, red and black spruces, Rhodora, Vacciniums, Kalmias, Andromeda and other heath plants were found. Then, as the country became more broken and we wound through valleys and over hills, the vegetation became entirely changed. Along the courses of streams the osmundas and ostrich ferns lifted their luxurious fronds, purple trilliums and violets, blue and white, reminded us that this northern country was still in the midst of its spring season. As we neared Trowsers Lake magnificent forests, some of them such as I had never seen before, crowned the sides and summits of the ridges. Gray, yellow and white birches, rock maples, beech, spruce, with occasionally some giant white pines told of generous conditions for growth. The white birch and red spruce were especially noteworthy. The white birch in all its luxuriance I had never seen until I saw it on these hillsides. Some well-rounded and symmetrical boles, fully two feet in diameter, rose tapering to the height of sixty or seventy feet, the white bark contrasting with the vivid green of its wealth of foliage. It deserves its title of "The Lady of the Woods." And here were lordly spruces that guarded the gateway to what might be well termed the "Country of the Spruces" that we were now entering. They rose from seventy to ninety feet in height, straight as an arrow, long, slender cone-shaped trees like church spires that were suggestive of some sylvan city of churches—and who would not be a worshipper in a city like that?

When our guides left us at the lower end of Trowsers Lake on the morning of the 5th July, we devoted ourselves to the consideration of how our 300 pounds weight of baggage and stores could be put away with sufficient compactness and safety in our little basswood canoe of sixty pounds weight. This accomplished, we paddled up the left "leg" of the lake, before a stiff north-west breeze, to the site of our first permanent camping ground, five miles away. Here we remained several days exploring the lakes and forests in the vicinity.

The next morning we started out through a woodland portage path to the next lake, about a mile and a half distant, carrying our canoe, Indian fashion, on our shoulders, resting at times and enjoying the rare beauty that met the eye at every step. It was an ordinary well-beaten path, trodden, perhaps, for centuries past by the feet of Indian hunters, guides, trappers, and perhaps by mere adventurers like ourselves. The vegetation was typical of nearly all our northern forests, but the different layers of vegetation had never appeared so distinct and well arranged as along this particular woodland path. Lowest down was a carpet of moss, chiefly hypnums, amid the dead leaves of previous summers. Struggling through this and forming the second layer were those plants that delight the wayfarer in nearly all our woodland groves, the Wood Oxalis not yet in bloom, the slender Linnæa, "with its twin-born heads" and delicate fragrance, the Solomon's Seal (Smilacina), occasional patches of blue violets, the Clintonia, the Gold-thread (Coptis trifolia), the Star of Bethlehem (Trientalis Americana), with occasional clumps of ferns and lycopodiums. Forming the third layer were the shrubs and young growths of trees, viburnums, maples, the Canadian Holly, etc.; while towering above all these were the trees — spruces, firs, white, yellow and grey birches, maples and others.

The end of our portage path brought us to Milpagos Lake, which means the lake of many coves. It is about two and one-half miles long, very irregular, as its name signifies. A red deer on a little interval fifty yards away gazed on us with wondering eyes for a moment and then disappeared into the woods. We paddled along the shore of this lake for about half a mile until we found a path leading to Gulquac Lake. This, like the lake we had just left, has low-lying and boggy shores. Both lakes are muddy and shallow, the shallower parts sending up a growth of rushes, yellow and white pond lilies, while among innumerable small plants along the shores the Droseras are spreading their leaves to catch unwary flies. Here we came face to face with our first moose. The wind was blowing toward us, and he did not see us, so we had a fine opportunity to examine him at our leisure, and a noble-looking animal he was. We watched him browsing, and not until the camp-fire was lighted for our mid-day lunch did he take the alarm. He saw the trail of smoke as it curled up over the trees and vanished. It is thus with all wild animals; the moment they see the smoke, or when the smell of fire reaches their delicate sense of smell, they flee in terror.

Gulquac Lake is a beautiful sheet of water, even though its shores are boggy and low in most places. To the north-west rise two mountains of equal height—about six hundred feet high, and these are in view from every part of the lake. It is about a mile and a half long, and, like Milpagos Lake, it has numerous little bays, with islands near each end, and a fine sheet of water between. Near its west end, where it flows out into the Gulquac river, we came upon a beaver dam, constructed across the narrow part of the lake, the difference of level between the water above and below being about eighteen inches. It was composed of sticks placed slanting in the water and made firm with mud and stones. The cutting of these sticks and small logs in the woods beyond, often a considerable distance away, the carrying and putting them in their places, and then firmly placing them together, anchored with rocks, and cementing the whole with mud and clay, shows not only the wonderful skill and ingenuity, but most extraordinary industry on the part of this animal. Their houses, too, are built on the same substantial plan. They are found usually on the borders of the lake, at some distance behind the dam, the water stored by the latter means being necessary to secure free entrance and exit at all seasons of the year. The beaver house is a broadly conical structure, built strongly of small logs placed deep in the ground and slanting upwards, secured by stones, the interstices being filled with moss, twigs and clay, forming a fortress absolutely invulnerable to all predatory animals.

Our approach to this, our first beaver house, was slow and cautious, with the hope of obtaining a sight of one of these interesting animals, and we were not disappointed. Just as we rounded a point and the house came in view, we saw a beaver basking in the rays of the afternoon sun, or perhaps taking in the beauties of the purple pitcher plants which bordered the avenue of water that led up to the house.

On becoming aware of our approach, he greeted us with a grunt of displeasure, then dived and entered his castle through its only portal. There was a communication to those below in the same grunting tones, sounding more like regret than anger; then all was still. We lingered about the house for a time awaiting some sign of that hospitality due to strangers in a strange land. But no sound came, nor did we get sight of another beaver on that whole trip.

The beaver dam in Gulquac Lake was the largest and best constructed of any that we saw. But nearly everywhere on these shallow lakes and their adjacent streams dams were found, and houses, many of them unoccupied. The advent of the lumbermen, who build dams, often on the sites of the beaver dams, has driven them to more remote wilds. The illustration here shown is of an unoccupied beaver house, in a good state of preservation, at the lower end of Serpentine Lake. Beyond the house may be seen the lumbermen's dam built upon the sight of a former beaver dam.

On Saturday, July 7th, and the following Monday, we made excursions beyond our camping ground to the lakes and sources of the streams in the South Tobique Basin. As a description of these has already been given to this Society by Dr. Ganong in his "Physiography of the South Tobique Lake Basin," I shall merely give an account of some of the plants found: A few of the most common were Ledum latifolium, whose white blossoms mingled with the white tufts of the cotton grass (Eriophorum polystachyon) formed a striking contrast to the rose-colored blossoms of the Rhodora Canadensis and the two Kalmias (K. augustifolium and K. glauca), and the rich purple blossoms of the Pitcher Plant (Sarracenia purpurea).

The abundance and variety of blossom, mingled with the vivid green of the foliage in the foreground of these lakes, relieved the sombre character of the woods of black spruce and other evergreens which extended to the hillsides beyond. The black spruce, with its jagged, uneven tops, is everywhere in evidence here. There were very few tamaracks, few alders, except along the courses of the streams, a sprinkling of white birch of a small growth, numbers of Spiræa (especially S. salicifolia), Viburnums (Viburnum cassinoides, V. opulus, V. pauciflorum), Cornuses (C. stolonifera, C. alternifolia), Rowan tree (Pyrus Americana, with its smaller congener P. arbutifolia), wild cherry and bilberry (Prunus Pennsylvanicum and Amelanchier Canadensis.)

The lakes were filled with Yellow Pond Lilies (Nuphar advena, and N. kalmiana). The root stocks of these, especially the newer portions as well as the young shoots, serve as food for the moose and other wild animals. The moose may often be seen out in the lakes with head in the water digging them up out of the mud, and on these occasions when their eyes are blinded with the muddy water, and with the wind in your favor, a very near approach to the animals can be made. The older and tougher portions of the root stocks of the yellow pond lilies cover the surface of the lakes sometimes, especially along the shore, to such an extent that it is difficult to make a landing from a canoe. Whether such a wholesale destruction is caused by moose and by beavers, which are also said to feed upon these, or whether it is caused by the ice in winter freezing down to them and raising them up with the mud in the spring freshets, we could not decide. Along with these the white, sweet-scented Pond Lily was growing, whose root stocks are also said to be relished by moose. Then there were Brasenia peltata, numerous potamogetons, Limnanthemum lacunosum, the horsetail, Equisetum limosum, very abundant, a grass whose bright steel blue leaves lay on the surface of the water — Glyceria borealis — which turns out to be a new plant to the province, many sedges, especially carices, with some half dozen species also new to the province. A fuller report of the new and rare plants is given in an appendix in Bulletin Number XIX.

The farthest point examined in these lakes, the waters of which find their way to Trowsers Lake, was a small lake in the form of a triangle, its vertex pointing to the south-east. Into this flowed a stream of ice-cold water from springs in the hills beyond, indicating the sources of the southwest branch of the Tobique. The lake was shallow, with low-lying grounds around, the shores covered with flat stones, and numerous moose and deer paths leading to the water's edge. In the meadow, bordering the stream that flowed into this lake, were found Iris versicolor, Osmunda regalis, O. claytonana, Onoclea struthiopteris, Ranunculus abortivus, R. septentrionalis, Calla palustris, with droseras and violets in profusion; and Hydrocotyle, Nasturtium palustre, several carices and the moss, Fontinalis antipyretica—all lovers of cold water.

The country about the sources of the South Tobique River has been untouched by forest fires. May it long remain so! Owing to its remoteness, it has not been lumbered to any great extent. Far as the eye can reach from the top of some lofty pinnacle, it is a great evergreen forest — the country of the spruces — the swamps and lake borders covered with the slender black spruce of the swamps, the higher grounds and ridges covered with red spruce, that valuable timber tree, intermingled with birches, maples, and a few pines.

