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OF

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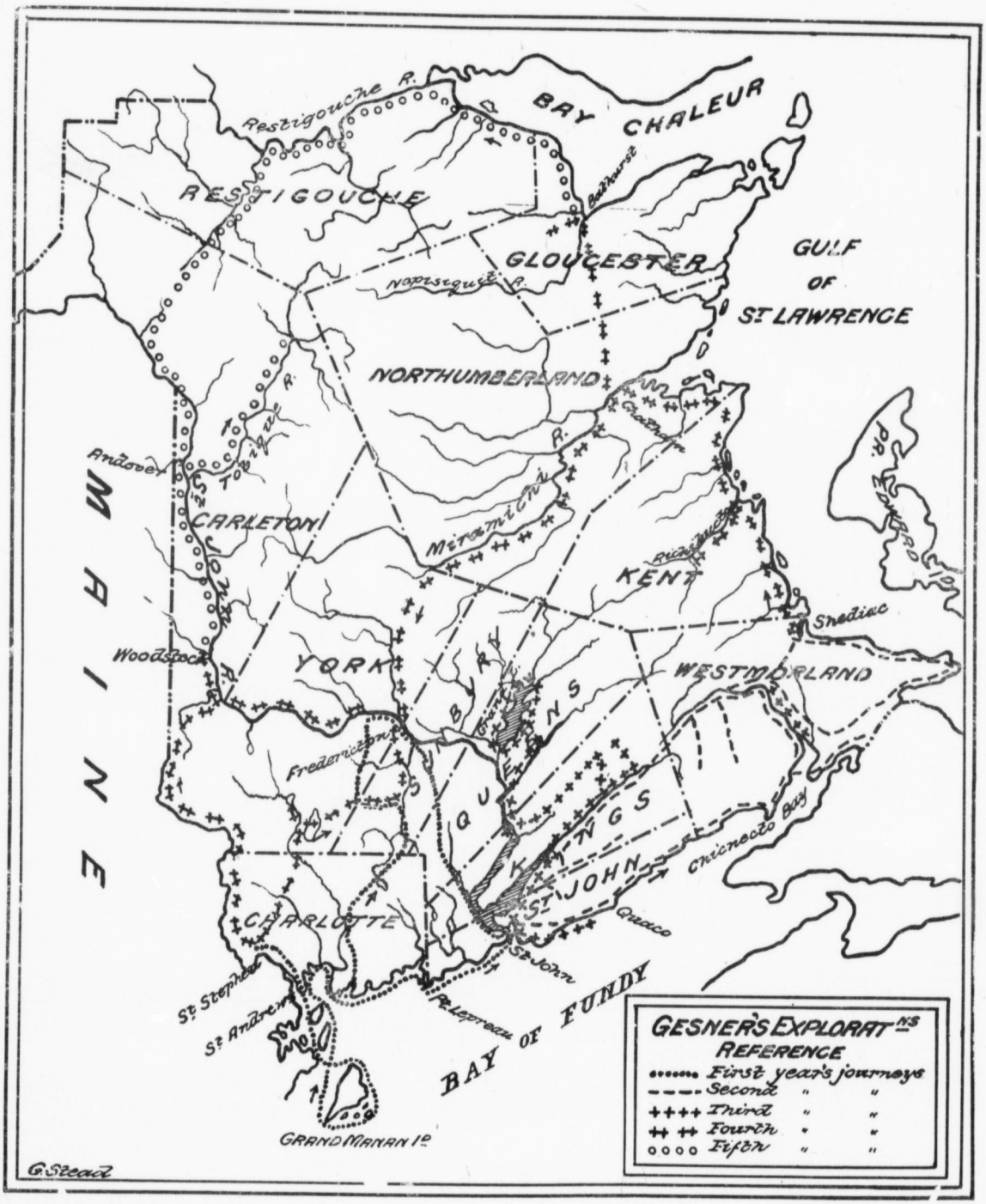
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BULLETIN
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ARTICLE I.

ABRAHAM GESNER.

A REVIEW OF HIS SCIENTIFC WORK.

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

Read November 1st, 1892.

About half a century ago the name of Abraham Gesner became widely spread in the Maritime Provinces of Canada, from his efforts to make known the mineral wealth and great natural resources of his native province of Nova Scotia; and from his zeal in proclaiming the truths of the new science of Geology.

Born in the midst of a district famed for its natural beauty and its fertility—the land of Evangeline—he was within easy reach of some of the most prolific mineral localities, and some of the most remarkable natural geological sections to be seen in the Maritime provinces of Canada. It is not surprising, therefore, that he should have been filled with enthusiasm for the new science, and should have endeavored by tongue and pen to make known the natural wealth of the Acadian land.

A knowledge of the early life and character of Gesner will naturally be sought for by those who are interested in his scientific work. Fortunately this has been supplied by his surviving sons, now living in New York; and a biographical sketch of his father written by G. W. Gesner has been published in the fourteenth Bulletin of this Society (1896).

The following sketch of Dr. Gesner's scientific work was read before this society some years ago but was held over from publication, awaiting a more detailed account of his early life and education than was then available. This account has been furnished by the Messrs. Gesner in the sketch of his career given in Bulletin No. XIV, and to this will naturally succeed the account of his literary labors.

Geology and Mineralogy of Nova Scotia.

The earliest important work of Dr. Gesner of which the writer has any knowledge is one on the Geology and Mineralogy of Nova Scotia published in 1836.*

In the preface to this work, Dr. Gesner claims for Nova Scotia that abundance of useful and important minerals which she has since been shown to possess, and this at a time when her coal industry was in its infancy, and her gold mines unknown; and he says that she will maintain her pre-eminence in this respect unrivalled by any country of equal size.

The author tells us that this work was written for the "perusal of the general reader," and in accordance with this intention it is prefaced with a short introduction to the science of geology and mineralogy, drawn from the works of eminent writers of the first half of the present century. Among the writers frequently quoted in this book are Mohs, Brongniart, Buckland, Cuvier, Lyell and Cleveland. An outline such as Dr. Gesner gave was the more necessary in those days because scientific text-books on the science of Geology were few, and difficult of access in a new country.

Gesner acknowledges receiving some information from the writings of Messrs. Jackson and Alger, two Boston chemists, and from Mr. Haliburton's history of Nova Scotia. On comparison with the work of the two former the reader will perceive that Dr. Gesner has drawn largely for information from this source, but at the same time he does not show a slavish adherence to the opinions of these authors.

* Remarks on the Geology and Mineralogy of Nova Scotia by Abraham Gesner, Surgeon, 313 pp., 2 pl., 1 map. Halifax 1836.

The essay of Messrs. Jackson and Alger* was written in 1831, and gave the first full and accurate account, that had been published, of the minerals of the "North Mountain" of Nova Scotia. In connection with the principal topic of their work they gave also an outline of the geology of the province as a whole.

Considering the time at which it was written, this work was an excellent digest of information on the minerals of Nova Scotia, but it was too technical for the ordinary reader, and Gesner's book, written in a more popular style, and from the stand-point of the colonist, had a wider circulation, and served to diffuse more generally among the provincials a knowledge of the resources of Nova Scotia.

Gesner found four geological districts in the province, these he called the Primary District, the Clay Slate District, the Red Sandstone District and the Trap District.

A division into four districts had been adapted by Messrs. Jackson and Alger, but while Gesner classed all the red sandstones together, the above authors, on their map, distinguished the red sandstones of the Annapolis valley from the others and described them in connection with the trap rocks—a more natural arrangement.

Of the *primary district* extending along the Atlantic coast from Canso to Shelburne, Dr. Gesner observed that the "clay slate" succeeded the granite, except where the gneiss and mica schist are interposed. He thus recognized the antiquity of the slates of this tract as contrasted with those of the district next to be described. How little the mineral wealth of this district was suspected at this time, may be gathered from another remark wherein he says (in speaking of the country east of Halifax) that no indications of ores were seen on any part of this coast.

In the country west of Halifax Dr. Gesner found a variety of quartzites, mica schists and clay slates, with hills and masses of granite interspersed. He lays special stress on the rocking

* Remarks on the Mineralogy and Geology of Nova Scotia by Chas. T. Jackson and Francis Alger. Published by the American Academy of Science, 1831.

stones and perched boulders observed in this district, as curious objects of much interest. In this district also he found deep fissures in the granite, and supposes that there have been violent earthquakes and volcanic explosions, which had rent the rocks asunder and thrown these boulders to the tops of the highest hills.

This primary district of Dr. Gesner corresponds to the quartz-rock and slate district of Messrs. Jackson and Alger, but the boundaries given by Gesner are more natural than those of the Boston authors. Also it corresponds to the Lower Silurian of Sir Wm. Dawson's map* but is much narrower.

In his account of the second, or *Clay slate district*, Dr. Gesner, while remarking upon the occurrence of granite, gneiss and mica schist in this district, found it to contain also gray-wacke and the "old mountain limestone" with remains of marine animals and plants. The boundaries of this district as given by Gesner nearly correspond with those of the "Transition" clay slate of Messrs. Jackson and Alger, but where they differ Gesner's boundaries are more correct and natural.

Gesner's description of the iron ores of Clements and Nictau also agree very nearly with that of the authors above named, and both also describe in somewhat similar terms the fine quartz crystals of Paradise river and the bog iron ore of Aylesford.

There is a difference in condition between the iron ores of Clements and Nictau, for while the former are converted into magnetite, the latter are still hematitic ores. The Boston chemists thought the alteration of the Clements ore due to heat from the mass of trap in the North Mountains on the opposite side of the Annapolis valley; Gesner on the contrary attributed it to the vicinity of intrusive granite.

An interesting account is given by Dr. Gesner of the discovery of a fossil of the zoophyte family† and of dendritic markings in the grey slates at Beech Hill in Horton. Fossils (encrinites and trilobites) were also discovered in the clay slate formation at New Canaan. Several pages are devoted to a description of the iron

*In Acadian Geology. 2nd Ed. London 1868.
†Now known as *Dictyonema Websteri.*

ore beds of the Pictou district, which also had attracted the attention of Messrs. Jackson and Alger.

In explaining the transportation of large masses of rock in this district which are found far removed from their parent beds, and are found on the surface of the newer rocks or promiscuously scattered over the ground, Dr. Gesner invokes the aid of powerful currents. From his further remarks it is evident that he supposed these currents to have been ocean currents and to have been those of a general deluge.

All the western part of this district is spoken of as the South Mountain, and the rocks are said to be generally of transition age, and are "among the most ancient of the secondary strata."

This slate district, both as defined by Gesner and by the two Boston authors, comprises the Silurian and Devonian rocks of the province,* (except such as appear in the Cobequid range) and the interior or northern part of the Cambrian belt of the Atlantic coast.

In the sheltered and fertile valley of Annapolis, Dr. Gesner found the new red sandstone, a comparatively recent deposit, and inferred that the red sandstones to the northeast of it were of the same age. Hence he described all the northern area of Nova Scotia as the *Sandstone district.* In this district the soils are more fertile than in other parts of the province, and Dr. Gesner had a high opinion of its marl as a fertilizer. He does not fail to describe the extensive desposits of limestone, gypsum and calcareous marl which are formed here. The extensive tracts of marine alluvium formed in the northern part of Nova Scotia are said to be laid down on these red sandstone rocks.

The account given of the Wilmot spring is an interesting bit of local history, in view of the extensive use now being made of its waters:—

"In the town of Wilmot, about three miles from Gibbon's Inn, there is a mineral spring possessing medicinal properties of considerable importance. When the discovery was first announced to the public, numerous were the persons who, being afflicted with different diseases, hastened to the waters, then supposed to

* In a work written thirteen years later Gesner classes these slates as Silurian.

be the *elixar vitæ* and quite sufficient to remove all the ills that flesh is heir to. Without reference to the nature of their diseases, and at every stage of their complaints they hoped and vainly hoped to obtain relief. In the midst of the forest the little village near the pool of this modern Bethesda was all bustle and confusion, while many for want of accommodation were obliged to depart not healed. * * * Many were the cures reported to have been made at this spring. Newspapers teemed with its praises. But experience soon proved that its powers were not sufficient to remove all the ailments of its visitors; hence Wilmot spring is already abandoned and its name is seldom spoken. So changeable and unsteady is public opinion." * * *

"The waters of the spring have been analyzed by Dr. Webster and are found to contain sodium, lime, sulphuric acid and magnesia. They will doubtless be beneficial in all scrophulous and glandular diseases. They are generally aperient and cannot fail to be serviceable in dyspepsia and other diseases of the digestive organs."

Dr. Gesner found various classes of marine organisms in the limestones of Windsor, Shubenacadie and Gay's river connected with the red sandstones and shales. These he at first referred to the Lias of Great Britain in accordance with his view that the sandstones were New Red, but in a later work stated that these rocks were Carboniferous.

Dr. Gesner mentions the occurrence of salt springs at several places in the red marl or shale group in Cumberland county, and infers from this the presence of important beds of salt beneath the surface. Both he and Messrs. Jackson and Alger take the salt springs as an indication that these sandstones are "New Red" or Triassic.

The districts that Dr. Gesner included in the new Red Sandstone have been since divided by geologists into New Red or Trias and Lower Carboniferous. In later years Dr. Gesner accepted this assignment of the red marls and gypsum beds to the Carboniferous, as may be seen by consulting his later work, Industrial Resources of Nova Scotia (1849) p. 236.

While Dr. Gesner found only *four districts* in Nova Scotia, his Red Sandstone district included also the *Coal formation*,

which he regarded as underlying the red sandstones and so did not distinguish on his map. His map in this respect does not differ from that of Jackson and Alger. He devotes considerable space to a description of the various coal basins in the northern part of the province; and to the Cobequid Mountains. He claims to have discovered the importance of this chain as a natural division between the various coal basins there. This chain, says he, contains primary rocks, but is in general composed of gray-wacke and has enormous ridges of porphyry.

The coal mines at Pictou had been opened at this time. The Albion mine was being operated by the General Mining Association, but only to a moderate extent, and coal mining elsewhere in Nova Scotia was then scarcely pursued at all. Dr. Gesner mentions that he found a few men at work on the "King Vein" at the Joggins. No work had been done at Springhill, although a good seam of coal had been found there. The locality was not at that time within the reach of profitable mining owing to its isolated situation.

We find that Dr. Gesner with many of the geologists of his day, held the opinion that the coal flora in its "tropical luxuriance indicated the presence of a very hot climate at the time when it flourished. Lofty palms, cacti, Araucarian pines, ferns and enormous rush-like plants" then covered the ground. These, on account of the perfect preservation of their most delicate parts, he conceives to have lived, died and been buried before the Noachian Deluge.

Among the fossils occurring at the Joggins Gesner enumerates the following:—*Lepidodendron aculeatum* Sternb. *Sphenopteris trifoliata* Brongt. Flag-like leaves [*Cordaites borassifolia* Sternb?] Cacti = *Variolaria* Sternb. [= *Stigmaria* of modern authors.] Conifers [= *Dadoxylon*] *Syringodendron* [probably *Sigillaria* sp.] *Palmites sulcatus* [probably a *Sigillaria*]. *Phytolithus transversus* Steinhaur, possibly a *Sternbergia*. Other plants are referred to in general terms. Gesner estimated that half of the plants he found were ferns.

In describing the *Trap district* Dr. Gesner began at the western end, at Brier Island, and as Messrs. Jackson and Alger began at the same point the two descriptions are very similar as far as Peters Point, eastward of Digby Gut, where the exploration of the last named writers ceased, so far as the Bay of Fundy is concerned. East of this at French Cross Dr. Gesner had the good fortune to discover the red sandstone cropping out from below the amygdaloid and trap at low water mark. Along this shore as far as Black Rock, Dr. Gesner found beautiful crystals of calcareous spar, heulandite, laumonite, stilbite, analcime and other zeolites. Here also he found prehnite [a rare mineral in the Nova Scotian trap].

In the vicinity of Parrsboro, where Dr. Gesner appears to have spent some time, more careful explorations were made and a variety of rocks and minerals were observed. From this convenient centre he made excursions in various directions; visiting the high cliffs of Blomidon, along whose base a variety of agates and zeolites are found; in a westerly direction he visited the broken shore by Spencer's Island and Cape d'Or, collecting native copper, etc., from the trap; he did not find at Cape Chignecto the large area of trap rocks described by Jackson and Alger; in the opposite direction he explored the north shore of Minas Basin, studded with small islands and projecting points of trap.

Our author was greatly impressed by the noble scenery along the northwestern coast of Nova Scotia, and takes great delight in describing the peculiarities of this basaltic range—the columns of the trap and the step-like successive layers; the crumbling cliffs of amygdaloid and the varied and beautiful minerals it contains. He supposes these minerals to have been introduced into the amygdaloid by the agency of heat, either by igneous fusion,* or by sublimation.† These views would hardly be accepted at the present day, especially as regards the zeolites.

The theories presented in this work by Dr. Gesner show an extensive acquaintance with the writings of the earlier geologists. We find him quoting the geological works of Buffon, Werner,

* Pp. 180, 192 and 236. † Pp. 218, 241.

Hutton, Burnet and Conybeare and Philips as well as Buckland. He displays considerable acquaintance with the "Principles" of Lyell but of course knew nothing of Lyell's later works, consequently his reasoning in this book on Nova Scotia is all based on the opinions of the early writers

All through this work there are very sanguine opinions expressed as to the mineral wealth of Nova Scotia, especially in coal and iron. As regards the former mineral these opinions have been fully borne out by later developments, and it is probable that as time goes on the large deposits of iron ore which Nova Scotia possesses will also be more fully utilized.

Titles, Subjects, and Itinerary* of Dr. Gesner's Geological Reports.

First Report on the Geological Survey of New Brunswick, by Abraham Gesner, Provincial Geologist, etc., 1839, St. John, (87 pp).

Second Report on the Geological Survey of the Province of New Brunswick, by Abraham Gesner, Provincial Geologist, St. John, 1840 (i. to xii. and 1-76 = 88 pp.)

* See Map of his journeys opposite the title-page.

Third Report on the Geological Survey of the Province of New Brunswick, by Abraham Gesner, F. G. S., Provincial Geologist, etc., St. John, 1841 (i. to xv., 1-88 = 103 pages.

Fourth Report on the Geological Survey of the Province of New Brunswick, by Abraham Gesner, F.G.S., Provincial Geologist, etc., St. John, 1842 (101 pp.)

Report on the Geological Survey of New Brunswick, with a topographical account of the Public Lands (and the district explored in 1842), by Abraham Gesner, F. G. S., Provincial Geologist, etc., St. John, 1843 (88 pp).

N. B.—Of the 467 pages of texts of these reports, 85 are devoted to a description of the coal fields and their products.

Geological Survey of New Brunswick.

It would appear that immediately after the publication of his work on the geology and mineralogy of Nova Scotia, Dr. Gesner turned his attention to the neighboring province of New Brunswick, for in his first report on the geology of this province he stated that in 1837 he had obtained an outline of the geographical features of that part of the province which borders the Bay of Fundy; and it would seem that before he began exploration for the provincial government he had (by request of private individuals?) visited the lead mine at Lubec in Maine.

At the close of his first season's work he was able to give the following general sketch of the geological structure of the southern part of New Brunswick:

"The southeast side of New Brunswick, or that part which reaches near the coast, extending from Shepody Bay in the county of Westmorland (now Albert) to the American boundary line in the county of Charlotte, is occupied by an extensive and moderately-elevated chain of mountains, composed principally of granite and other primary rocks. This range is situated at an average distance of fifteen miles from the shore of the Bay of Fundy, and includes the highlands eastward of the river St. John. Westwardly, it embraces Bald, Eagle, Douglas, Pleasant and other mountains. The course of this mountainous district is from southwest to northeast.

"At the southern base of this elevated region the slates and limestones of the transition series, and the sandstones and conglomerates of the secondary formations, are placed in their usual order of succession, wherever they have not been broken up and buried by extensive eruptions of volcanic matter. All these rocks have been penetrated by large and numerous dykes of trap, basalt and porphyry, and the surface of the country * * * exhibits the clearest evidence of having been the theatre of violent earthquakes and intense volcanic action.

"The granite entering into the structure of this mountain chain is also succeeded on its northern side by slate and graywacke * * * then follow the rocks of the great coal formation which extends from the head of the Oromocto river in a north-east direction to Northumberland Straits."

Such is the outline which Dr. Gesner gives of the geology of southern New Brunswick; and this his various journeyings during the first three years that he was engaged on the survey of New Brunswick served to complete and extend. His fourth year's work took him beyond the district covered by this outline and in his fifth year he was engaged in exploring the wild lands and thinly settled districts in the northern part of the Province.

Dr. Gesner began his exploration in Charlotte County by making an examination of the St. Croix river and the islands off the coast of that county. On the river he found two mineral springs, of one of which, at St. Stephen, he gives an analysis; on the islands he found indications of various metals, at Campobello veins of galena, in the bold trap cliffs of Grand Manan, zeolites and other minerals similar to those of the traps of the North mountains in Nova Scotia; a remarkable discovery here was that of an extensive tract of sunken ground off the south-eastern coast of the island, where the anchors of vessels become entangled in the roots of trees imbedded in the bottom of the sea near the shores.*

At Lepreau he found the coal formation with coal-measures containing various fossils, some of which were like those of the fir tribe, others were ferns, and others stigmariæ. The coal basin, however, was of very limited extent, as it was found to terminate about three miles inland. Further along the coast, at Musquash, he found verd-antique marble and alum slates.

Dr. Gesner now made traverses of the interior for the purpose of obtaining a knowledge of the strata on both sides of the granite axis of the Nerepis hills. He first passed across the granite ridge by way of the Nerepis road as far as Oromocto, and then made a traverse further west along the Magaguadavic and Oromocto rivers to the same point, intersecting the metamorphic and igneous rocks, and a part of the central Carboniferous area of the province. In these traverses he discovered some iron ore, roofing slates and a granite quarry. During these journeys he had excellent opportunities of observing the southward move-

* First Rep. p. 40.

ments that had occurred in the loose surface deposit or "diluvial collections." These he attributes to the effects of a "general deluge that swept over the country from north to south," and to this cause also he refers the glacial striæ; "these are seen to cross each other at different angles, and this affords evidence that the course of the current was not always uniform."

In his second year he first made a voyage along the coast eastward of St. John to the head of the Bay of Fundy. He then returned to St. John and made a parallel traverse of the country along the valleys of the Kennebecasis and Petitcodiac rivers, and examined the eastern coast of Northumberland.

In going eastward along the coast Dr. Gesner found a small coal field at Quaco, where excavations had been made upon an impure seam of coal, and at Quaco Head he examined the intrusive trap and deposit of manganese that exists there. Following the coast eastward he found some remarkable conical hills of serpentine and trap at Great Salmon river. At Hopewell he again met the coal formation and the valuable freestone and grindstone beds of that parish, and this formation was found to extend across the Petitcodiac river.

In his traverse of the interior Dr. Gesner found another coal basin, which he called the Westmorland coal field. This was found to extend from Sussex, where he examined a bed of coal, to the eastern shore of the province at Shediac. He found coal also on the Pollet River and Turtle Creek, and further east. These last were probably cannel coal, or highly bituminous slate. The ash varied from twelve to twenty-five per cent.*

In his third year he re-examined a part of the coast east of St. John, and then the "new red sandstone" district in Kings county. Afterward he made excursions on various branches of the St. John river, among the rest Belleisle Bay, and Washademoak and Grand Lakes.

In the report on this year's explorations Dr. Gesner summed up the result of his three years work in this difficult region, whose complicated geology has exercised the minds of many

* Second Report, p. 66.

investigators since then. His work was so far advanced that he now prepared a geological map of this southern part of the province, the first that had been made. This map, which has never been published, is now in the hands of the Natural History Society of New Brunswick, and is complete for the work of these three seasons.*

In the first report, Dr. Gesner had announced the occurrence of Carboniferous limestone and Old Red sandstone among the "secondary" rocks north of the granites, and now in this third report gives a somewhat extended account of raised beaches and estuarine deposits. These raised beaches with their shells he refers to the *Newer Pliocene* of Sir Chas. Lyell.

Following this is an account of the Westmorland coal field and of the New Red sandstone of Westmorland and Kings counties; the minerals of the latter formation are said to be lead, iron, gypsum and rock salt. It is probable that if Dr. Gesner had worked long enough in this "New Red sandstone" tract, he would have referred it to the Carboniferous System, as he subsequently did that of Nova Scotia, similarly characterized by gypsum and salt springs. Dr. Gesner observed several valleys of denudation in this district. The report closes with an account of the Grand Lake coal field and of the alluvium of the St. John river.

In this report it will be observed that Dr. Gesner had made an advance in his knowledge of the "transition" rocks in the southern part of the province, for while he had previously spoken of the Graywacke as one system, he now finds that there are two. One he calls the upper, or newer, having found it to rest unconformably on the other, and to be characterized by the remains of marine shells and land plants. The older Graywacke did not contain organic remains. A figure is given of one of the molluscous animals of the newer Graywacke (which he compares to the *Silurian* of Mr. Murchison) and as Dr. Gesner mentions

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* An amended copy is on file in the Crown Lands Office at Fredericton. See description of the orginal map on a later page.

† They are now regarded as Post-Pliocene.

the locality from which it came we know it to have been obtained from the shales of Division 1, Band *c*, of the St. John Group. In the fauna of this band, the only fossil that will answer to Dr. Gesner's "terebratulite" is *Orthis Billingsi*, Hartt. Examples of this fossil, in which the ears are broken off or concealed in the matrix, would resemble the terebratulite.* Dr. Gesner also found this formation to contain plant remains in the form of a "cactus" (or Stigmaria).

Fig. 1.

A Terebratulite Slate of St. John.

In an upper set of beds other plant-remains were found. These were discovered at Little River and consisted of trunks of trees, *conifera*, a calamite, impressions of leaves, and a plant called a *Phytolithus*†, which probably was a Sigillaria. From the description of the locality it is evident that these plants came from the Dadoxylon sandstone, of the Little River group. Dr. Gesner was thus the pioneer in making known the fauna of the Cambrian and the flora of the overlying pre-carboniferous rocks in New Brunswick. That he did not reach the full significence of his discoveries is not at all surprising, for the district where these two classes of remains are found is a very complicated one; and the study of its geology for half a century past has hardly yet resulted in the unravelling of its complicated structure.

Dr. Gesner's older Graywacke group is exemplified in the Huronian schists of the Coastal group and the altered schistose rocks between Cape Mispec and Emerson's Creek along the shore of the Bay of Fundy.

In his fourth report we find that Dr. Gesner revised his reference of the Graywacke system, and upon the ground of the scarcity of organic remains, a few *terebratula* and some land plants only having been found, he classes it with the Cambrian system of Professor Sedgewick. This classification he carried out in a more systematic way, as regards the northwestern part of New Brunswick the next year, when he made his final report.‡

* Second Report, p. 8. † Second Report, p. 12. ‡ Fifth Report, p. 54.

During the fourth year of his survey, Dr. Gesner was engaged in extending the work of previous years to the United States boundary and Woodstock, on the one hand and to the mouth of the Miramichi on the other. He traced a belt of "primary" rocks (granite, etc.) from the Cheputnecticook Lakes to the sources of the Miramichi, marked the boundaries of a large forked area of Cambrian rocks, and located the western and northern bounds of the large central carboniferous area of New Brunswick.

At this time, apparently, Dr. Gesner became acquainted with the Glacial theory, and refers to the inquiries of Agassiz, Buckland, Lyell and others into facts connected with the glaciers of Switzerland, Scotland and Ireland,* and he thinks it probable that many parallel ridges of sand and gravel in New Brunswick have been produced by the operations of ice; but we do not find that he used this theory subsequently in accounting for grooved surfaces on the rocks, which he still attributes to diluvial floods from the north. "The Glacial Period," says Gesner, "introduces the opinion that between the period of the enormous animals, the bones of which are buried in diluvial districts, and the present epoch, there was a period of intense cold."†

The fifth report (entitled "Report on the Geological Survey of New Brunswick with a topographical account of the Public Lands and the district explored in 1842) describes the country of the Upper St. John and the wilderness and forest country on the headquarters of the Tobique and Restigouche rivers. In this area Dr. Gesner found an extensive area of Silurian slates and overlying tracts of red sandstones with limestone and gypsum deposits.

Through the information on the geology and natural products of the province which these reports contained, a great deal of interest in her mineral wealth was excited, and the popular mind was filled with large expectations of the development of her mines. A number of mining adventures were undertaken, some of which were successful, but many the reverse. In Albert

* Fourth Report, p. 59. † Fourth Report, p. 12

county, especially, large amounts were invested in the Albertite mine (discovered soon after Gesner completed his surveys) and in the sandstone quarries on the coast and the Petitcodiac river. The mining of coal in Queens county was prosecuted with vigor, and iron furnaces were started at Woodstock. But the returns from these sources did not prove so valuable as from the mines of the neighboring province, and discredit was thrown on the work of Dr. Gesner. He had committed the error of expressing an opinion on the mineral wealth of the province more favorable than the after results justified, and hence a reaction came which probably helped to terminate his engagement with the provincial government. This, however, hardly justified the withholding of his salary for the last year, which was not paid for some time after the work of exploration terminated.*

In judging of Dr. Gesner's work, I think sufficient allowance has not been made for the imperfections of the science of geology in his time. He lived, or at least his training was obtained in the formative period of the science, almost before its general principles and laws were formulated. From his earlier works it will be noticed that he interpreted geological phenomena by the theories of Werner and Hutton; in later years he decides the age of the several terranes which he found in the metamorphic hills of southern New Brunswick on the tests and data of Sir Roderick Murchison and Professor Sedgewick, and finally he became acquainted with the theories of Agassiz and Lyell, relative to the glacial period. We are not to expect from a geologist living in that early period, the exact methods of the modern trained specialist.

The limestone beds in the Narrows of the St. John river to which Gesner drew attention, have been largely quarried for lime of late years, and that a similar result has not flowed from the discovery of deposits of iron ore and gypsum described in his reports, is in part due to the modern conditions of trade, and

* The following is an extract from a letter from Dr. Gesner to Hon. G. S. Hill, St. Stephen, dated Cornwallis, N. S., 7th August, 1844: "I need scarcely add that so far I am unable to obtain a whole year's salary due from the province for services ordered and duly authorized by Sir William [Colebrooke, the Lieut. Governor] * * * and I can hardly express my dissatisfaction and mortification."

especially to facilities for transportation in recent years which shuts out from commercial competition all but the purest and most extensive mineral deposits.