This country, with other tracts at the headwaters of our great rivers, may be preserved for ages, and, by judicious management, it may yield every year a handsome revenue, and still steadily increase in value. New Brunswick's greatest source of wealth must be her forests. What has taken many generations of the past to come to perfection should not be despoiled by one generation. It should be the pride of our government and people, and a sign of their growing public spirit and scientific knowledge, sacredly to hand down that wealth that we have inherited to future citizens of the country.

The dangers threatening extinction to our forests are three: from forest fires; from selfish, illegal and unintelligent plans of lumbering; and from the cutting of young trees for pulp mills. The bare tracts of country in the southern parts of the province, and on the Nepisiguit, and some portions of the Miramichi, show how a country may be utterly devastated by ravages from fire, without hope of restoration to its former condition for many generations. The pictures of desolation from forest fires, which can be seen from so many hill-tops in the province, should show us how careful we should be to lessen this great danger to our forest wealth; and not only have forests been destroyed,— in many instances the land has been rendered incapable of production perhaps for centuries.

If our lumbermen select the largest and best trees for their operations, gathering the tops and branches, with some of the smaller growth in the denser portions, for the pulp-mill manufacturer, this region of the South Tobique and others through the province would increase in value each succeeding year. The great need in these forests is a judicious pruning of small trees, especially on the low grounds, in order to give an opportunity for the stronger and more shapely trees to grow; and the careful removal of branches and tops to lessen the danger from forest fires. Thus the waste products of the lumberman, which have been the source of so much damage in times past to our forests, and the stunted and misshapen growth of smaller trees in the denser woods, would not only be removed, but much of it made use of for manufacturing purposes. In Germany the forests, in spite of the large and profitable lumber "cut" each year, are constantly becoming more valuable. And this is the result of trained and intelligent supervision. And so it would be in New Brunswick if similar methods prevailed. Our game and fish wardens should be trained in forestry. It would pay the government a hundred, yes a thousand-fold, to give our game commissioner added authority over forests, give him intelligent and trusted wardens, skilled not only in the knowledge and habits of game and fish, but also in forestry. It would take a little time to train such a body of experts, but the results would be great, placing New Brunswick in a position to preserve and add to what must prove the source of her greatest material wealth—her forests, her game, and her fisheries. At the same time she would place herself in line with those countries which, by wise and effective legislation, are laying a foundation for the preservation and future development of rich material resources.

We were encamped at the head of Trowsers Lake for five days. During the next ten days, amid almost continuous rains, with here and there a fine day, we journeyed eastward to the Serpentine river, passing over Long, Portage, Adder and Serpentine Lakes with several smaller lakes and ponds. Owing to the heavy rains the streams were swollen to freshet size, and the swamps and low grounds near them were difficult to cross. There was water everywhere. Of the portages, one was two and a half miles long (between Trowsers and Long Lakes); another was fully three miles, and very rough and uneven, but several small ponds intervened, which were easily crossed in canoes. The lakes, above named, are all very beautiful, especially Long Lake, a sheet of water bordered by high hills, six miles long and from one to two miles in breadth The soundings at one place in this lake showed a depth of 117 feet. A mile or two to the southwest of this lake is Milnagek, or the "Lake of Many Islands," no less than fourteen of which dot its surface. About six or seven miles to the southeast lies the lake which is the source of the Little Southwest Miramichi, the portage path to which, described by Professor Hind many years ago, Professor Ganong, aided by Mr. Furbish and guide, attempted to find, but in vain.*

The Serpentine Lake and River, both of which have remarkable windings, brought us into the Right Hand Branch of the Tobique river, and from that we came to the main Tobique to our place of starting. The Serpentine river is thirty miles long, and descends in

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*During the summer of 1901 Professor Ganong and Mr. Furbish again visited this section, made a path for themselves across the country from Long Lake, and descended the Little Southwest Miramichi. See Professor Ganong's articles in this Bulletin.

that length 1,000 feet. The water was very high and the stream running like a race-horse. Our canoe shot over boulders and turned the many windings of the river with a speed that was exhilarating to the highest degree. I shall never never forget the joy of that first afternoon on the Serpentine, the delight of riding full speed on the back of a rapid torrent, racing past little islands covered with Osmundas (O. regalis and O. claytoniana), the tumultuous waters rioting among the fronds, whose dainty green contrasted with the darker shades of alder and viburnums on the banks. Virgin's Bower twined gracefully in festoons over shrubs, with Meadow Rue and Joe-Pye Weed bending their tall stems over the waters, while on the near hill-

sides beyond were the darker evergreens. It was difficult to take in the full beauty of the scene, as each turn of the river brought fresh pictures constantly into view. The delights of days like that, with a little spice of danger thrown in, linger in the memory for a lifetime. I have often since found myself careering in imagination over that wild and capricious little river, involuntarily ducking my head to escape an overhanging branch, or shying to avoid some dangerous boulder as we swept by; and then as we came into more quiet stretches of the river, resting on our paddles and taking in these scenes of wildness and beauty.

I can only briefly refer to two side trips that we made while descending the Tobique,—one to Sisson gorge, six miles from the forks of the Tobique, and the other to Bald Head mountain, a picture of which is here given from a photograph taken from the plain near the base. The trip up the Sisson Branch, as far as the gorge, was accomplished with the greatest difficulty, owing to the high water, although the stream itself presents no obstructions. We were well repaid, however, for the extra exertion by a view of the gorge, one of the wildest and most picturesque spots in New Brunswick. There is a succession of five cataracts tumbling one after the other to a depth of one hundred feet, after which the stream flows in a series of rapids through a gorge walled by perpendicular rocks until it reaches the smoother stretches beyond. On the rocks overhanging the stream further down were found *Aspidium fragrans* and *Woodsia glabella*, two of the rarest ferns in the province.

The descent of the Sisson Branch and the main Tobique, as far as Riley Brook, a distance of twelve miles, was made in a little over an hour and a half in the midst of torrents of rain. On the following afternoon, Friday, July 27th, we paddled leisurely twenty miles further down in about three hours, which may show the swiftness of the current, the river being unusually high for this season.

On the morning of this day we visited Bald Head, a distance of five miles from the village of Riley Brook. This elevation, which is about 1,400 feet above the valley of the Tobique, is perhaps the most typical and regular mountain in New Brunswick, rising one thousand feet from the plain at its base, in the shape of cone, the upper portion covered with loose stones and boulders. On the top we found a narrow ridge which contained a great variety of plants, as follows, the trees being stunted and irregular: Pyrus Americana, Betula lenta, B. papyracea, B. pumila, Prunus Pennsylvanica, Acer rubrum, A. Pennsylvanicum, white and black spruces and firs, Nemopanthes fascicularis, Ledum latifolium, Sambucus pubens, Epilobium angustifolium, Cornus Canadensis, Vaccinium Canadense, V. Pennsylvanicum (narrow and wide leaved forms), Ribes lacustre, R. prostratum, Rubus strigosus, R. triflorus, Antennaria margaretacea, A. plantaginifolia, Galium triflorum, Kalmia angustifolium, Aralia nudicaulis, Trillium erythrocarpum, Aspidium spinulosum; besides several grasses and carices, two species of lycopodium; hypnums, polytrichums, and lichens covering the rocks and trunks of trees.

[For a list of the new and rare plants found during the trip, see Bulletin XIX, 1901.]

APPENDIX.

PRESIDENT'S ADDRESS.

By Hon. J. V. Ellis, D. C. L.

With considerable feeling of anxiety I have undertaken to prepare what our programme describes as the annual address of the president. If custom had made it imperative that I should review the incidents of our operations during the year, describe our meetings and criticize our proceedings in a judicial and friendly spirit, I would have considered myself fortunate; but on looking over the addresses delivered by gentlemen whom it is my good fortune to succeed here, I got no suggestion as to the form which the address of a mere layman might take. It has been the practice of almost all of the preceding presidents to consider some matter of interest along their own special lines of study and of knowledge, and from their fields of information and observation both interest and enlighten us. Unfortunately, I cannot take any excursion into the field of natural history in which I would care to be your guide, and you will see from this the difficulties of my position. Yet as I have turned over the numbers of our Bulletins for several years, I have had some reward. I have been able to appreciate more fully than ever before the amount of work which has been done by our more active members in their varied fields of labor, in their study of land animals, birds, fishes, insects, plants; in their close enquiry into our past and present geological conditions; and in the facts which they have acquired respecting the habits and customs and general life of the original occupants of this land, by means of which they have increased our interest in all forms of life in our province, and widened and enlarged the bounds of knowledge in many useful and attractive directions.

As near as may be, this meeting is our fortieth anniversary. The first steps in the formation of the Natural History Society of New Brunswick were taken at a meeting held in the Mechanics' Institute on January 29, 1862, at which it was resolved to form a scientific association under the name which we now bear. Two specific declarations were made, viz.: that "one of the efforts of the society shall be to form a collection of books of a scientific character for the use of the members," and another, that it shall be a special aim to make "such a collection of specimens in the different branches of scientific research as shall fully illustrate the natural history of this province, and, as far as possible, that of other countries." That was our beginning, and the field of work laid out has been amply tilled and cultivated, and we have developed investigations whose fame has gone out far beyond the limits of our city and province, and of whose work as original discoverers we are justifiably proud.

The forty years that have elapsed have been years of marvellous progress in the scientific world. Of course it cannot be claimed that what has taken place in the forty years is the product alone of the period, for there are antecedent causes and the work was well under way with the commencement of the nineteenth century. But the practical application of science to utilitarian purposes has, in the words of Huxley, created a New Nature, begotten by science, and has worked miracles which have modified the whole fashion of our lives. Naturally and easily we may draw a mental distinction between those who investigate and endeavor to interpret the voices of nature, who pursue their work with untiring energy, and who are thrilled with joy as they extract from her some of her closely kept secrets; and those who merely make application of the knowledge thus acquired by others to the uses and needs of man. The first are nearer and dearer to us and we can share their joyous thrills at every discovery they make, not only for their own sake but because they make possible the labors of those who would apply *their* work to man's advantage.