Palæontology of Dr. Gesner's Reports.

Dr. Gesner appears not to have been deeply versed in the science of Palæontology, which in his day was going through the formative process. Its foundation principles were generally known, but the means of its special application were not always at hand. Authentic specimens of typical forms were not easily accessible on this side of the Atlantic, and the photographic camera and other appliances of which the modern artist can avail himself, were not within reach of the engraver half a century ago.

From these and other causes the palæontological references and figures in Dr. Gesner's reports are crude and often difficult to comprehend. Any errors into which the writer may have fallen in the interpretation of this part of Gesner's work, may perhaps, on this account, be excused.

The following outline references will enable the reader to determine how far it will be necessary for him to study the original reports. The marginal references are to the number of the report quoted, and the page.

I. 20. Johnston's and Simpson's Cove, Charlotte Co. Marl with clam, mussel and scollop shells. [Post-pliocene, Champlain.]

I. 40. Grand Harbor, Grand Manan. Sunken forest in the harbor. Pine, hemlock, cedar. [Recent.]

I. 52. Lepreau, St. John Co. Fossils of Fir tribe, ferns, stigmaria. [Little River Group.] *

I. 70. Hartt's Mills, Oromocto. Conifera, Calamites in Carboniferous conglomerate. [Millstone Grit.]

I. 74. Otnabog L., Queens Co., one mile south of. Limestone with ammonite [Nautilus] encrinite, trilobite, ostrea [some other genus], Mya [Edmonia?], arca [Macrodon?], are common. [Lower Carboniferous.]

II. 7. "The Valley," [City of St. John], Mya, Pecten, Mytilus, and other shells in clay, eighteen feet above level of the sea. [Post-pliocene.]

* The plants from this terrain have been determined by Sir Wm. Dawson.

II. 8. Valley, north side of, opposite Jeffrey's Hill [Garden street.] Slate with remains of shells, Terebratulite. [Supposed to be *Protorthis Billingsi*, Hartt, of the Paradoxides Beds on Seely street. [Cambrian.]

II. 12. North side of Little River, near the bridge, in compact Grauwacke. Trunks of two large fossil trees, belonging to the Conifera. [Trees similar to these have been determined by Sir J. W. Dawson as *Dadoxylon Ouangondianum.*] Other smaller plants and impressions of leaves, species of Phytolithus* and a calamite [*Archæocalamites* (=*Bornia*) *radiatus.*] Little River Group.

II. 12. City of St. John, near the residence of "His Worship," [*i. e.*, the Mayor, on the south side of King Square.] Remains of a cactus. [Probably a worm-pitted flagstone. Cambrian.]

II. 15. Quaco Head, St. John Co. In grey sandstone. Two species [*i. e.*, varieties] of cactus [*i. e. Stigmaria ficoides*] and a calamite. [Carboniferous.]

II. 25. Grindstone Island [Albert Co.] In sandstone. Fossil trees two feet across and forty feet long exposed on the side of a cliff. It is branched and belongs to the Dicotyledonous order. [Carboniferous.]

II. 34. Chignecto Bay. Coal formation. *Conifera*, *Syringodendron*, [*i. e.*, decorticated Sigillariæ] four species. At Cape Marenguin, *Phytolithus*, one species. Calamites are numerous—4½ inches across. [Carboniferous.]

II. 35. Same district. *Sigillaria*, two species. [The figures seem to represent *S. tessellata*, Brongn.] *Cacta* [*i. e.*, Stigmariæ.] Ferns [*Alethopteris lonchitica?*] and other plants. [Carboniferous.]

II. 59. Tantramar Marsh, Westmorland Co. Large trees of different kinds, collections of shells and bones of fishes found buried at different depths in the marsh. [Recent.]

II. 63. Sussex, Kings Co. In sandstone and shale. Large cacti [*i. e.*, Stigmariæ] and calamites, and leaves of other plants. [Carboniferous].

III. 5. Kennebecasis to Cape Mispec [near St. John], In clay slate frequently ferrugenous, Marine animals and land plants [?] alternately [Cambrian]. At Little River, in arenaceous beds, Fossil trees [Little River Group].

III. 7. St. John, near Jeffrey's hill, remains of marine animals, and land plants [?] [Cambrian].

III. 14. Ten Mile Creek, St. John Co. Sandstone and shale. Calamites, common, also fossil trees [Carboniferous].

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*Phytolithus was a generic term used very indefinitely by Steinhaur, it might mean any fossil stem not a calamite or a stigmaria. See notes on Gesner's Geological map, p. 31.

III. 17. Various localities in St. John County. In marl and marly clay; over thirty specimens of testacea and crustacea, *Mya mercenaria* [*i. e. arenaria*], *Pecten* [*islandicus*] *mactra*, *Solon ensis* [doubtful if these two occur] *mytilus*, two species, [probably *M. edulis* and var. *elegans.*] Claws of crab, bones of fishes [*Post-pliocine*].

III, 30. Buttternut Ridge, Kings Co. In limestone encrinites ammonites [Nautili] and several species of bivalve shells [Brachiopods]. [Lower Carboniferous.]

III. 56. St. John River, east side of head of the Reach, farms of Messrs. Carpenter, Queen's Co. In Carboniferous limestone, ammonites [*i. e.* Nautilus], encrinites, astrea [?], orthis [extinct in Carboniferous time, probably Productus] pectenite [perhaps Aviculopecten] several species of terebratula [*T. sacculus* and varieties].

III. 60. Long Rapid of Washdemoak River, Queen's Co. In sandstone, etc. Large trees, cacti [*i. e.*, Stigmariæ], calamites, etc.

III. 64. Grand Lake coal field. Point between Young's Cove and Cumberland Bay. Reddish calcareo-argillaceous deposit with remains of marine plants like *laminaria saccharina*.

III. 68. 69. Grand Lake, Long Point, south side of. Fossil trees [Conifera], a *phytolithus* and a *calamite*.

III. 74. Grand Lake, Salmon River mines. *Cacti* [*i. e.*, Stigmariæ], scarce; ferns more numerous.

IV. 19. Graywacke and State. Same fossils as are referred to in Report II, pages 8–12.

IV. 80. Richibucto, *sigillaria* 2 ft. 4 in. in diameter. Bathurst, Gloucester Co. Two species ferns different from any figured European species.

IV. 95. Chatham, Northumberland Co. In sandstone. Ferns and coniferous plants, no cactacea [*i. e.*, Sigillariæ] observed.

V. 60. Jacquet River, north of, Nash's Creek. In clay beds. *Mya mercenaria* [= *arenaria*], valves of *Balani* [*B. crenatus* and *B. Hameri* occur here], two species of *Mytili* [*M. edulis* and var. *elegans*] *pecten concentrica* [probably *Cyprina Islandica*].

V. 64. Point La Nim. Soft shales. Restigouche Co. *Stigmaria* [perhaps *Psilophyton.*]

V. 64. Escuminac Bay, east of, Restigouche Co. In sandstone and shale. Remains of a small fish [perhaps *Phaneropleuron*] and a small species of tortoise [fish, *Pterichthys Canadensis*], also fossil foot marks.

V. 67. Presqueisle River, Flannagan's Hill, Victoria Co.? In impure limestone *Cyathophyllum basaltiforme* [?] columns of encrinites, casts of producta. Elsewhere called *producta depressa*, [*i.e. Leptæna rhomboidalis*] of the Wenlock Limestone.

V. 70. Belledune Point, Gloucester Co. Impure limestone containing spirifera [*S. cycloptera?*] producta [*i. e. Leptæna rhomboidalis*]. Encrinites, *Favosites Gothlandica. Cyathophyllum turbinatum* [?] a coral like *Syringopora geniculata.*

V. 70. River Charlo, south side of Restigouche Co. In limestone, a shell like *Atrypa reticularis.*

V. 71. Bathurst. J. W. Henwood found *Favosites Gothlandica, Producta depressa* [= *Leptæna rhomboidalis*] *Atrypa aspera*, crinoidea, *Leptæna* [*Strophonema*] *euglypha* and *Spirifera* [*S. cyclopetera*]. Besides these, I [A. Gesner] observed several shells, whose species have not been determined.

Gesner's Geological Map of New Brunswick.

The absence of a geological map is greatly felt by the reader who attempts to obtain a knowledge of early geological exploration in New Brunswick from the reports of Dr. Abraham Gesner. From time to time in the text of these reports references to a map in course of preparation are met with; but no complete map of his exploratory work is extant, and the one he made to show the result of his first three years' work has never been published. This map for many years has been in the possession of the Mechanic's Institute at St. John, and has lately been acquired by the Natural History Society of New Brunswick. A copy of the map was lodged with the Crown Lands Department at Fredericton.* Dr. L. W. Bailey, of the University of New Brunswick at that place, has never seen any other map by Dr. Gesner, and does not know of any there. The original map in the possession of the Natural History Society, therefore, seems to be the one to which we must look to primarily for a representation of Dr. Gesner's work in New Brunswick.†

* See Report on the Agricultural Capabilities of New Brunswick, by J. F. W. Johnston, F. R. S., Fredericton, 1850, p. 6.

† The first reference to this map will be found in the Second Report, page xii, where Dr. Gesner says, "The geological map of the province has been commenced and is advancing towards completion." Again, in the Third Report, page iii, he says that the report "is accompanied by a geological map of that part of New Brunswick which has been examined." In the Fourth Report, page 4, he states that "a geological map will be with this report laid before your Excellency, the labor of past season being added to that which was before completed." Also at page 18. "Each of the different classes of rocks has been laid down on the geological map of the province, now in course of preparation." In the Fifth Report he adds, "an incomplete geological map of the province is submitted for your Excellency's consideration." I have not been able to discover that this "incomplete map" is any other than the one described in the previous report.

To Mr. Geoffrey Stead, C. E., the author is indebted for the copy of Gesner's map in black-line hatching which accompanies this paper. (See page 39).

It has been thought that Dr. Jas. Robb's geological map of New Brunswick embodies that of Dr. Gesner, but on a comparison of the two I find that this is not the case. It seems, therefore desirable that this first geological map of the province should be published so that those who wish to read Dr. Gesner's reports may do so with a map before them.

The publication of the map is also desirable, as no opportunity has heretofore been given to compare it with the geological map of New Brunswick published some years later by Dr. Jas. Robb.* It also affords the means of comparison with the geological map of New Brunswick, etc., published by the Dominion Geological Survey.

Dr. Gesner's original map represents only the first three years of his explorations, but from the one filed with the Crown Lands Department at Fredericton, a copy of which I received through the kindness of Mr. Loggie, I have added the results of his fourth year of exploration. This extends the map as far as Woodstock on the western side of the province, and to Shippegan on the eastern.

There is no index to the several geological formations on the original map, but the colors used by Gesner are easily understood from his reports, and from the index on the copy of the map in the Crown Lands Office.

Eight divisions are indicated by the colors on the original map, and are as follows :

Lias Limestone.
New Red Sandstone.
Coal Formation.
Mountain Limestone.
Old Red Sandstone.
Graywacke System.
Syenite, Trap, etc.
Granite.

* Published with Johnston's Report on the Agricultural Capabilities of New Brunswick. But many copies of this report were issued without any geological map. At page 6, Dr. Robb tells us that his map was to a great extent based on the reports of Dr. Gesner.

The Intrusive Rocks.

Dr. Gesner at an early date recognized the granitic range of the Nerepis hills as the key to the geological structure of southern New Brunswick. He noticed also that the sedimentary beds resting on the flanks of the granite hills were more or less broken up, and to some extent buried by extensive eruptions of volcanic matter, and had been penetrated by numerous trap dykes. This was the generalization he made at the end of his first year's work. But in the second year of his survey, he found that the true granite terminated at Belleisle Bay on the river St. John; and he also discovered (or thought he did) that the ridge of the crystalline rocks curved southward from there, and as a belt of syenite, etc., extended westward along the south side of the granite range, and eastward through Kingston, the Loch Lomond hills and along the Shepody road to Shepody mountain in Westmorland County.

In the fourth year of his survey he traced another granitic axis, extending from the Cheputnecticook Lakes, northeastward toward Bathurst on the Gulf of St. Lawrence. The western end of this axis is shown on the map, but the eastern lies beyond its limit.

In comparing this old map of Dr. Gesner's with that of Dr. Robb, who was his successor in the study of the geology of New Brunswick, one may observe that in some respects the former is more accurate than the latter, as, for instance, in the boundary of the granitic area of the Nerepis hills; and theoretically more correct in other respects, as, for instance, in the distribution of the syenite and trap rocks, which by Dr. Robb are represented as round isolated masses in many cases, but by Dr. Gesner as occupying elongated areas. Among the metamorphic tracts these intrusive rocks have usually come out through long fissures parallel to the general trend of the several bands of sedimentary rock. Only within the Carboniferous area, and at Grand Manan, are there broad sheets of eruptives undisturbed.

Later studies on the "trap rocks" of southern New Brunswick show that in many cases the rocks represented as intrusive

are really old lavas and ash-rocks, both of Post-Cambrian and Pre-Cambrian systems, originally spread out in broad sheets, but which, now, owing to the folding of the strata with which they are interbedded, exhibit their worn edges at the surface, and thus have the elongated out-crops which Dr. Gesner represented on his map.

Gesner's "New Brunswick"* gives the latest view which that author has expressed on the extent and arrangement of the intrusive rocks in that province. The *granite* in this work is described in much the same terms as in his reports above cited.

But in this work he divides the syenite ridge of his Second Report† into two parts; one of syenite extending from the Kennebecasis through St. John County to Albert County‡ corresponding in its western part to the syenite of the Laurentian axis of the Dominion Survey Reports, and in its eastern part to the syenites, etc., of the Huronian (Coldbrook) rocks of St. John County.

The other division of the syenite ridge is its western part and is called "trap." The places mentioned as being on the§ course of this band, except Red Rock Lake,‖ show that its western part is composed of the bedded traps which cap the (Upper) Silurian system in Charlotte County; its eastern part consists of the bedded traps of the Kingston series.

Dr. Gesner was thus by degrees learning to distinguish the differences which exist between the effusive rocks and the intrusive rocks forming the core or axis of the metamorphic range traced by him in southern New Brunswick. His divisions may be interpreted as follows:

Granite.—The Devonian granite of the Nerepis range.

Syenite.—The intrusive Syenites of the Laurentian and eastern Huronian (Coldbrook) areas.

Trap.—The old lava flows and intrusive dykes of the Silurian (Upper) and the Kingston series (Huronian).

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*New Brunswick, with Notes for Emigrants, by Abraham Gesner, F. G. S., etc. London, 1847.

†Second Report, p. 2. ‡"New Brunswick" p, 342 §Op. cit, p. 343.

Red Rock Lake is among the intrusive granites.

The Graywacke System.

In classifying the rocks in the southern part of New Brunswick, Dr. Gesner at first divided them into the three simple classes recognized by the earlier geologists, viz.: The Granite and other crystalline rocks; the Transition series; and the Secondary formations. Thus the transition rocks are the more or less altered rocks of the metamorphic *massif* or complex of southern New Brunswick; and include all the terranes from the Laurentian to the Devonian. Dr. Gesner, however, proceeded to improve his classification year by year as his survey progressed. In the second year of his survey he made some important discoveries of fossils near St. John which led him to conclude that the slates and graywacke of the transition rocks crossing the harbor of St. John, and at the entrance of the river of that name, were to be classed with the "Silurian group of Mr. Murchison."* This remark certainly applies to the slates and graywacke, and appears also to include the limestones north of them, for he asserts that the fossil shells found in the slates were afterwards met with in the limestones.† His opinion of the age of the plant-bearing beds is very clearly expressed (page 12) where he says "these plants belong to the first classes of vegetables that ever flourished on the earth. They * * are evidently far more ancient than those which afford bituminous coal."

Still extending his observations on the rocks along the coast, Dr. Gesner, in the third year of his work, found reason for a further division of the strata of the transition complex. In examining the rocks from Cape Mispec eastward he found an older and more altered set of beds, which, in relation to the Silurian rocks above mentioned, were *primary*,‡ and further he found that this older set had a reversed dip§ as contrasted with the "Silurian." In these apparently older and lower strata, no organic remains were found, and further they were harder, were more replete with quartz veins, and talc and chlorite were associated with them. Dr. Gesner therefore concluded that though

* Second Report, p. 3.

† Second Report, p. 8. This observation, however, is open to question, as these limestones are older than any rocks in which mollusca or molluscoida have been found.

‡ Third Report, p. 3. § Third Report, p. 7.

the whole of these rocks belonged to the Graywacke group, the upper only bore a close resemblance to the Silurian rocks of Europe.

For the purpose of making plainer Dr. Gesner's brief statements of the age of the two series of the Graywacke system, and to show its relation to the intrusive and the secondary rocks, the author has constructed the following section.

EXPLANATION OF SECTION.—2, Intrusive Syenite, etc., (of Pre-Cambrian age.) 3*a*, Older Graywacke System. 3*b*, Newer Graywacke. 7, Red Conglomerate and Sandstone. *a*, Fossil "terebratula." *b*, "Cactus." *o*, Anthracite coal seam. *c*, Fossil coniferous trees.

This section will convey Dr. Gesner's conception of the structure of the peninsula between the Kennebecasis river and the Bay of Fundy. On the south-east, at the base of his "older Graywacke group" is a mass of hard contorted slates, and schists with beds of volcanic ash rock; the middle of the group consists of Graywacke with some clay slate, and the upper part is a mass of coarse conglomerate.

Resting on these unconformably is his "newer Graywacke group;" having at the base limestones with beds of Graywacke and intrusive trap; then the series of slates and Graywacke on which the city of Saint John is built; and finally compact Graywacke with fine grained clay slates. Dr. Gesner compared the newer Graywacke group to the Silurian of Murchison, but he does not appear to have given any name to the lower group, or to have compared it with any European system.*

* They are called *Metamorphic rocks* in his "New Brunswick," 1847.

A casual reading of Dr. Gesner's reports would leave the impression that he continued to class his Upper Graywacke group with the Silurian; but no such classification is shown on his map, and if we examine his Fourth Report it will appear that this was not his final conclusion. There, in speaking of the Graywacke and slates of St. Stephen, which are colored as being of the same terrane as those of St. John, he calls them *Cambrian* system of Professor Sedgewick,* and if his language be carefully examined I think it will be plain that he intended this remark to apply also to the Graywacke of St. John. By placing together the paragraphs from the different reports, the basis for this inference will be seen.

2nd Report.	3rd Report.	4th Report.	Last Report.
P. 3, l. 12—Since we have discovered the remains of *molluscous animals, fossil trees*, and *anthracite* among these slates, * * * they may be classed with the *Silurian* group of Mr. Murchison.	*P. 5, l. 30.* — Clay slates * * containing *marine animals* and *land plants* alternately, appear.	*P. 19, l. 7.*—The only fossils found * * consist of a few impressions of *terebratula* and *plants* analagous to those of the *coal period.* * * I am inclined to believe that they may be properly classed with the *Cambrian* system of Professor Sedgwick.	*P. 72, l. 13.*— *Cambrian System* The few organic remains found in this group are sufficiently characteristic * * * * The strata consist of grauwacke, grauwacke slate and clay slate.
P. 8, l. 21.— A few strata of slate meet the chert and in them we found the remains of shells. They are all *terebratula.*	*P. 7, l. 28.*— In the upper series * * the remains both of *marine animals* and *land plants* were found, * * * and it appears that the *Silurian* group of Mr. Murchison is clearly developed in New Brunswick.		

Dr. Gesner carefully gave the localities for the fossil shells and plants referred to in the second and third reports, but in his fourth report he does not mention any locality for shells or plant remains near St. Stephen; hence it may be inferred that the remarks quoted are of general application and based on the discoveries at St. John.

From these extracts, especially when taken in connection with the context, in the several reports, it appears to me plain that in his later reports, Gesner intended to refer to the Cambrian, the strata which in the second and third reports he had compared with the Silurian. This classification was adopted by Dr. Robb for the districts described in the fourth and last report, *but not for those of previous reports*, which on his map are colored as Upper Silurian.

* Fourth Report, p. 19. † There are really several.

We thus find that while Dr. Gesner had first spoken of the Graywacke or transition rocks as one system, he soon discovered that there were two series † included in it, and that of these two series the upper one was characterized by the remains of marine shells and of land plants, and that the older series had no organic remains. Subsequently when he came to explore the Graywacke system in other parts of the province and could find no organic remains in it he came to the conclusion that the whole should be called Cambrian on account of the *scarcity of organic remains.* So far as the geological reports are concerned, he made this his final statement of the age of these rocks, they being in this way contrasted with the Silurian (Upper) of the northern port of the province in which he met with evidences of a more abundant marine life.

The description of the locality near St. John where the marine animals of the Cambrian system were found by Dr. Gesner is as follows: "On the north side of the ravine, not far from the pottery, and directly opposite Jeffrey's Hill (Garden street) there is a bed of chert extending some distance in an east and west direction, a few strata of slate meet the chert and in them we found remains of shells."

The pottery above mentioned was situated in the valley at the foot of Garden street, and the ravine opposite would be the hollow extending up from the west end of Wright street to the west end of Seely street. Here we find the quartzite or hard sandstone of Band *a* in Division 1 of the St. John group, and immediately in front of it the Paradoxides shale (Band *c*, of the same division). There is no chert in this neighborhood, and the rock so called by Dr. Gesner, I suppose to be the quartzite of the St. John group, Division 1, Band *a*. The "few strata" of slate in this case would be the shales of Band *c*. At this point they yielded to Dr. Gesner's hammer the remains of "molluscous animals." A figure of one of these is given and is called by him a "*terebratulite.*"*

We find greater difficulty in dealing with the "cactus"

* Second Report, p. 8. See page 17, *super.*

found by Dr. Gesner in the City of St. John, near the residence of the mayor [Robert F. Hazen, at the corner of King Square and Charlotte street.] Being found here it must have come from the flags of Division 2 of the St. John group. The strata of this locality are of such an age as to give to the cactus or *Stigmaria* an antiquity far greater than any fossil of this genus known up the present day. I therefore conclude that this object was some imitative form, and not a true Stigmaria. In the bed of Division 2 there are numerous burrows of Arenicolites; such burrows occurring in crumpled slates or flags would readily take on the appearance of Stigmaria. Many of the markings in Cambrian sandstones have been mistaken for plant remains, notably the varieties of Eophyton in the Swedish Cambrian rocks described by O. Torrell, and his *Cordaites Nilsoni;* even so cautious an observer as Linnarsson took Eophyton to be a plant.

But while we should be loath to admit of the presence of land plants in the St. John group without the strongest proof, there can be no doubt that Dr. Gesner did discover remains of plants at Little River near St. John, in beds now known to be much newer than the flags of King Square.* These plant remains were found in compact Graywacke, and consisted of "large fossil trees, *Conifera*, with other smaller plants and impressions of leaves." This locality, which is well known, is in the Dadoxylon sandstone of the Little River group and the trees are similar to others from this sandstone which Sir Wm. Dawson has described as *Dadoxylon ouangondianium.* Of the smaller plants mentioned, one is said to be a calamite, this probably would be *Archæocalamites radiatus (=Bornia radiata)* which occurs commonly with this Dadoxylon. Another of the smaller plants is called a *Phytolithus.* Phytolithus was a genus very loosely used by Steinhaur, having been applied by him to species of Lepidodendron, Stigmaria, Sigillaria and Ulodendron.† Gesner appears to have had access to Steinhaur's article, and I think he intended under Phytolithus to indicate here a species of Sigillaria. Badly preserved stems of species of this genus are

* Second Report p. 12. † Coal Flora of Pennsylvania, Lesquereux, 1878.

quite common in the Dadoxylon Sandstone in some places, and Sir Wm. Dawson has described one from the extension of these beds on the opposite side of the harbor, under the name of *S. palpebra.*

In connection with the plant remains (but not in the same beds) Dr. Gesner speaks of having discovered two small veins of *anthracite coal* in soft, fine grained clay slate. These slates were divided into layers of from half an inch to four inches in thickness, and were found at a small creek near the new Penitentiary. He speaks of the slate rock appearing in cliffs on the shore where the strata readily decompose. From these indications I conclude that this "anthracite" came from the fine black shales of the St. John group, which are well exposed in a low cliff on Courtenay Bay, in front of the County Alms House; the brook which discharges here comes past the Penetentiary. Much of the slate is black and highly carbonaceous, and layers of it might resemble anthracite; but the existence of true anthracite here is improbable, as the deposit is of marine origin and of Cambrian age; and its natural connection is not with the Devonian sandstone containing plant remains, but with the beds in which Dr. Gesner found the "terebratulite."

This author found the fine slates to be devoid of quartz veins, and for this reason, as well as because they contained anthracite, he associated them with the plant-bearing Graywacke sandstone, rather than with the slates and Graywacke of the St. John group, to which they properly belong, and which he found had numerous quartz veins. Dr. Gesner laid much stress on the presence of quartz veins as showing the antiquity of strata, and considered the great abundance of quartz veins in the older Graywacke group as a proof of its great antiquity.

Dr. Gesner was thus the pioneer in the discovery of Cambrian and other pre-Carboniferous fossils in the terranes at St. John; that he did not reach the full significance of his discoveries is not surprising, when we consider how little was known in those early days outside of the great centres of geological investigation, of the distinctness of the several faunas and floras included in the transition rocks.

Dr. Gesner's *older* Graywacke group also contained strata of various ages. To him, the distinctive features of this group, were its incipient metamorphism as shown by the innumerable quartz veins mixed with talc and chlorite, that traverse the rocks, and the absence of organic remains. Of the three masses of strata associated by Dr. Gesner in this lower Graywacke group, the lowest consists of the schists of the Coastal (Huronian) group, the middle of the southern basin of Dadoxylon sandstones of the Little River group and the upper part of the conglomerate beds to the north of them. The unusual hardening of the Palæozoic and older rocks at Mispec give to this "older Graywacke" group of Dr. Gesner an appearance of greater antiquity than that possessed by the strata further north.

Four years after closing his engagement with the government of New Brunswick, Dr. Gesner published a general work on that province, describing its topography, resources, etc., and giving an outline of its geology. In this there is a later expression of Dr. Gesner's views respecting the age of the schistose rocks of the southern coast. Here he classes the Lower Graywacke group with gneiss and the clastic schists under the head of *Metamorphic Rocks** and states that these rocks skirt the shores of the Bay of Fundy from Salisbury Cove to Chamcook Bay. He says that no fossils have been discovered in these rocks, and evidently they are his Lower Graywacke group.

As regards the Upper Graywacke group, it would appear that Dr. Gesner at this time was disposed to assign a part of them to a higher horizon than he had previously. In one of his geological reports he had remarked that several of these vegetable relics were discovered in slate and Graywacke, which agree in their general characters with the sandstones and shales of the upper coal series.† The thought here foreshadowed seems to have governed Dr. Gesner in his final remarks upon the plant-bearing and shell-bearing beds at St. John, for he says that the sandstones containing the fossilized remains of coniferous trees

* New Brunswick, p. 343. † Second Report, p. 12.

and those having a variety of terebratula, evidently belong to the imperfect coal measures, of which there are several instances in the province."*

One basin of such imperfect coal-measures is that of Lepreau described by Dr. Gesner;† another is that of Quaco.‡ Dr. Gesner believed that both of these basins were of Carboniferous age.

If my interpretation of Dr. Gesner's views of the age of the Upper Graywacke group is correct, he expressed successively the following opinions of the age of these rocks:

In the First Report — Transition.
In the Second and Third Reports — Silurian.
In the Fourth and Fifth Reports — Cambrian.
In the "New Brunswick," — { Part of them are called imperfect coal measures.

One more phase of opinion is that expressed in Dr. Jas. Robb's geological map of New Brunswick, where these rocks are colored as Upper Silurian. In all this time, from 1838 to 1860, no actual progress had been made in determining the true age of these strata. The first important step in this direction was taken when Sir Wm. Dawson, by the study of the plant remains, showed that the upper part of the group was at least as old as the Devonian; and the second, when Prof. C. F. Hartt found, by comparison of the mollusca with those of the Primordeal Zone, of Barrande, in Bohemia, that the lower part was Cambrian.

The unravelling of this complex Pre-carboniferous *massif* of southern New Brunswick has not only shown that it contains the plant-bearing terrane and the Primordeal terrane above mentioned, but three others in addition, besides the "fundamental gneiss," so that there is ample room for deposits of all the eras to which Gesner and Robb referred it.

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*New Brunswick, p. 343. †First Report, p. 52. ‡Second Report, p. 15.

Old Red Sandstone.

On this map the narrow strip of measures which Dr. Gesner has called old red sandstone will not easily catch the eye. The "mountain limestone," which immediately overlies it, was no doubt the occasion for referring this belt of measures to the Old Red Sandstone. To Dr. Gesner, if we may judge by the glossary of geological terms attached to his reports, the Old Red Sandstone was a "stratified rock belonging to the Carboniferous group." This glossary is extracted from one in Lyell's Principles of Geology, a book which Dr. Gesner seems to have used a great deal, and in which the term Old Red Sandstone is similarly defined.* It would appear that, at this time at least, the term Old Red Sandstone did not convey to Dr. Gesner's mind the idea of a system different from the Carboniferous, but rather that of a Lower or Sub-carboniferous Sandstone. However, some years later (in 1847) he refers to the Old Red Sandstone as Devonian.

The Coal Formation.

The compiler of this map rightly considered this system of rocks as one of the most important in the province; and he had less difficulty in recognizing it than in telling the age of the others. Abundant plant-remains furnished the test necessary for the determination of these rocks. Though Dr. Gesner's palæobotany belongs to the earliest years of geological science, and some of his names are now obsolete, we are able from his descriptions, and sometimes from his figures, to recognize most of the plants he mentions. They are the commoner species of the Carboniferous age, but sufficient to determine the kind of flora which flourished in New Brunswick in those times, and thus to assure Dr. Gesner that the rocks were Carboniferous.