The philosopher and student to whom I have just referred expressed the opinion that our epoch has produced three great things in physical science: one of these is that doctrine of the constitution of matter which is spoken of as molecular, the second is the doctrine of the conservation of energy, the third the doctrine of evolution.

No doubt Mr. Alfred Russell Wallace is correct in his assertion that in popular estimation and perhaps in real usefulness the establishment of the general theory of evolution, by means of the special theory of the development of the organic world, through the struggle for existence and its but necessary outcome, Natural Evolution, is the great scientific work of the nineteenth century. And a philosopher and student of an entirely different kind, Mr. Leslie Stephen, declares that he has no doubt that the future historian of thought will regard the promulgation and the rapid triumph of evolutionist doctrines, as the most remarkable phenomenon in the intellectual development of the century. Although there had been hints at such a theory in the past, they had been merely hints and no definite statement had been made. The ordinary amount of scientific knowledge or information in evidence concerning the material world, did not seem to require any general theory of how species came into existence.

With great pains and great care scientific men had classified birds and animals and plants, and had pretty well settled upon the order and species to which they belonged, but the enquiring mind could not rest here fully satisfied that all was known that could be known. How did these species originate? If all matter could be reduced to simple atoms, by what law did matter operate, and upon what principle did it arrange itself in the various forms, simple and complex, living and dead, in which we find it? No doubt the earlier students of natural history, so far as the living, growing world was concerned, busied with their classifications and efforts at determinations, were generally satisfied that each species of animals and plants was a distinct creation, and this was sufficient for their purposes, but there were among them men who often wondered how these distinct creations were produced, and by what law they came into being. Those who had studied or were studying the physical world, the earth, the solar system, the stellar universe, had had their attention drawn to the origin of things, and here and there were suppositions, vague theories, ingenious speculations, but it will be found among those who investigate the subject, that at first naturalists were less inclined to look with favor upon the idea of evolution than were the mathematician and philosopher, who were engaged in working out a natural law for the whole universe. I can remember reading about 1850 the work "Vestiges of Creation," which was published six years before by an anonymous writer, who for the first time gathered up and placed in a very attractive manner, the ideas of those English and continental students who believed in a progressive development, due to an impulse imparted to the forms of life, by which impulse they were advanced in definite lines by generation through grades of organization eventuating in the production of the highest plants and animals.

This work, after some years, was found to be the production of Mr. Robert Chambers, of the great publishing house of J. W. & R. Chambers, of Edinburgh. It was really the first publication in Europe in any orderly and popular way, of the theory of progressive development. Its tone was mild and serious. It went further, I think, than modern science will justify in respect of some statements which it made regarding the coming into existence of new creations of life, but it made no attempt to show how or why the various animals and plants have distinct characters, and how there came to be in the world all the existing variations. "Vestiges of Creation" was the first attempt to put into systematic shape, from the naturalist's point of view, the views of the evolutionists. In 1852 Herbert Spencer, who was not a naturalist so much as he was a logician, published his "Creation and Development" essays, in which, with all his logical force and consistency, he discussed the idea of development as against a special creation. Eight years later came Darwin's Origin of Species, an almost marvelous work, in which the whole subject was presented with a fulness and thoroughness which forced the question upon the honest consideration of thoughtful men; and thus the subject was before the world in all its strength! Of course it met with great opposition. It was believed to be a doctrine fatal to the received religious faith of Christendom, and even scientific men, liberal and broad-minded as Sir John Herschel, condemned it as heresy, while a no less eminent geologist, Mr. Lyell, declared in the earlier editions of his great work, that the known facts of geology were fatal to the theory of progressive development. Sir Charles must have receded from this position eventually, and, indeed, it is surprising that he ever held it: for his own view, which he so successfully established, that all the changes which had taken place in the earth's crust could be accounted for by conditions which now exist, and which are in operation in this age, was a declaration of a belief in a general and universal law governing the operations of nature; or, in other words, if natural causation is competent to account for the not living part of our globe, why should it not account for the living part? Although the literary and scientific world, as well as the religious world, regarded with disfavor the arguments and reasoning in support of the theory set forth by

Chambers and proved by Darwin; the theories advanced gained adherents, and, as fact after fact was brought to light, which sustained the idea, men gradually became reconciled to it. It may be of interest to observe that the theory of the survival of the fittest in the process of evolution was reached by two thinkers acting independently of each other. This theory is held to account for the variation and development which have taken place, and which are taking place in the origination and creation of species. Mr. Chambers declared that there was a principle of progressive development. He did not, as I have already stated, explain *how* or *why* there was such a law. Mr. Alfred R. Wallace and Charles Darwin thought out the subject. Mr. Wallace's statement of his share in the matter is an interesting paragraph in one of his latest books, page 140:

"While considering, he says, the problem of the origin of species, something led me to think of Malthus' Essay on population which I had read about ten years before, and the positive checks — war, famine, disease, accidents, etc.,—which he adduced as keeping all savage populations nearly stationary. It then occurred to me that these checks must also act upon animals, and keep down their numbers; and as they increase so much faster than man does, while their numbers are always very nearly if not quite stationary, it was clear that these checks in their case must be far more powerful, since a number equal to the whole increase must be cut off by them every year. While vaguely thinking how this would affect any species there suddenly flashed upon me the idea of the *survival of the fittest*—that the individuals removed by these checks must be on the whole inferior to those that survived. Then considering the variations continually occurring in every fresh generation of animals or plants, and the changes of climate, of food, of enemies always in progress, the whole method of specific modification became clear to me, and in the two hours of my fit I had thought out the main points of the theory. That same evening I sketched out the draft of a paper; in the two succeeding evenings I wrote it out and sent it by the next post to Mr. Darwin. I fully expected it would be as new to him as it was to myself, because he had informed me by letter that he was engaged on a work intended to show in what way species and varieties differ from each other, adding, my work will not fix or settle anything, I was therefore surprised to find that he had really arrived at the very same theory as mine long before (in 1844), had worked it out in considerable detail, and had shown the MSS to Sir Charles Lyell and to Sir Joseph Hooker; and on their recommendation my paper and sufficient extracts from his MSS, work were read at a meeting of the Linnæan society in July of the same year, when the theory of natural selection or survival of the fittest was first made known to the world. But it received little attention till Darwin's great and epoch-making book appeared at the end of the following year."

Enquiring as to the state of educated, literary and scientific opinion on the general subject at the present hour, Mr. Wallace says:

"Evolution is now universally accepted as a demonstrated principle, and not one single writer of the slightest eminence, that I am aware of, declares his disbelief in it. . . . . What was 'a great heresy' to Sir John Herschel in 1845, and the 'mystery of mysteries' down to the date of Darwin's book, is now the common knowledge of every clever school-boy, and of everyone who reads even the newspapers. The only thing discussed now is, not the fact of evolution—that is admitted — but merely whether or no the causes alleged by Darwin are themselves sufficient to explain evolution of species, or require to be supplemented by other causes, known or unknown. Probably so complete a change of educated opinion on a question of such vast difficulty and complexity was never before effected in so short a time."

One of the surprises which greets the ordinary mind in dealing with the Darwinian work is the extent of the variations which are possible and probable under the one general law. All that Darwin tells us of results obtained, of the effects of domestication, of cross-breeding in plants and animals, of knowledge which he derived from the motions of plants and from the lives of insects which lived among the vegetation that he observed, is delightful reading, and yet quite as much may we observe were our opened eyes at some flower show, where we see gorgeous masses of bloom, lovely developed and beautifully painted leaves, the very aristocracy of plant life, produced by the skill of the planter from some weed of humble origin.

Mr. Huxley raises the point — he almost vexes us by raising it — whether it may not be possible that while this existing universe is a universe of law and order, a universe of simplest matter and definitely operating energy, it is as well a product of evolution from some preceding universe in which the manifestations of energy were not definite, in which, in other words, law did not regularly prevail, in which there are, for example, some good units and some bad ones, and in which, possibly, like the boys and girls at school, the good are sometimes bad and the bad, at times, surprisingly good. It is sufficient for us now that we have a recognized law, and into its ancestry enquiry would be fruitless. The effort of the general acknowledgment of a law fixing definitely the rules of operation of the causes of motion and development of the material universe has been sought in every department of human investigation. If all kinds of matter are modifications of one kind, if all modes of motion are derived from the same energy, a great deal of difficulty is removed in consideration of causes which produce certain results. We seem to find this in the great advances which we have made in the last few years in electrical knowledge, and in the application of that knowledge to practical uses. So, too, the steadying influences of the law of evolution upon the "cell theory." Regarding this theory the fact appears to be established that all living bodies are composed of a substance which is nearly alike in all — protoplasm. This composition, in the language of Huxley, is the physical basis of life; and this substance resolved into minute cells, each cell having its own independent life makes up into the complex bodies of animals and plants, so that as regards the nature of the material of which animals and plants are composed there is little or no difference, the real difference being in the arrangement, differentiation and development of the cell. Huxley says that all the "physiological activities of animals and plants—assimilation, secretion, excretion, motion, generation—are the expression of the activities of the cells considered as physiological units. Each individual among the higher animals and plants is a synthesis of millions of subordinate individualities. With this brief and somewhat imperfect statement it may be seen that if men could master the nature, structure and metamorphosis of the nucleus of the cell he would stand, at least, on the very verge of the knowledge of the origin or principle of life. How far can he go? It was made a charge against Faraday that he believed electricity was life. There seems to be no good ground for this statement. One of his biographers declares that it may be doubted if Faraday ever tried to form a definite idea of the relation in which the physical forces stand to the Supreme Intelligence; but another states that on more than one occasion when Faraday had been discoursing on some of the magnificent pre-arrangements of Divine Providence so lavishly scattered in nature, "I have seen him struggle to repress the emotion which was visibly striving for utterance; and then, at the last, with one single, far-reaching word he would just hint at his meaning, rather than express it. On such occasions, he only who had ears to hear could hear." And I remember to have read in some report of his lectures that he declared that more than once, while in the midst of some important experiment, he seemed to be on the verge of some great discovery which, almost at the moment of success, eludes his grasp. I refer to this, because as naturalists, we cannot fail to have observed an interesting statement lately put forward in the public press concerning the investigations of a man of science in a western city. Prof. Loeb, a man of considerable eminence in the University of Chicago, seems to say absolutely what Faraday, undoubtedly, came so near saying, that life is electricity, and electricity is life, and that in taking food into our system we are taking in vitality through the electricity which the food generates. In other words, electricity, instead of the dynamic, force from heat, is "the basis for muscular health and activity."