The limits of the coal formation, as given on this map, do not differ greatly from those obtained by more recent explorations.

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*See Lyell's Principles, Ed. 1835, London; Vol. I, p. 396; Vol. IV, p. 313.

The numerous outcrops of coal which he found, led Dr. Gesner to infer the presence of valuable beds of this mineral within the Carboniferous area ; but the examinations made since in all parts of this tract by the Dominion Geological Survey, and through private enterprise, have not resulted in the discovery of any seams of considerable thickness. Although Dr. Gesner made a rapid traverse across the Carboniferous rocks in Gloucester county, he claims that he did not survey this county, except in the vicinity of Bathurst ; and the large wilderness district at the junction of Sunbury, Northumberland and Kent counties was not visited by him. The coloring which he placed on this area expressed his opinion of its probable age, and later explorations have confirmed his surmise that the area was occupied by coal-measures.

That Dr. Gesner attached great importance to the minerals of the coal measures as a source of wealth to the Province of New Brunswick is clear from many statements in his reports. Of the whole of these reports at least one-sixth is devoted to the Coal Measures. Not only did he believe in the existence of valuable beds of coal in the areas where the coal measures were visible, but his error in regard to the Red Sandstone of King's County also led him to infer the existence of valuable coal seams where we now know none such can exist.

New Red Sandstone.

In Dr. Gesner's time the earlier results in the study of geology in England had not been checked or corrected by comparisons with a wider field. The lithological aspect of the rocks, as the Chalk, the New Red Sandstone, the Oolite, were largely depended upon for determining the age of strata. In England the New Red Sandstone was a saliferous formation, and for this reason the saliferous sandstones which Dr. Gesner found in Nova Scotia and New Brunswick were by him referred to the New Red Sandstone or Trias ; and being such, of later age than the coal measures.

One belt of these sandstones, however, he referred to their proper position under the name of "Old Red Sandstone," and a

few years after his survey closed (1847) he said that the [red] conglomerates along the south side of the coal field might be so classed. This is stated in his book on "New Brunswick," in which he also inclines to defer to the opinion of Sir Charles Lyell, who was "disposed to class these rocks with the Devonian system, or the Permian rocks of Russia." Some years later Dr. Gesner more distinctly avowed this opinion in reference to the corresponding sandstones of Nova Scotia.

There was, however, a modicum of truth in Dr. Gesner's earlier view of the age of the red sandstones, because there are certain small areas among the rocks referred by him to the New Red Sandstone that actually are of Triassic age. These are small isolated patches along the shore of the Bay of Fundy, and perhaps some larger ones on the eastern coast of New Brunswick.

But while we thus gladly give Dr. Gesner the credit of having discovered certain small areas in southern New Brunswick that are truly referable to the New Red Sandstone, there are other larger areas of his map thus colored, that must be removed from this category. Such is the considerable district on the Kennebecasis river and extending thence through Westmorland county. Such, also, is the eastern end of this county; and such, also, two oval areas on Grand Lake in Queen's county. These latter, by the Dominion Geological Survey, are relegated to the Coal Measures, and the two former to the Lower Carboniferous series.

When reduced by the abstraction of these areas, the remaining tracts of New Red Sandstone are quite insignificant, and are strictly confined to the southern coast.

Lias Limestone.

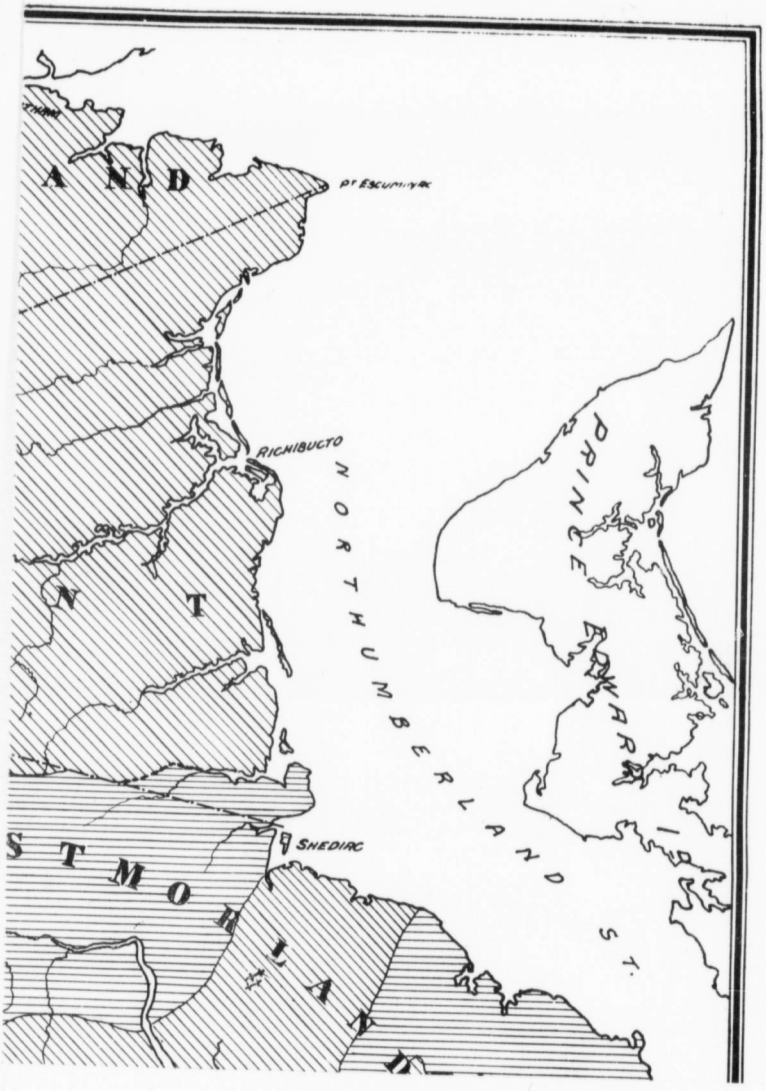
Having found salt springs and gypsum in the red sandstone district of Sussex and elsewhere in Kings county, Dr. Gesner, as we have observed, saw reason to refer the rocks to the New Red, or Triassic Sandstone. Hence he naturally supposed that the limestones which are found in these districts toward the centres of the "New Red" basins were of the age of the Lias of Great

Britain, seeing that they abounded in shells and some of them were of dark color and bituminous. The error was a natural one, though a better knowledge of the bearing and significance of the fossils which he found in these rocks would have corrected it. The genus Productus is so common in these limestones that the modern geologist wonders how the limestone could be mistaken for Lias. Dr. Gesner originated this error in the Carboniferous limestones of Nova Scotia, seen near Windsor, etc. But there there are two sets of limestones quite different in aspect and in the species of the fossils they contain. Of these the lower contains well marked fossils of the Lower Carboniferous, but the upper has many which are very like those of the Permian, the very latest of the Palæozoic rocks. There would be less surprise if these were mistaken for Mesozoic limestones, but there is no such reason applicable to Gesner's Liassic limestone in New Brunswick. We suppose, therefore, that having classed the upper limestones at Windsor as Lias because they overlaid the Red Saliferous Sandstones of Nova Scotia, he applied the same rule to New Brunswick.

In 1843 Dr. Gesner's survey was brought to a sudden and unexpected close, and he never completed the geological map of New Brunswick which he had commenced. This appears from a paragraph in his last report, where he says: "An incomplete geological map of the province is also submitted for your Excellency's consideration. By this it will be observed that the labor of another season will be required to bring the geological survey to a conclusion; and it is very desirable that the undertaking should be finished in the same spirit in which it was commenced." This however was never done.

Dr. Gesner tells us that at the close of his last season's work there still remained to be examined the chief part of the counties of Northumberland, Gloucester and Restigouche.

Dr. Gesner enlivened his geological reports in a way that is not usual now, though common enough in earlier narratives, by introducing descriptions of scenery and incidents of his journeys.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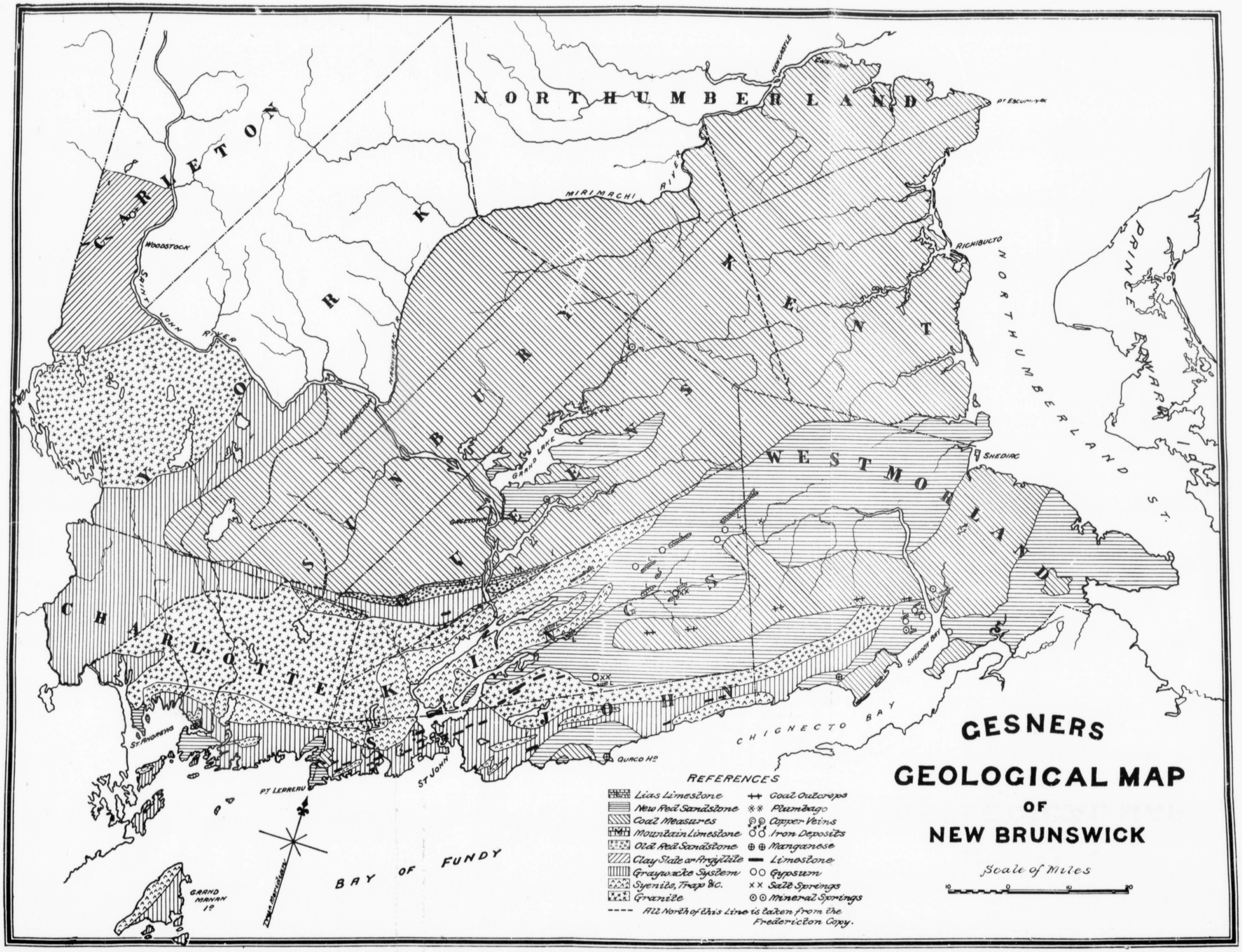
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CHIGNECTO BAY
GRAND LAKE
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WOODSTOCK
ST JOHN RIVER
NASHWAAK R.
ST ANDREWS
Pt LEPREAU
QUACO Hd
GRAND MANAN Is
BAY OF FUNDY
REFERENCES
Lias Limestone
New Red Sandstone
Coal Measures
Mountain Limestone
Old Red Sandstone
Clay Slate or Argyllite
Graywacke System
Syenite, Trap &c.
Granite
Coal Outcrops
Plumbago
Copper Veins
Iron Deposits
Manganese
Limestone
Gypsum
Salt Springs
Mineral Springs
All North of this Line is taken from the Fredericton Copy.
GESNERS
GEOLOGICAL MAP
OF
NEW BRUNSWICK
Scale of Miles
10 0 10 20

The following may be taken as an instance:

"It is impossible to conceive a more interesting sight than is presented in the Bay [of Fundy] during the summer season. Boats and vessels becalmed and carried away by the tide are at one instant hidden by the blackened rock, or the green foliage of some little island. At another they glide from behind the curtain, and appear, struggling with the overwhelming current. Often several hundreds of boats, huddled together and practising a deadly deception on the haddock and cod, from a signal given by the tide, draw up their anchors and hasten to the shore. The silence of evening is broken by the sound of the Indian's gun, levelled with deadly aim as the rising porpoise. The hollow sound of the "loon's" note is discordant with the scream of the gull. Here the glassy surface of the water is broken by a shoal of herring; yonder the spouting grampus is blowing up the spray in preparation for another dive. * * * The sea is alive with fish, its surface with human beings, and the air with feathered tribes."

Speaking of the shore between Beaver Harbor and Red Head, on the coast of the Bay of Fundy, he says:

"This part of the coast has a very gloomy and forbidden appearance; lofty precipices — shelving and overhanging cliffs — rise abruptly from the sea, and being inaccessible at almost every point, offer no way of escape for the unfortunate traveller who might be landed beneath them. There are also deep caves and wide chasms, where but a few rays of light ever enter, and no sound can be heard but the murmurings of the sea, ever washing their deepest vaults. That these openings were formed by earthquakes there can be no doubt, as the walls on either side clearly show that they were once united. The examination of such places is not free from danger on account of the violence of the waves, and the detached pieces of rocks, constantly falling from the cliffs above."

From Dr. Gesner's narrative we may judge that he met with many obstacles to his progress, due to the wild and unsettled condition of large tracts of the country, and to the imperfect means of communication. Of his journey on the St. Croix and Eel rivers, along the western boundary of the province (see sketch-plan of his journeys facing the title-page), he says:

"Having procured three expert Indians with canoes, and being accompanied by my son and Mr. Charles Ketchum, a volunteer — with a sufficient quantity of provisions and the requi-

sites for encampment, a portage of twelve miles was made from St. Stephen to the Upper Schoodic or Grand Falls. * * * About six miles above the Little Cheputnecticook Falls the river expands into a lake surrounded by a tract of low ground called Porter's Meadows.

"Above this, four miles (out of eight) are occupied by rapids, the most dangerous of which are the Elbow Rips at the foot of the Lower Lake. Our canoes were pushed up over an evenly inclined plain two miles long, where all our strength and skill were required to overcome the swiftness of the current. After much labor and difficulty the light barks were urged upward over the last rapid, and we paddled along the surface of the lake where the water is quiet and its gloomy stillness is strongly contrasted with the roaring of the river below. * * *

"We next encamped at the east side of the North Lake, where there is a portage to Eel River Lakes. The difficulty of discovering an old Indian path through the woods is always great to the unpracticed; and as the portage trail had become obscured by the growth of grass during the summer, and none of our Indians had ever passed this route, it was feared that the advantage of the path for carrying the canoes and baggage would be lost, and we should be obliged to steer through the thick forest by compass. From this embarrassment I was relieved by the discovery of some Indian hieroglyphics upon a tree, which expressed clearly the necessary information. On the clear wood of a large cedar there was clearly marked in a peculiar black and durable ink an Indian carrying a canoe; and the direction of the figures was exactly that of the portage; so that the old winter paths of the lumbermen were readily avoided. Two deer, with an Indian presenting his gun at them, were also exhibited, indicating to the traveller to look out for these animals: the the information was important and found to be strictly correct.