In some of his declarations Prof. Loeb has affirmed that death was not a "negative process, a simple breaking down of tissues, as it has been regarded up to this time, but an active agent born with the birth of the egg and destined, if not checked, to gain the upper hand of the life instinct and bring about extinction. But, greater even than the apparent discovery of this death agent in all substance, is Prof. Loeb's announcement that he has been able to check it in the eggs of the sea urchin at least, by means of chemical agents. This, it is claimed, means nothing less than that on a minute scale the secret of eternal life is in the power of mankind. The experiments, Prof. Loeb said, were simple. Unfertilized eggs of the sea urchin were placed in a weak solution of potassium cyanide and abandoned for several days. In ordinary conditions an unfertilized egg dies in a few hours, destroyed by the death agents born with it. At the end of several days the eggs were again examined and were found to be still capable of fertilization and of producing healthy animals." "I have no doubt whatever," said one of the greatest physicists of the United States in speaking of the subject, "that in Dr. Loeb's laboratory at Chicago or at the one in Wood's Hall, Massachusetts, life will be created, and that before long."

You will observe that Prof. Loeb really requires the egg before he can fertilize it, but another scientific man, Dr. Houghton, comes forward with what is an interesting assurance. If he cannot produce the egg he can the cell from which in time an egg may be developed. One of the lowest and simplest forms of life is what is known to the man of science as the amœba. A popular writer upon the subject says :

"It is composed of a single cell in a jelly-like substance. It is without organs of any kind. When it wants something to eat, it extends the part of its body nearest its food, in the form of a finger, draws in the food and proceeds to absorb it. When the time comes for the baby amœbas, the parent, if such it might be called, literally divides up its body, and each part becomes an independent amœba, to be divided again when the time comes. What Dr. Houghton claims is that he has produced and can produce from crystals, or dead matter, bodies that closely resemble the amœba. These artificially created bodies move just like the amœba ; they absorb their food as the amœba does; they show the same chemical qualities, and they make a brave attempt at reproduction by splitting up into different cells, each displaying the same qualities as the mother cell. But there they stop. While the progeny of the real amœba keeps on dividing and sub-dividing interminably, the artificial amœba fails after the first division, and in a time, varying from half an hour to three weeks, becomes a dead mass."

If, however, life can be produced artificially from mere matter which will live through two generations what may not yet result along this line? and if it can be shown that by chemical combinations a living creation can be made, it is an easy generalization that out of this earth, once a gaseous mass, out of conditions entirely azoic, came the combinations which gave us the primal cell, and that evolution and development have done the rest. But this is proceeding too far, just now. We must be content with what we know, while we go on the search for new facts. Patiently, slowly, even with toil, must we accumulate information ; and as by finding out things we add to the available state of knowledge we increase our satisfaction at the contemplation of the simplicity and the harmony of nature when we thoroughly understand her methods, and to some extent, perhaps, her purposes.

Naturally enough there has been consideration of and even anxiety over the effect of the doctrine of evolution upon our religious conceptions. You may at once understand that it is not my intention to discuss here any religious question. But it may be no harm to observe that with all his great knowledge of natural laws, Farraday remained throughout his life an adherent of a stern and simple division of the Presbyterians, and there are many able scientific men who can infer the existence of deity as easily from the regularity of the laws of nature as from the irregular operation of any of these laws. No doubt a great change in our knowledge of natural laws affects every department of human thought, and we are led to inquire more closely into what is history and which is legend. But we can perceive that an important phase of a supposed conflict between science and religion has passed and that no injury has resulted to either. Science cannot yield her place or surrender her facts, neither can she suppress or even ignore emotions, consciousness, aspirations or convictions which are not within her domain. It may be indeed, as Mr. Leslie Stephen found out, that evolution alarms religious minds by what might appear to be its ultimate tendency. "To have the origin of organic beings," he says, "brought to a period at which no life existed is to imply that nothing except matter exists, and that we are but a whirl of atoms."

Yet Mr. Stephen is also able to see that evolutionism—the systematic application of the principle of continuity to every department of thought—helps us to distinguish principles from dogmas and legends, and to estimate the forces which have been at work, which *are* at work, upon the moral nature of mankind; and he justly says: "Religion is an essential part of human nature. Men must always need some theory of the world, and of their position in it, as consistent as possible with the best established truths, some mode of uttering the emotions and of setting forth the ethical ideals congenial to the theory, and a social organization which may help to soften, purify and elevate human relations. The evolutionist perceives the importance of making the prominence of theory strong and sound—such as may have nothing to dread from the moral unequivocal acceptance of the results of scientific and historical enquiry. Therefore, however, great may be the change, the evolutionist must recognize the true value of the religious instinct in its place, and admit the best importance of finding a mode of embodying it in the future. How that is to be done is the great problem of the coming generations."

I began these somewhat detached observations with a reference to the beginning of our organization forty years ago. How will it be forty years hence? Will Dr. Matthew, Dr. Hay and Mr. Kain and Mr. Lovitt, and Mr. Banks, and Mr. Stead, and Mr. Shaw, and Mr. McIntosh, and Prof. W. F. Ganong, and all of our fellow workers and inspirers, have covered completely their chosen fields of labor, and reached the outer bounds of knowledge with respect to life organic and inorganic in this province. Will our provincial park and reserve be the happy home of our native fauna, innocent of the lumberman's axe, and immune from the sportsman's gun? Will our museum be more completely housed and all of its treasures more effectively displayed for our information and our pleasure? No doubt you will say that these are vain questions. Perhaps they are.

We may only hope that the Chicago professor will so readily and so rapidly write out his theorem respecting the physical basis of life, so speedily develop the life-continuing elixir that we may all participate, and thus have the opportunity to assemble here forty years from now and see for ourselves with our mortal eyes just how things are. The prolongation of our longevity, even by any physical, chemical, or electrical appliance invented at Chicago or elsewhere, would not, I am sure, lessen our friendship or weaken our moral forces or dilute the strength of our intellectual and spiritual consciousness.

REPORT ON ARCHÆOLOGY.

During the past year considerable field work was done in this department. In July I visited Albert County, and spent some time examining the region adjacent to the Shepody river. I was not able to find any ancient Indian village sites on the Shepody river, but this is not surprising, as the conditions there are not favorable for a hunting and fishing people.

There is, however, a fairly well marked camp site on the northwest side of the Germantown Lake. Here on a flat by the lakeside, on the farm of Mr. Berryman, a number of flints have been found, and the situation is in every way favorable both for fishing and for hunting.

The Honorable A. R. McClelan informed me that many years ago he had found a stone axe on the hillside above the village of Riverside.

Prof. W. F. Ganong accompanied me on this trip, and made some interesting observation on the remains of the early French occupation of this region. The results of his work will appear elsewhere.

In August I proceeded to McDonald's Point, at the mouth of the Washademoak. Landing at Wright's wharf I spent some days exploring the surrounding region. Some two hundred yards to the westward of the wharf I found a "pitted stone," while at and near the wharf I found large quantities of flakes and chips of jasper, chalcedony, etc., all undoubtedly made from material procured from the quarry not far away, which have been described by Dr. G. F. Matthew.* I found one broken arrow-head, but no perfect implements. Residents have found arrow heads, gouges, celts, spear heads and scrapers here, and some of these specimens are very good. Mr. R. P. McDonald has a very fine felsite spear head inches long, and with sharp serrated edges. When found in 1877 it was perfect, but it is now broken.

From McDonald's Point I went to Lakeville Corner. Here I spent some considerable time in company with Mr. D. London, one of our corresponding members, in exploring what is to the archæologist probably the most interesting region in our province. An examination was made of the physiography of the French and Maquapit Lakes,

* Proc. Royal Soc. Canada, new series, VI, section ii, 61-69.

particularly the course of the thoroughfare. Large collections of Indian remains were made, and as a result, material is now available for study, which I believe will enable us to form a much better idea than we have hitherto had of the antiquity of man in central New Brunswick. I wish to express my thanks for the aid rendered me in this work by Mr. London.

Later in the season I spent some weeks in field work at Grand Lake. I made my headquarters at Douglas Harbor, and my excursions ranged from Indian Point to Sypher's Cove.

At the Key-hole, about two and a half miles above Douglas Harbor, a long, wide and high sea-wall confines a large pond. This pond has a small, winding outlet known locally as the "Lead." This pond is a great resort for fish, and as the outlet is narrow and shallow, it is an excellent place to catch them. For this reason, probably, the inner side of the sea-wall was occupied as a camp site in prehistoric times. On the left hand side of the highway, about a hundred yards eastward beyond the bridge over the "Lead," I made several excavations in the sand and gravel, and secured numerous fragments of aboriginal pottery. The storms and freshets of generations had piled sand and gravel over the old camp site, and at depths of three and four feet, I uncovered fragments of pottery, flakes, charred wood and charcoal. I consider this the very best place in New Brunswick to look for ancient pottery.

I also examined Grand Point, and was able to make an improved map of this point as well as of the "Key-hole."

On the east side of Douglas Harbor is pointed out the Indian Bath house of Louis Joseph, an Indian proprietor who died about sixty years ago.

While at Douglas Harbor I received aid from Messrs. Asa Balmain, David Balmain, Lemuel Colwell, Abijah Coakley and W. S. Butler, to all of whom I wish to express my thanks.

When my health will permit I hope to lay the results of my summer's work before the Society in extended and illustrated form.

Muskoka, Ont., January, 13, 1902.

REPORT OF THE COMMITTEE ON BOTANY.

There is urgent need of a new list of plants of the province that will include the many additions to our flora since Professor Fowler published his list more than twenty years ago; and also to bring the nomenclature more in accordance with the usage of botanists which prevails at the present time. A strong effort should be made by our botanists during the approaching season to accomplish this work for the Society.

The list of fungi collected, new to the province, during the past year, embraces some twenty species, several of which are rare in North America. The study of these interesting plants is now engaging the attention of several students in different parts of the province, including Miss Van Horne, at St. Andrews; Mr. Vroom, at St. Stephen; Mr. Moser, in King's County, and several others. Additions to the list will be presented next year.

The following is a list of flowering plants new or little known in the province. A list of plants collected on the borders of Maine and New Brunswick by Mr. M. L. Fernald, of the Botanic Garden, Cambridge, Mass., and accompanied by specimens has been presented by that gentleman to the Society. He has for years manifested a deep interest in our botanical section, and merits our hearty thanks for his help and encouragement.

1 Clematis verticillaris, D. C. New Canaan, Queens County. J. Moser. A new station near St. Stephen. J. Vroom.

6 Anemone riparia, Fernald. Dry open woods. Four Falls. M. L. Fernald.

60 Raphanus Raphanistrum, L. Of late years becoming a very troublesome weed in Charlotte County. J. Vroom.

63 Viola lanceolata, L. In different parts of Charlotte County. J. Vroom.

64 V. primulæfolia, L. Quite frequent on banks of St. Croix River, above Sprague's Falls. J. Vroom.

68 V. cucullata, Ait. As heretofore understood in New Brunswick, this species must be divided into several, of which, probably, the true V. cucullata is among the least common. The group needs study.

68*a* **Viola ovata,** Nutt. A violet found some years ago on the shore of Lake Utopia should probably be referred to this species, which occurs near Bear River, Nova Scotia.

69 Viola Labradorica, Schrank (=V. canina, var. Muhlenbergii of last year's report, and V. canina, var. sylvestris, of former lists). In wet soil under trees near St. Stephen. J. Vroom.

69*a* Viola subvestita, Greene. Much more abundant and showy than V. Labradorica, with which it has been confused. It grows on dry hill tops in and near St. Stephen, and is probably the form reported from other places in the province under the name of V. canina, var. sylvestris. Easily distinguished from V. Labradorica by its habitat, and by its deep violet color, as dark as the darkest of our stemless blue violets, and more reddish in hue. [In Prof. Greene's description of V. subvestita (Ottawa Naturalist, December, 1901), the bractlets are said to be very near the flower, and notably auriculate at their base. These characters are not very evident in the St. Stephen plant.] J. Vroom.

122*a* **Ilex glabra,** Gray. Found in Shelburne County, Nova Scotia, by Mr. C. S. Bruce.

125 Vitis riparia, Michx. A single plant seen on the bank of St. Croix river, above Sprague's Falls, 1899. J. Vroom.

125*a* **Vitis Vulpina,** L. Gravelly bank of Aroostook river, Four Falls, Victoria County. M. L. Fernald.

147*a* **Astralagus elegans,** (Hook) Britton. Aroostook Falls. M. L. Fernald.

165*a* **Spiræa Sorbifolia,** L. Old pastures. Aroostook Junction. M. L. Fernald.

191*a* **Agrimonia striata,** Michx. (See *Rhodora*, ii, 237). Sent from Digby, N. S., by Mr. N. W. Hogg.

257 Cornus circinata, L'Her. Bank of Aroostook river, Four Falls. B. L. Robinson and M. L. Fernald.

268 Viburnum Lentago, L. Abundant on Blood Island, St. Croix River.

270*a* Triosteum perfoliatum, L. Rich wooded banks of Aroostook river, Four Falls, Victoria County. M. L. Fernald.

307 Aster Lindleyanus, Torr and Gray. Dry woods. Four Falls. M. L. Fernald.

347 Artemisia absinthium, L. Dry borders of woods, Grand Falls. M. L. Fernald.

363*a* Hieracium aurantiacum, L. Rapidly spreading as a weed in hay fields in different parts of Charlotte County. J. Vroom.

433*a* Gentiana rubricaulis, Schwein (=G. linearis, var. latifolia, Gr.) Dumbarton (the third station reported in Charlotte Co.) J. Vroom.

434*a* **Bartonia tenella,** Muhl. Shelburne, N. S. C. S. Bruce.

446 Echium vulgare, L. Welsford, Queens County. G. U. Hay.

494 Calamintha Clinopodium (L.) Kuntze (Satureia Clinopodium, Carnel). Alluvial soil. Four Falls. B. L. Robinson.

582*a* Salix glaucophylla, Bebb. Gravelly beach of Aroostook river, Four Falls, Vict. Co. M. L. Fernald. A form with pubescent twigs found at the same place.

583 Salix nigra, Marsh. Washademoak Lake and Canaan Forks, Queens Co. J. Moser. Brandy Point, St. John River, Macoun and Hay.

583*a* **S. sericea,** Marsh. Washademoak Lake. Rare. J. Moser.

586 Salix myrtilloides, L. (This willow, found last summer in Magnerawaak meadow, Calais, probably occurs on the Canadian side of the river. J. Vroom).

639*a* **Smilax rotundifolia,** L. Found at Lake Annis, near Yarmouth, Nova Scotia, by Mr. D. Soloan ; and near Shelburne harbor, N. S., by Mr. C. S. Bruce. (This and the other plants named above from Nova Scotia may be looked for in New Brunswick.)

713 Naias flexilis, Rostk. St. Croix River, below Grand Falls (the second station in Charlotte County). J. Vroom.

939*a* Lycopodium clavatum, L. Var. **Monostachyon,** Hook. Open spruce woods, Grand Falls. M. L. Fernald.

940 L. complanatum L. Open woods. Grand Falls. B. L. Robinson and M. L. Fernald. (The typical form with more distinctly dimorphous and narrower leaves and less erect and bushy branches than the variety *Chamæcyparissus*.

940*b* L. sabinæfolium, Willd. Open spruce woods. Grand Falls. B. L. Robinson and M. L. Fernald.

OBSERVATIONS OF PLANTS, 1901.

After a winter of severe though not intensely cold weather and abundant snow, the spring opened in early April with many warm days during which the grass grew rapidly. In later April and early May cold east winds prevailed. Tussilago farfara (coltsfoot), one of the earliest plants to appear, was observed in bloom by the side of the street opposite the Custom House, St. John, April 23rd.

Wild Garden at Ingleside, Kings County.

May 1st.—In the wild garden, at Ingleside, Viola blanda and Epigæa repens were observed in full bloom. In exposed places a few strawberry blossoms were appearing. The red maple was coming into bloom, and the Dog-tooth Violet (Erythronium Americanum) blossoms were beginning to open.

May 10th.—A beautiful day—warm and spring-like—followed by three days of rain. Temperature moderate, grass growing rapidly and buds on the trees bursting into leaf, the white birch leading. Red maple blossoms falling. Sanguinaria Canadensis in bloom. Blue violets coming in flower, Dog-tooth Violet, the Gold Thread, Grove Anemone and Mountain Fly Honeysuckle (Lonicera ciliata) in full bloom. A few plants in bloom of the Painted Trillium, Dandelion, Marsh Marigold, Strawberry, Bluets, the involucral blossoms, of broad leaved Viburnum, (V. lantanoides), Purple Trillium, Bellwort (Uvularia sessilifolia). The Woodsias and other small ferns on the rockeries with fronds nearly expanded.

May 17th.—In full bloom—Blue violets, Purple and Painted Trilliums, Strawberries and Dandelions, Marsh Marigold, the Fetid Currant (Ribes prostratum). Coming into bloom were the Amelanchier Canadensis, central blossoms of Viburnum lantanoides, Thaspium aureum, and a few blossoms were appearing of Rhodora, Vaccinium Canadense, and the wild red cherry. Of the trees—white birches, lilacs, black cherry (Prunus serotina), Viburnum lantanoides, mountain fly honeysuckle, hazel, hawthorne, mountain ash, were in full leaf. The leaves of poplars, horsechestnuts, and white maples were just unfolding ; also those of the smaller trees of red maples and the Amelanchiers, the latter very beautiful from the contrast of the purple leaves and the white blossoms. The delicate yellowish-green of the unfolding leaves of the aspen (Populus tremuloides), the greenish-white of the poplar (Populus grandidentata), and the delicate green of the Lombardy poplar added to the almost indescribable variety of coloring in the groves and woodlands. The shrubs and trees not native, chiefly those from the Central Experimental Farm, nearly all in leaf.

May 25th.—The white petals of Amelanchier falling. Plants in full bloom—Prunus Pennsylvanicum, Cornus Canadensis, Corallorhiza innata, Trientalis Americana, Rhodora Canadensis, Vaccinium Canadense, Trillium grandiflorum (not native), Trillium cernuum, Viola Watsoni (not native), V. pubescens, Menyanthes trifoliata, Oxalis corniculata, Aralia nudicaulis, Actæa alba, Clintonia borealis. The blossoms of the Stemless Lady's Slipper (Cypripedium acaule) just unfolding. The following named trees and shrubs just coming into leaf : Quercus rubra, Acacia, Rhus typhina, Ilex verticillata Viburnum opulus, Fraxinus sambucifolia ; also the leaves of the ivy Ampelopsis quinquefolia) on the cottage.