"The trail is a deep and narrow path, worn out by human feet, and at some places the solid rocks were found to be furrowed by the moccasins of our native tribes. After carrying our canoes across this portage, we again embarked for the exploration of the rocks of the Eel river and its lakes."

Another instance in which Dr. Gesner found the benefit of Indian pictorial representation was when his party was about to descent a dangerous rapid and fall on Eel river. Here they saw a large drawing of two Indians with their heels uppermost and their canoe capsized, executed in black ink on a broad piece of cedar fixed to a post on the bank of the river.

Difficulties with his Indian guides prevented Dr. Gesner from carrying his exploration of the Tobique to a completion.* He had at this time reached the forks of the Tobique where it parts into four branches; at this point one of his Indians had deserted and the rest refused to proceed further into the wilderness, with a short stock of provisions and with shattered canoes. He was therefore reluctantly compelled to return. Generally, however, he found the Indians willing and intelligent guides.

Dr. Gesner's scientific activity did not cease with his work on the Geology of New Brunswick, for about this time he must have written a memoir on the geology of Nova Scotia, accompanied by a geological map of that province, showing an advance on his earlier work there by the delineation of the crystalline axis of the Cobequid hills. That he was still thoroughly imbued with the belief that the gypsiferous sandstones of these provinces were not Carboniferous is shown by this map, in which they are represented as Devonian, or Old Red Sandstone.

This memoir (or an abstract of it) was published in the Proceedings of the Geological Society of London (Vol. IV, Pt. I, No. 95, 1843), and curiously enough the same number of this journal contains an article from the pen of Sir Charles Lyell, "On the Coal Formation of Nova Scotia, and on the Age and Relative Position of the Gypsum and accompanying Marine Limestones." Both from palæontological and stratigraphical considerations Sir Charles adduces convincing reasons for placing these gypsiferous sandstones in the Carboniferous system beneath the coal measures.

Sir Charles also describes a newer red sandstone without fossils on the Salmon river, near Truro, resting unconformably upon the edges of the Carboniferous strata; this we now know to be of the age of the Red Sandstones of the Annapolis valley, which are universally recognized as Mesozoic.

Except for the error in regard to the age of the red sandstones, this later geological map of Nova Scotia of Dr. Gesner is much in advance of his earlier one.

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*Fifth Report, p. 32.

"New Brunswick."

In the course of Dr. Gesner's geological survey of New Brunswick, he picked up a great deal of information on its natural history and resources. This information he embodied in a work published in London a few years after the close of his survey, bearing the above title.*

The first three chapters are given to the history of the province, first as a part of ancient Acadia, and then as a part of the Province of Nova Scotia, and finally as a province by itself. Another chapter is given to the boundary disputes and a general description of the country, and a fifth chapter to the native Indians or aborigenes of the province.

This chapter describes the character, customs, dress, dwellings, etc., of the two tribes which have inhabited the province since it became known to Europeans.

A long chapter is devoted to a description of the topography of the province that of each county being given separately, with valuable information relative to the settlements, lumbering, soil, minerals and fisheries. Agriculture forms the subject of another chapter, in which the climate is favorably spoken of, the forest trees described, and directions are given for applying manure and clearing up the wild land.

The author devotes considerable space to an historical account of the colonial fishing rights and of the aggressions of the American fishermen. The timber trade, the manufacture of lumber and the export trade in this commodity, also receives much attention from Dr. Gesner in this book.

The next chapter treats of the population of New Brunswick, and of its religious, social and political status. An examination of this chapter will show the great increase in the material prosperity of the province since this book was written. The imports and exports have greatly increased, and there has been a like increase in the material comfort and prosperity of the

* New Brunswick, with Notes for Emigrants, by Abraham Gesner, Surgeon, F. G. S., etc., London, 1847.

people. There has been some change in the denominational status of the population. The number of clergy of the Church of England has more than doubled. The relative change in numbers of the Roman Catholic population, then imminent, has come about, and they are now the most numerous of all the Christian bodies. The Baptists and Methodists have greatly increased. King's College, established in 1828, had been thrown open to all denominations, but there still remained a course in divinity in connection with the Church of England. The social conditions of the population in New Brunswick half a century ago, as described in this book, contrast greatly with the existing state of society. The isolation of the people in the winter time no longer exists; and social pleasures are not now, as then, so much limited to the coldest season of the year. Nevertheless, according to this author, the City of St. John at that day had grown from its foundation by the Loyalists sixty years before to a population of 26,000 souls. The revenues of the city were only £5,000 per annum; a contrast to the large amount collected for civic purposes at the present day.

In speaking of "society" in St. John and Fredericton in those old colonial times, Dr. Gesner says:

"There is a constant struggle between the aristocratic principle and the spirit of freedom and equality characteristic of the American. Persons who have risen from the lower ranks, and have arrived at affluence, are apt to overrate their importance; and such as have the advantage of birth and education are frequently supercilious. It is to be regretted that from these causes endless jealousies arise, and society is divided into small circles and parties."

The author of "New Brunswick" devotes a short chapter to the geology and mineralogy of the province, and another to its natural history; and the work closes with "Notes to Emigrants."

"Industrial Resources of Nova Scotia.

The next important work published by Dr. Gesner was a volume of 375 pages on the "Industrial Resources of Nova Scotia."

This work opens with an historical sketch of the province, beginning with the early French settlement of the country and extending down to the time in which Gesner lived. This is followed by a geographical outline, giving an account of the harbors, lakes, marshes, etc. In another chapter the vegetable products of the province are described, and then in succession the fisheries, agricultural capabilities, manufactures, geology, mines and minerals. Chapter X gives an account of the climate, history and resources of Cape Breton; and there is a final chapter devoted to prospective railways and to emigration.

This book is imbued with the local politics of the time at which it was written. It advocates the protection of the sea-fisheries from foreign aggression, complains of the monopoly of the mining rights, and calls for the construction of a railway from Halifax along the Gulf shore of New Brunswick to the Metapedia river and Quebec. This railroad has since been built almost exactly on the line advocated by Gesner.

One remarkable feature of the book is the strong advocacy of a protective policy in relation to the commerce and manufactures of Nova Scotia. It outlines the "national policy" adopted by the Canadian confederation soon after the consolidation of the provinces. The policy of protecting domestic manufactures was adopted in New Brunswick about this time, but soon after abandoned for a tariff purely for revenue.

The geological chapter may be considered to contain Dr. Gesner's matured views on the geology of his native province. Thirteen years had elapsed since the issue of his work on the Geology and Mineralogy of Nova Scotia, and several able geologists had in the meantime given their attention to the geology of Nova Scotia.

The views expressed in this work differ in some points from those of the earlier one. His first division consists of granitic

or hypogene rocks, and as he speaks of the associates of the granite he also would include the gneisses and mica schists. He now describes the clay slates and quartzites of the primary district and those of part of his former "clay slate district" as *Cambrian*—a natural out-growth of the improvement of geological nomenclature, and parallel to his recent work in New Brunswick. Under the head of *Silurian Group* he includes the remainder of the "clay slate group" of his first book on Nova Scotia. His fourth group is the "Old Red Sandstone," or Devonian group, for the red rocks that were found below the coal measures, etc. This is merged in the Lower Carboniferous by later writers. The fifth division is the "Carboniferous rocks or coal formation." The sixth is the "New Red Sandstone." This division, extensive in the former work, is now limited to certain strata near Truro. The seventh group is the "Intrusive and Igneous rocks" of the North Mountains. The eighth is the Boulder or drift formation. This group was not recognized in the earlier work, for in that the surface deposits are mentioned casually in connection with the coherent rocks of the older formations. Dr. Gesner attributes both the unstratified and stratiged drift to the action of water, manifested through ocean currents, floe ice, etc.

Over thirty pages of this work are devoted to a description of the economical minerals of Nova Scotia, with statistics of the exportation of coal.

Dr. Gesner lived in a period when the science of geology was in its infancy. Hence we see proof, as we peruse his works, of the gradual acquisition of new ideas upon the theoretical part of the science. Now a geological surveyor enters upon his work after a long course of preliminary training; then he had to make himself acquainted year by year with the rapid development and new phases of thought in his favorite science. Now he enters the field provided with the stores of knowledge accumulated in the last one hundred years; then he was slowly gathering those facts and observing those phenomena which lie at the base of geological theory.

We cannot judge Dr. Gesner by modern standards, but by the criteria of the times in which he lived; nor should we omit from consideration the slowness and difficulty of communication in those times. Knowledge of the kind required by the geologist was not disseminated in those days by the magazine and scientific journal; there were no great schools for investigation and for teaching the science to the same extent as now; and for those who lived far from the active centres of thought the attainment of exact knowledge in natural science, and especially of its new discoveries, was slow and difficult. Hence we should give Dr. Gesner full credit for the good he accomplished and excuse the mistakes and deficiences incident to his times and position. That his later life was to some extent clouded cannot but be a matter of regret to those who witnessed his zeal in pursuing the chief object to which he devoted himself, viz.: the development of the natural resources of his native country. That he struck out the main geological features of the maritime provinces of Canada correctly there can be no question, that he committed errors of detail is also undeniable, but this is what every geological surveyor who works in a difficult and complicated region is liable to do.

He recognized what would now be termed the Pre-carboniferous "massif" or "complex" of these provinces in the complicated rocks of the several bands of crumpled and more or less metamorphic rocks which traverse them. These he included under the name of Graywacke system, referred by him at one time to the Silurian, but finally to the Cambrian age; and as regards the northern metamorphic belt in New Brunswick in part to the Silurian. This massif or complex is now known to contain rocks ranging from the Laurentian to the Devonian.

He recognized as overlaying these a mass of secondary strata consisting of softer and unaltered rocks as covering extensive tracts in these provinces. These he referred to three geological systems—the Old Red Sandstone, the Coal Formation, and the New Red Sandstone. His Old Red Sandstone is now regarded as Lower Carboniferous, and while we retain his "New Red" Sandstone, we eliminate from it large areas which he supposed were of this age, and refer them to the Carboniferous system.

Gesner thought he found Tertiary deposits in certain places along the coast, but as these contain marine shells, all of living species, it is evident they are of later date than he supposed, and should be referred to the Quarternary age.

Though Gesner outlined correctly in a general way the geology of the Maritime Provinces, his work cannot be accepted in all its details, as his methods were not sufficiently exact for modern requirements, and notably, in the department of Palæontology. We should, however, in estimating its value, bear in mind the difficulties he had to encounter, and the short time at his disposal for the exploration of a province mostly covered with forest, with few exposures, except on rapid streams, and along the coast, and with means of transportation imperfect and tediously slow. We should rather wonder that under these circumstances he was able to accomplish so much, and to inspire an enthusiasm for geology which has borne fruit until the present day.

Supplementary.

The Gesner Museum. A Corresponding Member of the Natural History Society, Henry F. Perley, C. E., writes to me to say that he remembers well the formation of the Gesner Museum, and how it expanded until it out-grew the house,* and quarters had to be taken for it in the upper story of a building on Prince William Street, near where McMillan's bookstore now is. Mr. Perley remembers, as a very little boy, attending a course of lectures given by Dr. Gesner in 1841, in a building just south of the corner of Germain and King Street ("Foster's Corner").

Dr. Gesner involved himself in considerable expense in collecting and arranging his museum, and it was sold to a company of gentlemen in St. John, who deposited it in the Mechanics' Institute (then a new building) on certain conditions and with reservation of rights to have it open to the public. Many of the owners gave in their shares to the Institute, and this institution came in time to be considered the owners. When this body was dissolved, the Gesner Museum with the collections which the Institute had added to it, was purchased by the Natural History Society of New Brunswick, and added to their museum.

* Where Dr. Gesner lived, near the corner of Coburg and Hazen Street.

The most valuable parts of the Gesner and Institute Museum are the ethnological collections now in the lecture hall of the Natural History Society, and the collection of minerals from the Jurassic Trap of Nova Scotia, made by Dr. Gesner. The collection of birds and mammals has been superseded in importance by that of the Natural History Society. The minerals are kept in a room called the "Gesner Museum."

The Albert Mine Case. Early in the "forties" a peculiar mineral was discovered near Hillsboro in Albert County, N. B., which was claimed to be coal, and a license was obtained to mine it. Gesner contended that it was not coal, but asphaltum, and obtained a license to mine this mineral. The contending parties laid their claims before the court at Halifax and a long trial was the result: both sides brought expert testimony; Dr. C. T. Jackson and Dr. A. A. Hayes of Boston, and J. G. Percival of New Haven, were brought to show that the mineral was coal. R. C. Taylor and Prof. Jas. Robb were the experts called by Gesner and his associates to prove that the mineral of the Albert mine was asphaltum. After long argument on both sides, when the question was passed to the jury, the judge drew attention to the fact that the license to mine coal included "and other mines and minerals," and stated that the substance was a mineral. On this point the question was decided in favor of the defendants, and Gesner lost his case; though there is no doubt his contention was right, for the mineral is not a coal, but a variety of asphaltum (melan-asphalt).

Dr. Gesner was appointed Commissioner to the Indians in Nova Scotia, and in 1847 made a report on their condition to the provincial government.

Other Publications. To the list of publications referred to in this article, or mentioned in that published in Bulletin No. XIV., the following may be added — Geology of New Brunswick, Nova Scotia and Prince Edward Island, Fisheries of the Provinces; Practical Treatise on Coal, Petroleum and other Distilled Oils.

ARTICLE II.

DESCRIPTION OF AN EXTINCT PALÆOZOIC INSECT, AND A REVIEW OF THE FAUNA WITH WHICH IT OCCURS.

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

Read 4th May, 1897.

The fortunate preservation of the remains of land-animals, consisting of snails, myriapods, crustaceans and insects, in the finer beds of a delta deposit of the earlier Palæozoic time, near St. John, N. B., in Canada, enables us to form some conception of the inhabitants of the land in that far-distant age.

A knowledge of these early types of land animals is of the greatest interest to naturalists, so many of whom hold the doctrine of the continuity of life, and of the evolution of the later forms of animals from the earlier. This has induced the writer to assemble in one view the figures, scattered through various publications, that present the forms of these ancient land animals, so far as they are known. This land fauna lived eons before the Carboniferous age, and even before the later Devonian, and includes types which are strange to the student of the Carboniferous land fauna, and still more so to the investigator of modern species.

In presenting figures of these types we have added to them two objects, claimed to be insect wings, of equal or greater antiquity; and have also inserted the form of a gigantic insect that lived in the Carboniferous age, which was found at Commentry, in France, and has been described by C. Brongniart. This insect, which was nearly a foot and a half long, is given for comparison of the venation of its wings with those of the insects of this ancient fauna of eastern Canada.

At the end of the article is the description of the new species of insect—a Thysanuran.