June 1st.—After a week of wet, cold weather, June came in bright and warm. The weather was so warm on June 2nd that shade from the sun's rays was grateful. Warm showers alternated with the bright sunshine and vegetation was rapid. The nights remained cool in early June up to the 15th and 16th, when frosts did much damage in low places along the river, killing buckwheat, strawberries and other tender plants, and wilting the fronds of what is perhaps the most sensitive of our ferns to frost—Osmunda cinnamomea. Ice formed in many places in the ponds and along the margins of the rivers and streams.

During the remainder of the summer and fall, but little rain fell. The streams became very shallow and wells were dried up. The crops which were very promising in spring and early summer, suffered greatly in later months from the prolonged drought. Fruits ripened early (ripe strawberries were found as early as June 13th) and these with raspberries and other small fruits in dry places were a scanty crop.

June 8th.—In full bloom — Lilacs, Oak-leaved Mountain Ash, Honeysuckle, Horsechestnut, Yellow and Stemless Lady's Slipper, Iris versicolor, Viburnum opulus, Pinguicula vulgaris, Geranium Robertianum, Oenothera pumila, Leucanthemum Vulgare, Erigeron Philadelphicum, Aster graminifolius, Ledum latifolium, Prunus serotina and others.

FORTIETH ANNUAL REPORT

OF THE

COUNCIL

OF THE

NATURAL HISTORY SOCIETY

OF

NEW BRUNSWICK.

Your Council beg to submit the following report for the year now ending :

Membership.

During the past year the Society has added four ordinary and seven associate members to the roll. The following shows the classes and total membership enrolled :

Honorary members	4
Life members	5
Corresponding members	22
Ordinary members	70
Associate members	110
Total membership of	211

Finance.

Treasurer's Report, 1900–1901.

Receipts —

Balance from 1899–1900	$ 204 41	
Membership fees	39 00	
Bulletins sold	1 00	
Interest on investments	231 30	
Donations	28 83	
Government grant	300 00	
Special deposit Bank of Nova Scotia withdrawn	2,400 00	
		$3,204 54

Receipts brought forward,		$3,204 54
Expenditure—		
Printing and distributing Bulletin XIX	$ 155 48	
Maintenance of museum	74 79	
Library, books and binding	3 15	
Miscellaneous	117 58	
Loaned on mortgage Hazelhurst property	2,500 00	
Balance in Bank of New Brunswick	353 54	
		$3,204 54

The balance of $353.54 in Bank of New Brunswick includes $33.00 held in trust for the Ladies' Association.

The total funds of the Society are now represented by:

Balance Bank of New Brunswick	$ 353 54
Mortgage (Hazelhurst property)	2,500 00
Special deposit, Building Fund, in Bank of N. B.	10 00
	$2,863 54

Our interest in the Hazelhurst property is protected by fire insurance policies to the amount of $2,700.00, and the specimens, etc., are insured for $2,500.00.

A. GORDON LEAVITT, *Treasurer.*

Examined and found correct.

JAMES A. ESTEY,
THOMAS STOTHART, } *Auditors.*

LIBRARY.

The year shows a considerable increase in the library, due principally to our large exchange list. A number of works on various branches of nature study have been purchased, and several valuable books have been presented by members of the Society.

PUBLICATIONS.

Bulletin XIX has been published. It contains articles by Dr. Geo. F. Matthew, Dr. Geo. U. Hay, Samuel W. Kain, Prof. W. F. Ganong, W. McIntosh and Chas. F. B. Rowe; also a report of the Fredericton Natural History Society. Several of the shorter papers read before the Society have been published in the daily press.

Lectures and Essays.

Nine regular meetings were held, at which the following papers were read :

1901.

Jan. 8. (a) Botanical Trip among South Tobique Lakes. Additions to New Brunswick Plants, by G. U. Hay.

(b) Changes in the River Valleys of New Brunswick, by Prof. W. F. Ganong.

Jan. 15. (c) Annual Meeting. Reports. President's Address.

Feb. 5. (a) Sketches of Bird Life, by A. Gordon Leavitt.

(b) Native Plants in Rockwood Park, St. John, by G. U. Hay.

(c) Catalogue of New Brunswick Plant Formations, by Prof. W. F. Ganong.

Mar. 5. (a) Mountain, Lake, and River Scenery in New Brunswick, by Prof. L. W. Bailey.

(b) A Plea for certain Birds, considered destructive, by J. W. Banks.

April 2. (a) Insect Life in the Nerepis Valley, by W. McIntosh.

(b) Physiography of the Digdeguash Lake Basin, by Prof. W. F. Ganong.

May 7. An Evening with the Microscope, by Members of the Section on Microscopy.

June 4. (a) Note on the Possibility of Developing Power by the Movement of Tides at the Falls, by Prof. A. W. Duff.

(b) Morphology of New Brunswick Water Falls, by Prof. W. F. Ganong.

(c) Report of Delegate to Royal Society.

Oct. 1. (a) Random Notes on Cape Breton, (b) Additional Notes on the Cambrian of C. B., with descriptions of new species, by G. F. Matthew, D. Sc.

Nov. 5. (a) Observations on a Summer's Work, by L. W. Bailey, Ph. D.

(b) Notes on the Physiography of the Tu-a-dook (Little Southwest Miramichi) Lake Basin, by W. F. Ganong, Ph. D.

Dec. 3. (a) Our Forests and their Inhabitants, by W. A. Hickman, M. A.

(b) Preliminary List of Coleoptera of New Brunswick, by William McIntosh.

(c) On the Physiography of the Tobique-Miramichi Water Shed, by W. F. Ganong, Ph. D.

(d) Observations in Wild Garden at Ingleside, by G. U. Hay, D. Sc.

In addition to the above, an elementary series of lectures was delivered, viz :

Jan. 22. (a) Depths of the Ocean.

29. (b) Tides and Erosion of the Bay of Fundy, by Dr. Geo. F. Matthew.

Archæology.

Mr. S. W. Kain has been doing some very valuable archæological work in the vicinity of Grand and Maquapit Lakes during the past summer.

This region owing, no doubt, to the abundance of fish and game, was a favorite camping ground of the Indians, and, in exploring these ancient camp sites, Mr. Kain discovered a large number of stone implements, consisting of arrow-heads, stone-axes, hammer-stones, celts, and many fragments of aboriginal pottery. A number of these fragments show ornamentation distinct from any hitherto observed in New Brunswick specimens of the Indian potters' art. All the articles collected were presented to the Society.

While at Grand Lake Mr. Kain purchased for the Society a large number of relics of the New Brunswick stone age from local collectors.

Geology.

Dr. Matthew has been doing some geological work in Cape Breton and New Brunswick during the past summer. Among interesting additions to our knowledge of Cambrian geology from the former region, is the discovery of two new faunas in the Cambrian—one in the flags corresponding to those in St. John, this is the Upper Paradoxides fauna. The other is the Tremadoc fauna of Wales, whose place at St. John would be in the channel of the river at the Straight Shore, therefore inaccessible here.

Dr. Bailey has done a summer work for the Geological surveys of Canada in Central and Eastern New Brunswick ; in the former district he has found extensive areas of Upper Silurian slates, and in the latter has been investigating the probable occurrences of coal and oil.

Mr. Kain's discovery of submerged fire-places of the stone age seen in Maquapit Lake are referred to in the report of the Geological Committee.

Warping of the Earth's Crust near St. John in Recent Times.

By the term " recent times," in the above title, is intended times geologically recent.

Assuming that Post-Pleiocene time closed with the emergence of the Leda clay and the formation of the Saxicava, or Macoma sands, the overlying, bog, marl, and marsh deposits, will be included in recent deposits.

Certain phenomena observed in Southern New Brunswick, involving these deposits, indicate a differential sinking of the land in portions of the interior which are best explained as a warping of the earth's crust.

About twenty-five years ago, excavations of the marsh-mud in Harris' Cove, fourteen miles from the mouth of the Kennebecasis river, were made for the purpose of obtaining fertilizer. It was found that for five feet below the present low water summer level of the river there were marsh surfaces, indicated by layers of partly decayed marsh grass, with roots and attached leaves.

These marsh grasses could not have grown under present conditions, but must have flourished when the mud in which they grew was at a level considerably higher, relative to the water level of the river, than it is now.

Two possible causes of this former condition of the Kennebecasis river may be suggested in explanation, one that the upper part of the river stood at a higher level relative to the lower part than it does now. The other is that there existed formerly a lower outlet of the river than the present one at the Falls of the St. John.

The second possible cause of a lower outlet is not borne out by any indications of a lower discharge for the waters of the St. John since Post-Pleiocene time. Except the rock-bottomed passes of Drury's Cove and the present outlet, all other possible passages are at present filled with Post-Pleiocene deposits.

Even if the passage at the "Falls" had been lower in former times, it would not mend the matter, for at present the level of the water in St. John harbor at high tide is about six or eight feet above the summer level of the water in the Kennebecasis river. The only result, therefore, of a lowering of the barrier would be to flood the Kennebecasis marshes at high tide and prevent the marsh growth, even at the present level.

With the opening of the barrier it would be necessary that there should come a reduction in the height of the Bay of Fundy tides, in order that the marsh-plants might flourish in Harris' Cove five feet below the present summer level. Such an assumption is gratuitous, and without any evidence in fact.

With the constant wear on the crown of the reef at Union Point in the "Falls" it might be supposed that the tides would gain more and have easier access to the river. But it seems a question whether this cause of abrasion — the rushing water with its load of mud and sand — has had any appreciable effect in historic times in reducing the height of the barrier; and there certainly has been a countervailing force at work, tending to lift the barrier higher.

In a former Bulletin attention was called to a force operating later than the glacial period to raise certain portions of the solid rocks around St. John. Of this, evidence may be seen on the hillside south of the "valley" in St. John, where, in a short space on the slope of the hill, the rocks have been raised five feet since the glacial period. There seems nothing to indicate subsidence at the barrier at the "Falls," and whatever evidence there is, favors elevation.

It would seem then that we are forced to regard differential uplift, or in other words, warping of the earth's crust, as the cause of the phenomenon observed in Harris' Cove. And, further, it would seem that this movement was slow and continuous, as there were not only marsh-surfaces at five feet below the present marsh only; but the marsh-surface was many times renewed, from the lower layers observed to the present surface.

As bearing upon the phenomenon of the drowning of the upper part of the lower Kennebecasis valley since Pleistocene times, one might call attention to a like condition of things effecting the valley of the St. John river, as observed by members of this Society, when the summer camp of observation was held by it at French Lake some years ago.

During exploration along the south shore of the Maquapit Lake a curious short creek was observed without outlet, save two, close together, on the lake shore. This short creek seemed to be a bend or loop of a creek, once existing, which had been obliterated, except for this bend, by the encroachment of the lake.

One of our members, Mr. S. W. Kain, who spent some time at Maquapit Lake last summer when the water of the river was low, has traced this submerged creek under the shallow water at the south end of the lake, and found that Ring Creek is indeed a bend of what was formerly a continuous creek or thoroughfare from French Lake to Grand Lake. And further, he made the interesting discovery that along the banks of this drowned creek, under the shallow waters of Maquapit Lake, can be seen collections of stones in some places, such as the Indians would leave, of their camp fires, where they had lived alongside the creek; stone implements and other indications of aboriginal occupancy were also found at these places.

Evidences of camp fires of the aborigines along this submerged water-way shows that the subsidence of this area was prolonged into a comparatively late period, since such fresh marks of Neolithic occupancy can be found.

A closer study of the sunken area in this part of the valley of the St. John river would probably give interesting and valuable results.

Ornithology.

The Ornithological Committee report that the year has been an exceedingly quiet one as far as new material is concerned.

At present they have under consideration the preparation of a catalogue of specimens in the museum, which, when completed, will fill a long felt want.

The specimens have, as usual, been the centre of attraction to the majority of visitors.

Entomology.

The Entomological Committee report that during the past year over 2,500 specimens have been collected by members of the Society. Not only has a great deal of valuable field work been done, but the majority of the specimens taken have been determined by specialists.

Field Work.

Two field meetings were held under the auspices of the Society during the past summer, one at Ingleside, August 24th, and the other in Rockwood Park in September. Both were well attended. The one at Ingleside occupied the whole day. In the morning the members of the Society and their friends examined the plants in the wild garden, and in the afternoon a visit was made to a hill near Brandy Point overlooking the St. John river. Here the meeting was called to order by the president, Hon. J. V. Ellis, and an address was given by Dr. Matthew on the geology of the locality, linking with it a very interesting history of the St. John river valley in ages past. G. U. Hay followed with a talk on the plants found in the neighborhood, their habits, uses, and the many curious ways they adapt themselves to their surroundings. W. A. Hickman gave an address on evolution and some tendencies of modern science. Prizes were awarded in geology and botany for collections found during the day.

At the meeting at Rockwood Park some of the most interesting natural features of that beautiful locality were examined, including the geology and botany. At the conclusion of the afternoon's outing the members were hospitably entertained at Dr. Matthew's home, and prizes were awarded to successful competitors in geology and botany.

Your committee would suggest, that as there are difficulties in the way of holding a summer camp at a distance from the city, a series of field meetings on a more extended scale than heretofore be held during the coming summer. One at Ingleside, or some point on the St. John river, or C. P. R., in which some effort should be made to have the Fredericton Natural History Society unite; one on the Kennebecasis river, in which the Kings County Society may share, one to the west, and another to the east of St. John city, and one on the sea shore—five in all.

And your committee would further suggest that adequate prizes be provided that shall reward certain definite efforts, which it is hoped may be put forth by our own younger members, to make collections of specimens of natural history in the places visited, these prizes to be awarded at the next annual meeting when the collections made shall be exhibited and become the property of the Society.

G. U. HAY, *Chairman.*

GENERAL.

The museum has been open to the public on Tuesday, Thursday and Saturday afternoons, and, as the register shows, has attracted many visitors.

We regret that other duties make it necessary for Miss McBeath to retire from the office of assistant curator. Three years ago the museum was opened to the public three afternoons of each week with Miss McBeath in charge, and the success which has attended this movement is largely due to the courteous and efficient manner in which she performed the duties of her office.

The council wish to express their thanks for the very hearty co-operation and valuable work done by the associate members. The many improvements seen in the library are due to the efforts of the ladies' branch, and the general work of the Society owes its success, in no small measure, to their efficient assistance.

To the press of St. John our thanks are due for the free insertion of notices and reports, and for the publication of articles from time to time. The council also wish to thank those who have delivered addresses or lectures before the Society.

While reviewing the past year we do not find so many remarkable features as in the preceding one. But we feel satisfied in considering it a year of more than average progress. There has been a gain in membership, and we have had a considerable increase in our grant from the provincial government.

In archæology, geology, botany and entomology much important field work has been done. Our lecture course has been varied and interesting, and our meetings well attended.

Respectfully submitted,

W. McIntosh,
Secretary to Council.

DONATIONS TO THE MUSEUM, 1901.

Date.	Donor's Name and Description of Gift.
Feb. 5	Dr. Geo. F. Matthew, St. John. Two Colored Charts, Bay of Fundy.
	Mrs. Baxter, St. John. Two Specimens of Fossil Plants.
Mar. 5	Miss Georgie E. Curry, Shreveport, La. Miniature Bale of Cotton.
Apr. 2	D. Ferguson, Esq., Chatham. Two Bayonets, a Shoe-buckle, and two Knife or Spearblades.
	Stanley Thompson, St. John. Two Specimens Rock Crystal, from Sheet Harbor, N. S.
Oct. 1	S. W. Kain, Esq., St. John. Stone Implements and Pre-historic Pottery, from Grand Lake Region.
	A. Gordon Leavitt, Esq., St. John. Shells from Nerepis River.
	Stanley Thompson, St. John. Native Woods.
	S. A. Coakley. Pisolithic Iron Ore.
	Dr. W. D. Matthew, New York. Series of Photographs of fossil remains of Pre-historic Horse.
Nov. 1	Geoffrey Stead, Esq., C. E., St. John. Copper Ore.
	Prof. L. W. Bailey, Ph. D., Fredericton. Fossils and Geological Specimens.

DONATIONS TO THE FUNDS.

Anonymous $28 83

DONATIONS TO THE LIBRARY, 1901.

Donor's Name.	Residence.	Work.
Mrs. Geo. A. Hamilton	St. John	Books.
Prof. W. F. Ganong	Northamp'n, Mass.	1 year's Subt. to Science
Mrs. John Berryman	St. John	Books.
Royal Society of Canada	Ottawa	Proceedings.
Geological Society	Manchester	Transactions.
Royal Colonial Institute	London	Journals.
Marine Biological Association, U. K.	London	Journals.
Geographical Journal	London	
Royal Gardens	Kew, England.	Bulletin.
British Museum	London	Hand List of Birds.
New Zealand Institute of Science	Hobartown	Proceedings.
Western Australian Government	Perth	Mining Stat., (Gazette.)
N. S. Wales Linnæan Society	Sydney	Proceedings (Abstract.)
Smithsonian Institution	Washington	Reports.
New York Academy of Science	New York	Jour., Annals, Memoirs
Academy of Natural Sciences	Philadelphia	Proceedings.
Field Columbian Museum	Chicago	Reports and Bulletins.
Wyoming Historical and Geological Society	Wilkesbarre	Proceedings.
American Museum Natural History	New York,	Bulletins, Report.
Wisconsin Natural History Society	Milwaukee	Bulletin.
Indiana Department of Geology	Indianapolis	Reports.
Newport Natural History Society	Newport, R. I.	Proceedings.
Natural Science Association	Staten Island	do.
South Dakota School of Mines	Rapid City	Bulletins.
New York Public Library	New York	do.
Cornell University	Ithaca, N. Y.	do.
Hamilton Scientific Society	Hamilton	
University of Toronto	Toronto	Studies.
Morphology of Central Cylinder in Angiosperms		By E. C. Jeffrey.
Library and Scientific Society	Ottawa	Transactions.
Entomological Society of Ontario	London	Canadian Entomologist
Historical and Scientific Society of Manitoba	Winnipeg	Reports and Transac.
Department of Inland Revenue	Ottawa	Bulletins.
Dalhousie University	Halifax	Calendar.
Royal Society	London	Proc., Rep'ts. Year Bk.
Maryland Geological Survey	Baltimore	Atlas, Eocene.P-Am.Ex
Wisconsin Academy of Science, Arts and Letters	Madison	Transactions.
School of Geography	Lancaster, Pa.	Journals.
University of Michigan	Lansing	Bulletins.
Linnæan Society	New York	Abstract.
U. S. Commissioner of Agriculture	Washington	Circul'rs, Bul'ts, Repts.
U. S. Geological Survey	Washington	Mono'gphs, Rpts, Bul'ts
Canadian Institute	Toronto	Proceedings.
Department of Inland Revenue	Ottawa	Bulletins.
Johns Hopkins University	Baltimore	Circulars.
Connecticut Academy of Arts and Science	New Haven	Transactions.
New York State University	Albany	Report.
McGill University	Montreal	Papers
Essex Institute	Salem, Mass	Magazine, Can. Erb.
Natural History Association	Miramichi	Proceedings.
California Academy of Science	San Francisco	do.
Colorado Scientific Society	Denver	Proc. College Studies.
Australian Museum	Sydney, N. S. W.	Records, Reports.
Rochester Academy of Science	Rochester, N. Y.	Proceedings.
University of California	Berkley	Bulletins
Director of Bureau of Ethnology	Washington	Annual Reports.
Public Museum	Milwaukee	Annual Reports
Geological Society	London	Abs. of Proceedings.
Missouri Botanical Gardens	St. Louis	Report.
Ohio State University	Columbus	Report.
Society of Natural Sciences	Buffalo	Bulletin.
Society of Natural History	Boston	Proceedings.