Of the two objects referred to above, the most ancient fossil is that lately described by Dr. J. C. Moburg, from the Lower Graptolite schists (Arenig age) of Sweden, and supposed to be the wing of a bug. This fossil is very much older that those of the Canadian strata, but the characters are obscure; and although several Swedish and Finnish naturalists, who have seen the fossil, are inclined to concur in Dr. Moburg's statement that it is the wing of a Hemipter, or Bug, the object is not very clearly of this origin, and the confirmatory evidence of other organisms of a similar kind, is lacking. Its occurrence in Graptolite schists, which are open ocean deposits, is also against the view that it is an organism of the land. If such, it must have floated out to sea a long distance, and have escaped the sharp eyes and hungry maws of the scavengers of the deep.

Elsewhere in the world there has been one other object found which is claimed to be an insect wing of great antiquity. A figure of this fossil is given in the accompanying plate, and it seems to be of about equal age with the insect remains at St. John. This fossil is the *Palæoblattina Douvillei* of C. Brongniart from Calvados in France. Mons. Brongniart considers it to be the wing of an ancient cockroach, and in a general way it seems to be similar in venation to wings of that family of insects; but the peculiar way in which the anal and interno-median veins become confluent along the lower border of the supposed wing, is unusual in ordinary insects. In this case, as in that in Sweden, there is no confirmatory evidence from associated animals, or surrounding conditions, to show that this object is the wing of an ancient cockroach.

The real significance of the primitive land-fauna in the beds at St. John will be better appreciated if we sketch briefly the physical conditions of the early Palæozoic time in Acadia (the Maritime Provinces of Canada.) It would seem that the oscillations of the surface of the earth in this region had a rule of their own, different from that in Europe, so that the geological terranes here do not correspond to the geological systems of

Europe. Thus our Cambrian terrane includes the Lower Ordovician, and we have no trace of the Upper Ordovician over a large territory in eastern North America, including Acadia, and most of New England.

The next terrane includes the Silurian (Upper) and the Eo-Devonian (Oriskany) and its deposits are spread over Acadia, but not in an equal manner, some areas having been above water through a considerable portion of the time when this terrane was forming, and other portions, that were submerged at the beginning, arose above the sea during its progress. Hence we find that in some areas the terrane begins with the base of the Silurian (Medina and Clinton) and in others not until the Eo-Devonian (Oriskany). The Lower Helderburgh Fauna has not been recognized in this region, so that the groups known by marine fossils are the Clinton, Niagara and Oriskany. Throughout this terrane there are more or less of remains of a flora which, we may surmise, originated on the great emerged area of this part of the earth that was above the sea in later Ordovician times. The first traces of it that we have are found in beds of the age of the Clinton. It reaches its full measure in the Niagara period, and continues to be represented by many of the same species in the higher beds, thus extending up into the Devonian.

Great disturbances occurred after the Oriskany beds were deposited, and the region was subjected to violent earth movements, with intense pressure, and the eruption of granitic rocks. The terrane which preceded or accompanied this time of disturbance is the Upper Devonian, and consists of coarse conglomerates and red slates; in the conglomerates are fragments of Silurian (Upper) corals, in the slates obscure remains of plants.

Upon these Upper Devonian rocks, after their elevation and folding, was laid down the Lower Carboniferous conglomerates and shales containing a fauna and flora very different from that of the older time. The condition of the Carboniferous beds indicates the removal of the pressure which had plicated and altered the older rocks, though volcanic eruptions continued to occur to a more limited extent.

The Silurian-Devonian terrane is composed of three principal members, of which the two lower, by their marine faunas, are Silurian, and the upper apparently corresponds to the Eo-Devonian terrane on the south side of the Bay of Fundy.

The land fauna is found in the middle member of this Siluro-Devonian series, and briefly the following is an outline of the conditions marked by the several terranes resting on the St. John group.

At the top are:

Red sandstones with overlying conglomorates. These are equivalent to those of Nova Scotia, which are called Triassic and Jurassic.

A marked unconformity occurs here.

Beneath these are:

Coal measures, etc. Beds horizontal or inclined at low angles. Containing the Coal Flora.

Lower Carboniferous Conglomerate and Shale. More disturbed. Containing a Flora allied to that of the Devonian. The coals are *bituminous.*

An unconformity occurs here with great erosion and extrusion of granite.

Devonian Conglomerate and Shale. No distinctive fossils known. Plant remains of this terrane and all below are *non-bituminous.*

Unconformity with much erosion.

LITTLE RIVER GROUP.

Upper Cordite Shales (Eo-Devonian?) The Flora of the Plant Beds continues up into this group.

Lower Cordaite shales, Silurian. Appearance of the typical Flora of the Plant Beds in bed No. 2. *This is the place of the Land Fauna, described and figured in this article.*

Dadoxylon Sandstone, Silurian. An earlier Flora here, including that of Plant Bed No. 1.*

Bloomsbury Conglomerates (local) resting on old eroded land surfaces.

Marked unconformity to the St. John Group, etc.

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*Spoken of in Transactions Royal Society, Canada, Vol. VI., Sec. iv., p. 61 (at bottom) as a Devonian Flora.

In this little oasis at St. John which formed a refuge for the air-breathers of Silurian time, there no doubt was a much greater variety of animals than we know of at present, but it is questionable whether a single vertebrate of the land was then in being, and it is quite sure that none has been recovered. Vertebrates, in the form of small mailed fishes, were living in the estuaries around the borders of the land, but probably none were adapted for locomotion over a dry surface, and so we have no terrestrial vertebrates in the Silurian age.

The bulk of the land fauna consisted of air-breathing articulates, some of which are of novel and bizarre types, others like forms found in the Coal Measures, but all widely divergent from any living types.

The large proportion of millipedes and centipedes is remarkable; they form a quarter of the fauna, are mostly of large size, and several of the genera are like those of the Coal Measures. If we had not these genera to supply intermediate links no one would recognize in the Arachnoids, the scorpions and spiders of modern times. We have attempted a restoration of one of the forms related to the spiders on the basis of the specimen preserved, and of some Carboniferous forms described by Dr. S. H. Scudder. The way in which the thorax grades into the abdomen, though seen to some extent in the Carboniferous forms, is more complete in those of the St. John beds.

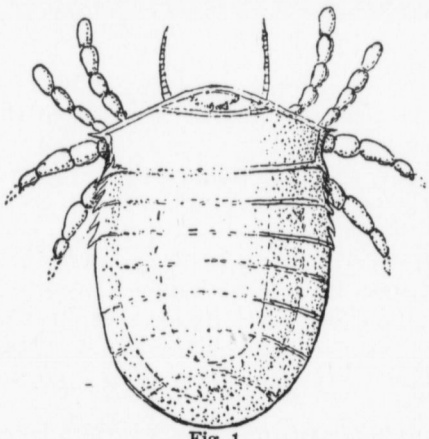

Fig. 1.
EURYMARTUS LATUS. Mag. 4. Restored.

An order of insects which is insignificant in the modern world—the Thysanura—had a larger proportion in this ancient fauna. These insects, by their want of wings, the absence of a distinct division of the body into three regions, and the unifor-

mity of the segments of the body, show a low type of structure, and an approach to the primitive insectean forms. A restoration of one of these insects is given here, and the full description of another (with a figure of the same) is given on a following page.

Fig. 2.
PODURITES SALTATOR. Mag. 2. Restored.

Perhaps a higher interest centres in the winged insects of this early time than in the wingless creatures described above. Among these air-breathing insects none of the modern orders of insects are present. Among the missing are the Hymenoptera (bees and wasps), Lepidoptera (butterflies and moths), Diptera (flies); even the Coleoptera (Beetles) have not been recognized. The remains found are all of such insects as go through only a partial metamorphosis, like the Orthoptera (grasshoppers and crickets) and Neuroptera (dragon flies, etc.) Among these fossils we find examples of a family comparatively rare now, but then apparently plentiful—the Phasmidæ or Walking-Sticks. A gigantic May-fly, also, is known from these early beds.

The presence of a small scorpion, two little snails and some articulates of doubtful affinities serve to add further to the variety of types of land-animals in these strata, and tell us of the life of the world in Silurian times.

The remains recovered from these beds consist of about two dozen forms of animals; and when it is known that with scarcely an exception, *only one individual of a species has been recovered*, it will be seen that the objects figured in the accompanying plates represent only a mere fraction of the great number and variety of air-breathing articulates that must have existed in Silurian time, even at this one locality. The air must have been alive with winged insects and the plants and ground must have teemed with crawling creatures of strange and surprising shapes.

GERACUS TUBIFER. n. sp.

Apterous. Body obscurely divided into three regions of head, thorax and abdomen; somites of the head cemented and fused (?) with the prothorax, all the others separate, and approximately of equal width.

Fig. 3.
GRACUS TUBIFER. n. gen. and sp. mag. 4.

Head conical, prolonged into a tube or proboscis, which is thrice as long as the rest of the head (and of separable parts?). No eyes or antennæ are recognizable.

The rest of the thorax consists of two separate rings of subequal length; of these the mesothorax is wider than the other laterally. The metathorax narrows backward at the sides, and at its posterior edge the body of the insect is narrowest. Under this interpretation of the thorax, we suppose the prothorax fused with the head, or suppressed. The legs are unknown, except that there is an obscure impression of the second one on the right side.

The abdomen is ovate and somewhat pointed behind, and consists of six joints. The first ring of the abdomen has the posterior margin pushed forward in the middle. The three next have directly transverse margins, but the line dividing the fourth and fifth joints is slightly arched foaward in the middle, and these two joints may be anchylosed. At the back of the last joint is a narrow obscure slope, slightly emarginate. No appendages are visible.

Size. Length 13 mm. Length of head, including the tube, 4 mm.; width 2 mm. Length of thorax 3 mm.; width 3 mm. Length of abdomen 6 mm.; width 4 mm.

Horizon and Locality. Dark shales of Plant Bed No. 2, Lower Cordaite shales of the Little River Group. Lancaster, St. John County, N. B. Rare.

Condition of Preservation. This fossil presents the brownish-black, shining surface, characteristic of the insects and myriapods

of this locality. In lustre and hue they differ from the plant remains, which are of a pure grey and more lustrous, often brilliantly so, on account of their graphitized surfaces.

The body of this insect is cracked longitudinally and flattened by pressure. On the right side the margin is perfect throughout, but on the left it is broken away, or crushed in, from the head to the second joint of the abdomen; on this side also the margin is slightly pushed in at the last two segments. These defective parts are restored in the figure.

Comparisons with other Species. Such is the peculiar aspect of this fossil that only with hesitation can one refer it to any existing order of insects. There are apterous forms among the Hemiptera which may seem to have points in common; such are the lice, but in these the sucking tube is soft, whereas in Geracus, judging from its distinct preservation in the stone it consisted of hard chitin, and the head is not distinctly separated from the thorax.

There is a superficial resemblance in the conical head and long proboscis to the weevils among the Coleoptera, and the small number of rings in the abdomen is also a feature in which it resembles these compactly built little insects, but the loosely-jointed body is quite at variance with the structure of the weevils; and there were no wings.

As regards the size and to some extent the form of the head, Geracus compares with more than one of the Palæozoic insects. Thus *Lithomantis carbonaria* Wood, from the Carboniferous of Scotland* has a small pointed head with an elongated anterior process; and a similar head, but with a long lance-like sucking tube belongs to *Eugereon Boeckingi* Dohrn, of the Permian of Germany;† this tube is about the same proportionate length as that of Geracus. In both these insects, however, the head is distinctly separated from the thorax, and not connected by a broad base as in our species; they also have transversely oval prothoraces.

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* Quart. Jour. Geol. Soc. London, Vol. xxxii., pl. 9, 1876.
† Palæontograph. Bd. xiii., Taf. 41, Cassel 1866.

The sum of characters in Geracus undoubtedly point in the direction of the Thysanura, especially if we include in this group that remarkable insect which inhabited the ancient lake basin of Florissant, described by Dr. Scudder under the name of *Planocephalus ascelloides.** (See figure below).

The Thysanura are distinguished among insects by the loose aggregation of the body rings, and the imperfect specialization of the thorax and abdomen. As Dr. Scudder has well remarked, they in this respect, more than other insects, approach the Myriapods; and like these are devoid of wings.

The Podura or Springtails, a section of the Thysanura, are notable for their compact bodies, especially the abdominal part, and for the few rings of which the latter region is composed; in these respects they are constituted similarly to Geracus.

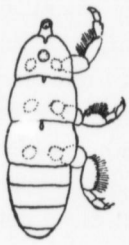

Fig. 4. PLANOCEPHALUS ASCELLOIDES. Mag. 3. Restored.

But while the modern Spring-Tails illustrate some points of structure in this Acadian genus, others are more strikingly paralleled by Dr. Scudder's extinct genus, Planocephalus. This remarkable genus differs from other active insects in the reduction of the cephalic region to a probosis with masticatory plates at the orifice. The proboscis was capable of being withdrawn under the thorax or could be projected the full length of the body; when thus projected the head and oral tube must have presented a close resemblance to that of Geracus.

In the thoracic region the resemblance was not so close, as here the Acadian genus more nearly resembled the Podura and the higher insects.

The abdomen of Geracus by its compactness is like that of Scudder's headless genus Planocephalus, but has two joints more, and by this and by its form is near *Iotoma plumbea* Packard,† among the Thysanurans.

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* U. S. Geol. Surv. Vol. xiii. Tertiary insects of North America, S. H. Scudder, p. 94, Figs 1-3, 1890.

† Guide to the Study of Insects, p. 626, Pl. 10, Fig. 6 and 7, New York, 1880.

The variety of forms which now begin to be associated together in the Thysanura, give support to Dr. Scudder's suggestion that this group may be regarded as one of "equivalent taxonomic value to the larger divisions of winged insects."* As we learn more of the Palæozoic insects we are likely to find this group one of greater importance than we could suspect it to be from our knowledge of its prominence in the present age of the world. In this connection it is a matter of some significance, that in the insect fauna of the Little River group, the oldest known up to the present time, the only insects (three in number) whose bodies are known, are wingless, and *two of them are Thysanurans;* while the third was a lowly form, loosely articulated, and with body rings very uniform in aspect, described as the larva of a Neuropterous insect, but also possibly a Thysanuran.

Some time ago the writer met with the description of a strange aquatic insect (or insect larva), having jointed dorsal appendages, observed by Miss Adele M. Field at Swatow, in China. (See plate I, fig. 12). It was found in still pools of fresh water, crawling slowly on water plants. It appeared to feed on microscopic objects (heliozoans, rotifers and infusoria). Exuviæ of varying size found in the water they inhabit, show that they moult. The head is flat and has eyes and antennæ, but is very small and almost reduced to a sucking tube; the thorax has three segments, bearing paired legs; the abdomen has nine segments which bear long slender jointed appendages containing tracheæ. The abdomen was terminated by two sharp, jointed styles, nearly as long as the body. In its general form this insect resembles Archæoscolex (plate II, fig. 9), in its microscopic head Geracus (see fig. 3 above), and in the stylets, Podurites (pl. II, fig. 8). It is only in such rare and exceptional examples as this Chinese insect that we find modern forms explanatory of these strange creatures with which the Reign of Life on the land began.