DONATIONS TO THE LIBRARY. —Continued.

Donor's Name.	Residence.	Work.
Lloyd Library	Cinncinati	Bulletin.
Society of Natural History	Cincinnati	Bulletins.
Museum Association	Cincinnati	Annual Report.
Astronomical Society	Toronto	Transactions.
U. S. Coast and Geodetic Survey	Washington	Report.
U. S. Fish Commission	Washington	Bulletin.
Iowa Geological Survey	Des Moines	Report.
Minnesota Academy of Natural Sciences	Minneapolis	Bulletins.
Society of Natural History	Portland	Bulletin
Geological Survey	Ottawa	Reports, Maps.
Yorkshire Geological and Polytechnic Society	Leeds	Proceedings.
Biological Society	Liverpool	do.
Geological Society	Liverpool	do.
Museum's Journal	Sheffield	do.
Academy of Science	St. Louis	do.
Nova Scotia Museum	Halifax	Report.
Field Naturalist Club	Ottawa	Ottawa Naturalist.
National Museum	Montevideo	Annals.
Feuille des Jeunes Naturalistes	Paris	Journal.
Societe Geologique de Belgique	Liege	Transactions.
Geological Instnution	Upsala	Bulletin.
Societe Scientifique du Chile	Santiago	do.
U. S. Weather Bureau	Washington	Weather Review Rep'ts
Colorado College		Studies.
Experimental Farms	Ottawa	Bulletins.
Indiana Academy of Science	Indianapolis	Proceedings.
Institute Geologico de Mexico	Mexico	Bulletin.
Crown Land Department of New Brunswick	Fredericton	Annual Report.
Royal Academy of Science and Arts	Barcelona	Bulletin.
Imperial Academy of Science	St. Petersburg	do.
Field Naturalist Club	Ottawa	Canadian Botany.
Field Naturalist Club, Sir Wm. Dawson	Ottawa	Bibliography.
Royal Academy of Science	Stockholm	Proceedings.
Royal Societe Malacologique Belgium	Brussels	Bulletin.
Queen's Quarterly	Kingston	Journal.
Public Library	Toronto	Catalogue.
Department of Agriculture	Ottawa	Bulletin.

PURCHASED.

Chambers' Cyclopedia of English Literature. Two Volumes.

Hicker's Epidemics of Middle Ages.

Archaia. By Sir J. W. Dawson.

Drew's Chronological Chart.

Statistical Year Book of Canada.

LIST OF MEMBERS.

Honorary Members.*

Bailey, Prof. Loring W........Fredericton.
Ganong, Prof. W. F........Northampton, Mass.
Laflamme, Monsignor J. C. K........Quebec.
Marr, Prof. John E........Cambridge, G. B.

Life Members.

Chamberlain, M........Boston, Mass.
Hegan, James B.*........Charlottetown.
Hay, George, U........St. John.
Matthew, R.*........Cienfuegos, Cuba.

Corresponding Members.

Baxter, Dr. John........Chatham.
Brittain, John........Fredericton.
Butler, W. S........Butler, Queens County.
Chalmers, Robert........Ottawa.
Cox, Dr. Philip........Chatham
Duncan, Dr. G. M........Bathurst, N. B.
Forir, H........Liege, Belgium.
Gesner, G. W........New York.
Gilmor, Dr........Quaco.
London, Duncan........Lakeville Corner.
Hickman, W. Albert........Pictou, N. S.
Kirkland, Dr. R. J........Grand Rapids, Michigan.
Livingstone, Colin H........New York.
McLaughlin, D. J. W........Grand Manan
Matthew, Rev. C. R........Kingsville, Ont.
Matthew, Dr. William D........New York
Moore, W. A........York County.
Perkins, Henry........McAdam, N. B.
Smith, Dr. A. C........Tracadie, N. B.
Trueman, Geo. J........Sackville.
Vroom, James........St. Stephen, N. B.
Wilson, W. J........Ottawa.

* Members since organization in 1862.

Ordinary Members.

Addy, H. Geo. M. D.
Allan, W. Watson.
Barnhill, Geo. E.
Bowden, Wm. C.
Burdett, W. F.
Bustin, S. B.
Banks, J. W.
Campbell, J. Roy.
Clarke, C. P.
Day, Geo. A.
deSoyres, Rev. J.
Ellis, Hon. J. V., LL. D.
Ellis, W. L., M. D.
Estey, James A.
Fairweather, G. Ernest.
Fisher, W. S.
Flood, Edward H. S.
Fotheringham, Rev. T. F.
Frink, J. H., M. D.
Gilmour, A. B.
Hall, Percy G.
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Holman, F. E.
Howe, John D.
Inches, R. P., M. D.*
Jones, Fred. C.
Kain, Samuel W.
Kingdon, Right Rev. Dr.
Kinnear, Harrison
Leavitt, A. Gordon
Lordly, Arthur R.
Lordly, Henry R., C. E.
Markham, Alfred
Melvin, Dr. G. G.
Morrisey, Alfred
Mowatt, Jas.
Mowatt, W. H.
Murdoch, Wm., C. E.
McIntosh, W.
McKinnon, John
Paddock, M. V.
Reynolds, James
Rowe, Chas. F. B.
Rogerson, John
Scammell, J. H., M. D.
Scovil, E. G.
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Seely, Alfred
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METEOROLOGICAL ABSTRACT FOR 1902.

OBSERVATIONS RECORDED AT ST. JOHN OBSERVATORY, LATITUDE 45° 17′ N. LONGITUDE 66° 4′ W.

D. LEAVITT HUTCHINSON, *Director*.

	Barometer.			Thermometer.			Clearness: 0 = clear; 10 = wholly clouded.	Precipitation: Rain and melted snow.	Wind Direction and Velocity.																		Thunder Storms.
									N.		N. E.		E.		S. E.		S.		S. W.		W.		N. W.				
	Mean.	Highest.	Lowest.	Mean.	Maximum.	Minimum.			Hours.	Miles.	Hours.	Miles.	Hours.	Miles.	Hours.	Miles.	Hours.	Miles.	Hours.	Miles.	Hours.	Miles.	Hours.	Miles.	Hours Calm.	Total Miles.	
January	29.94	30.57	28.80	19.6	42.5	—14.8	7	4.73	93	943	221	2713	15	132	37	588	10	97	59	920	30	254	241	3452	38	9,099	0
February	29.57	30.08	29 04	19 5	38.7	3.1	5	0.99	71	921	42	642	1	16	3	36	3	28	79	843	24	176	432	7097	17	9,759	0
March	29.91	30.46	29.52	29.8	48.7	—1.5	7	3.21	60	485	96	682	30	195	103	1658	52	473	144	2162	76	593	141	2276	42	8,524	0
April	30.13	30 57	29.54	43.9	64.8	25	7	3.56	5	56	307	3930	50	370	185	2354	65	298	37	197	5	15	3	9	63	7,229	0
May	29.96	30.30	29.39	49.4	69.6	32	7	4.07	35	513	133	1328	41	413	71	670	97	533	290	2323	14	92	13	111	50	5,983	1
June	29.98	30.31	29.70	57 9	78.6	40 6	6	6.84	21	162	67	815	21	259	13	136	144	1073	380	3373	10	59	54	763	10	6,640	3
July	29 92	30.32	29.65	63.4	84.3	49	5	1.16	70	516	22	195	53	319	22	96	176	973	231	1800	47	314	66	666	57	4,879	2
August	30.09	30 34	29.76	65.1	78.5	52	5	1.47	70	565	44	489	19	105	6	79	192	1209	286	2646	45	319	49	673	31	6,085	1
September	30.03	30.48	29 61	58	80.3	40	5	3.35	94	948	44	389	7	60	11	80	105	799	282	2660	23	187	99	1762	55	6,885	0
October	30.05	30.69	29.31	48.5	63.5	31.2	6	1.51	115	1108	39	349	...	...	27	308	57	655	266	3753	42	317	159	2649	39	9,139	1
November	29.87	30.45	28 92	35.1	56.4	13	7	3.24	161	1687	142	1534	23	312	17	229	19	483	74	1260	38	392	208	3491	38	9,388	0
December	29.95	30.67	29.23	27.4	51.1	—2	7	4.99	142	1418	170	2175	8	92	69	1627	22	327	103	2328	50	575	162	2638	18	11,180	0

Barometer readings have been reduced to sea level and 32° Fahrenheit. The minus sign when used, indicates temperatures below zero, The maximum temperature, 84.3, was registered on the 15th July; the minimum, 14.8 below zero, on the 20th of January. The total precipitation for year was 39.12 inches.

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NOTICE.

The Society has for sale the following publications, which may be had on application to the Secretary.

	PRICE.
Geological Map of St. John and Vicinity, by William D. Matthew, 1894,	.10
Map of Nictor Lake and Vicinity, by Prof. W. F. Ganong.............	.10
Map of South Tobique Lakes, by Prof. W. F. Ganong.	.10
How to find Time of High Water on the St. John River, by A. W. Duff,	.10
Economic Mollusca of Acadia, by W. F. Ganong, Bound in cloth. Excellent handbook for students in the Atlantic Provinces of Canada and Maine ; also of value to fishery officials,.......	.50

The Bulletins of the Society contain the following articles, among others :

Bulletin X.—Discoveries at a Village of the Stone Age at Bocabec, N. B.; Fossiliferous Horizons of the Cambrian Rocks at St. John, N. B., by Geo. F. Matthew.................	.40
Bulletin XI.—The Climate of Acadia in the Earliest Times, by Geo. F. Matthew; Observations on some New Brunswick Fishes, by Philip Cox	.40
Bulletin XII.—An Outline of Phytobiology, by W. F. Ganong; Crystalline Rocks near St. John, by W. D. Matthew; and Outlets of the St. John River, by Geo. F. Matthew.	.50
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