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* Op. cit.

The following list will serve to explain the accompanying plates and at the same time show the number and the affinities of the several species of this fauna. References are given to the works where the species are described.

INDEX TO THE LAND FAUNA OF THE LITTLE RIVER GROUP AT ST. JOHN, N. B., CANADA.

(N. B.—The numbers in the margin refer to the several figures in the two plates (and one in the text) wherein the known forms of this Fauna are shown.

PLATE. FIGURE.

MOLLUSCA. (Land Snails.)

II. 18. *Strophella grandæva*, Dawson. Mag. $5\frac{2}{3}$. Am. Jour. Sci., Vol. xx. p. 413.

I. 1. *Pupa primæva*. Mag. 4. Trans. Roy. Soc. Can., Vol. xii., Sec. iv., p. 100 (1894)—1*b*, surface further enlarged.

CRUSTACEA. (Saw Bugs?)

II. 4 and 5. *Amphipeltis paradoxus*, Salter. Jour. Geol. Soc. London, Feb. 1863, and Trans. Roy. Soc. Can. 2nd Series, Vol. 1, Sec. iv., p. 278, Fig 4. Mag. $1\frac{1}{3}$; Fig. 5. Reduced $\frac{2}{3}$.

I. 4*a* and *b*. *Eurypteris pulicaris*, Salter. Ibid. This species is supposed to be founded on the body segments of two insects or myriapods. The objects are enlarged respectively $1\frac{1}{3}$ and 2 diam.

ARACHNOIDA. (Scorpions and Spiders).

I. 2. *Eurypterella ornata* (Geralinuridæ?) Mag. $2\frac{2}{3}$. Trans. Roy. Soc. Can., Vol. vi., Sec. iv., p. 60 (1888).

I. 3. *Palæophonus arctus* (Scorpion). Mag. $2\frac{2}{3}$. Ibid. Vol. xii., Sec. iv., p. 100 (1894).

II. 1. *Eurymartus latus*. Mag. $2\frac{2}{3}$. Trans. Roy. Soc. Can. 2nd Series, Vol. i., Sec. iv., p. 275 (1895).

II. 2. E——(?) *spinulosus*. Mag. $2\frac{2}{3}$. Ibid. p. 276.

II. 3. E——(?) sp?——. Mag. $2\frac{2}{3}$. Ibid. p. 277.

MYRIAPODA. (Earwigs, Millipedes).

I. 10. *Palæocampa* (?) *obscura*. Mag. $1\frac{1}{3}$. Trans. Roy. Soc. Can., Vol. xii., Sec. iv., p. 108 (1894),

I. 7 and 7*b*. *Euphoberia atava*. Mag. $1\frac{1}{3}$. Ibid.—7*b*, two legs, further enlarged.

I. 8. *E*—— sp.? ——. Mag. $1\frac{1}{3}$. Ibid. p. 109.

MYRIAPODA. (Earwigs, Millipedes).

PLATE.	FIGURE.	
I.	5.	*Ilyodes (?) attenuata.* Mag. 2. Ibid.
I.	6.	*Eileticus (?) antiquus.* Mag. 1½. Ibid.
I.	9.	*Chilopus dubius.* Mag. 4. Ibid, p. 110.

INSECTA-THYSANURA (Springtails, etc.)

II.	8.	*Podurites saltator.* Mag. 1½. Trans. Roy. Soc. Can., 2nd series, Vol. i., Sec. iv., p. 273 (1895).
Text	3.	*Geracus tubifer.* Mag. 4. Described at page 55.

INSECTA-PALÆODICTYOPTERA.

II.	11.	*Homothetus fossilis.* Scudder. Mag. 1½. Can. Nat., n. s. iii, p. 205 (1867).
I.	11.	*H—— erutus.* Reduced ⅔. Trans. Roy. Soc. Can., Vol. xii., Sec. iv., p. 95 (1894).
II.	12.	*Geroneura Wilsoni.* Mag. 2 + Ibid. Vol. vi., sec. iv., p. 57 (1888).
II.	13.	*Lithentomum Harttii,* Scudder. Reduced ⅔. Can. Nat., n. s. iii., p. 206 (1867).
II.	14.	*Xenoneura antiquorum,* Scudder. Reduced ⅔. Ibid.
II.	15.	*Gerephemera simplex,* Scudder. Reduced ⅔. Geol. Mag., Vol. v., p. 175 (1868).
II.	16.	*Dyscritus vetustus,* Scudder. Reduced ⅔. Ibid, p. 176.
II.	9.	*Archæoscolex corneus.* Mag. 1½. Trans. Roy. Soc. Can., Vol. vi., Sec. iv., p. 59 (1888). (To this section or the next).

OBJECTS FROM OTHER TERRANES, FIGURED FOR COMPARISON.

II.	10.	*Titanophasma Fayoli,* Brongniart. Coal measures, Commentry, France. Reduced 5½.
II.	7.	*Palæoblattina Douvillei,* Brongniart. Reduced ⅔. Middle Silurian, Calvados, France.
II.	6.	*Protocimex siluricus,* Moberg. Mag. 4. Lower Ordovician, Killeroed, Sweden.
I.	12.	A recent aquatic insect (or insect larva) from ponds, Swatow, China. Mag. 2. The small projection at the anterior end is the head.

Plate I.

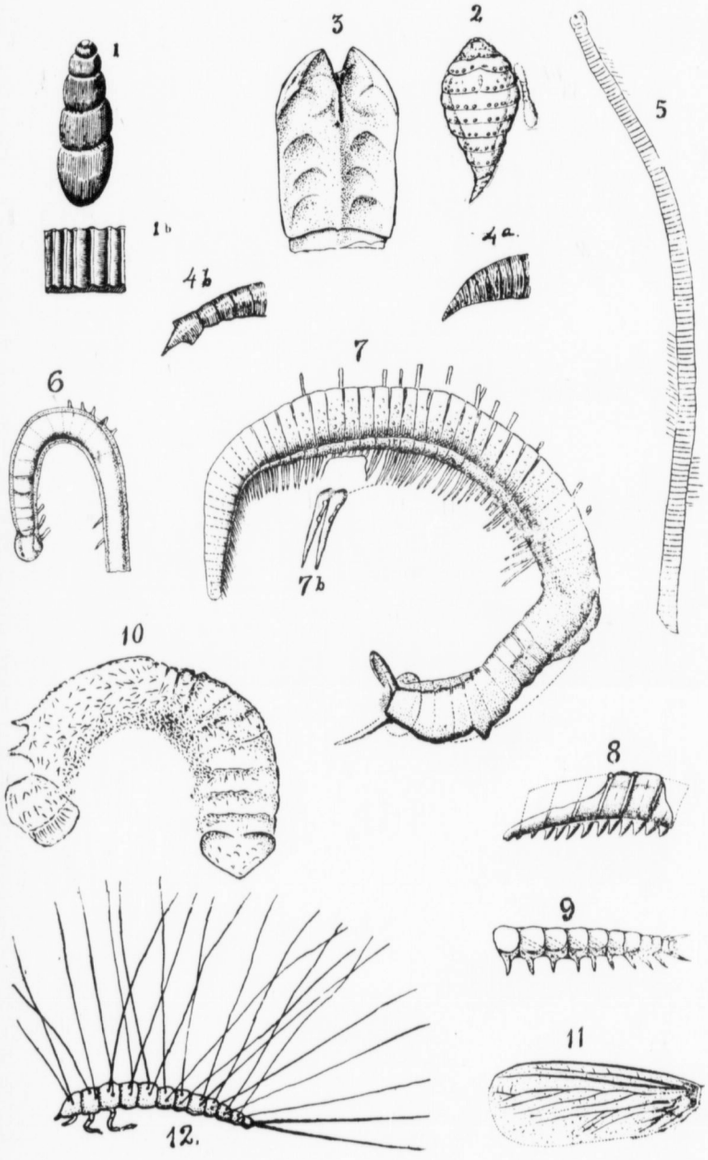
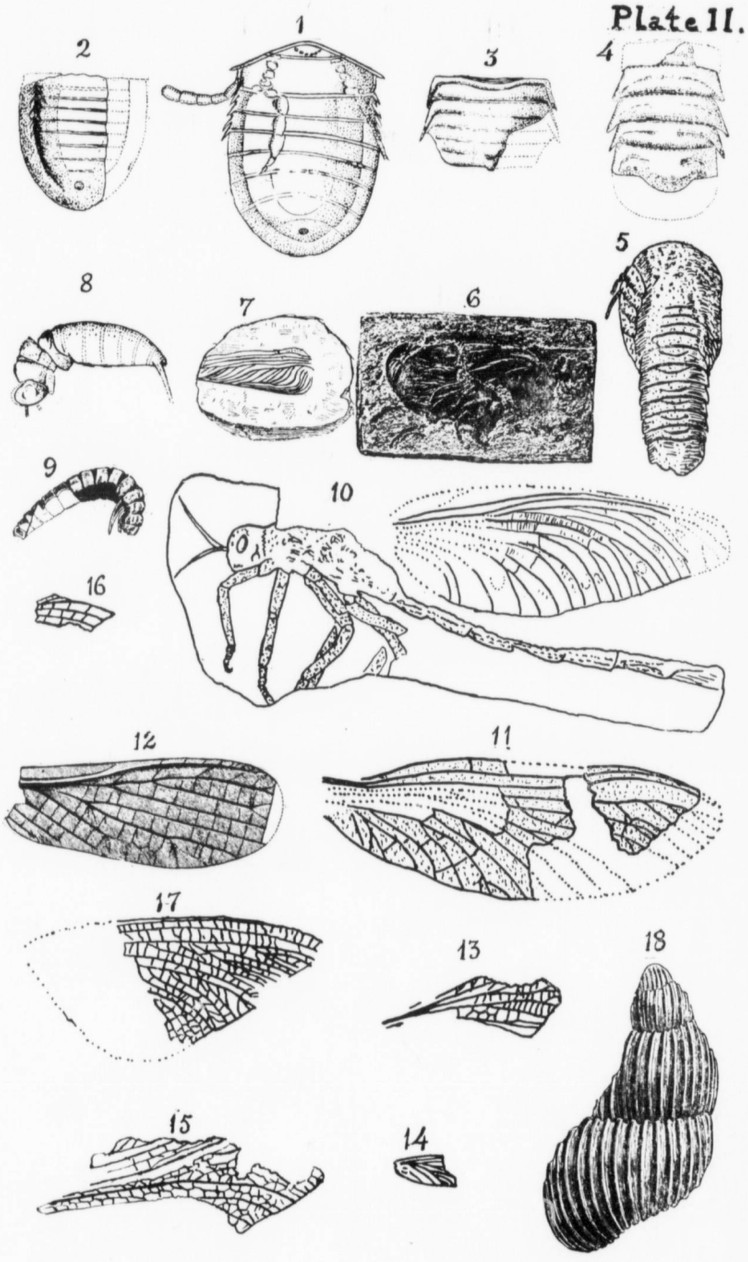


Plate II.



ARTICLE III.

NOTES ON INTRUSIVE ROCKS NEAR ST. JOHN, N. B., CANADA.

BY W. D. MATTHEW, PH. D.

Read 4th May, 1897.

[The following notes are in continuation of an article read before this Society 8th May, 1894 (See Bulletin No. XII., 1894) For the preparation of the sections on which the following observations are based, the author is indebted to the Laboratory of the School of Mines of Columbia University, New York, and for several of the rock specimens examined, to Prof. L. W. Bailey, of the University of New Brunswick, Fredericton.

No. 1 of the following list is similar to a granitic rock on Long Island, opposite Barlow's Bluff, which rock is in contact with slates and limestones of the Upper series (Grenvillian) of the Laurentian.

Nos. 2, 3, 4, 5 and 6 are intrusions in the slates and flags, (Division 2) of the St. John Group (Cambrian). Nos. 78–187 are from a mass, forming a rather prominent hill, called the Devil's Back, on the north shore of the Long Reach of the St. John river, which is bordered to the north and west by red sandstones of the Etcheminian series (Palæozoic but pre-Cambrian). This mass is similar to some others along the Long Reach which appear to have come through Silurian (Upper) beds.

Nos. 69–76 and 72–15 are igneous rocks bordering the granite and which are in contact on their south side with Silurian (Upper)

shales and sandstones. The age of these shales, etc., is determinable from fossils which they contain in some places not far from the igneous rock.

The name "Ox-bow," used in connection with one of these rocks, was applied to a sharp bend in the "Nerepis" Road at the locality designated. This road is the main highway between St. John and Fredericton.—EDITOR].

I have taken opportunity to look over the sections of some rocks gathered last summer, and send a few notes on them for the Natural History Society [of New Brunswick].

1. *Barlow's Bluff granite.*

A coarse grained grano-diorite (Tonalite). The thin section shows much quartz, orthoclase and plagioclase in about equal amounts, occasional green hornblendes, slight zonal tendency in a few of the feldspars. The hand specimen shows a few idiomorphic quartz crystals, but no trace of these appears in the section examined.

This rock is entirely of the type of the post-Laurentian granites at St. John, and belongs probably to the same series of intrusions.

2. *Hornblende Basalt.* From the heavy dyke in Cambrian slates back of Barlow's Bluff.

Augite and brown basaltic hornblende crystals, the former younger, with a little quartz and considerable plagioclase, much decomposed. No marked diabase structure. Considerable secondary green hornblende chlorite and calcite.

3. *? Feldspathic Diabase.* Fine grained. From the centre of smaller dyke in Cambrian slates, same locality as No. 2.

Fine-grained, porphyritic with triclinic feldspars. Very feldspathic; the little dark silicate entirely decomposed. Porphyritic feldspars not very sharply outlined; those in the groundmass show the diabase structure, and are probably a not very basic labradorite.

4 & 5. *Augite porphyrite.* From near edge of smaller dyke, locality same as the last.

Fine grained, the porphyritic crystals decomposed but having the outlines of augites, in a groundmass of minute idiomorphic

augites, and lath-shaped feldspars with flow structure. The augites of the groundmass are sharply outlined, not decomposed, and very pretty.

6. ? ? *Tachylite* (basic glass). Locality same as the last, from a small branch dykelet.

Very fine grained, with a few small crystals in a decomposed base, traversed with numerous cracks doubtfully perlitic, hence perhaps a devitrified glass.

Nos. 2–6 are none of them the usual style of the Huronian diabases, although No. 3 is technically a diabase; a more complete knowledge of the dyke would, perhaps, show it to be normally an augite-porphyrite. I am inclined to think that the usual type of the post-Cambrian dykes will be found to be *augite porphyrite* and *basalt*, that of the pre-Cambrian ones either *diabase*, connected with the "Huronian" rocks, or *diorite porphyrite*, connected with the intrusive granite-diorites. No. 2 may be a later dyke than 3–6; it had somewhat that appearance in the field, and is fresher in section.

No. 78–187. Dolerite. Devil's Back.

Coarse-grained, with crowded porphyritic crystals of augite in a groundmass of small augites and feldspars.

The large augites are very much zonally cracked — no variation in composition in the different layers, so that I take it to be the result of sudden cooling in a rock half solidified. The cooling was accompanied and followed by some motion of the mass, which caused the crystals to break up more or less.

This tallies with note on the Cambrian dykes as to composition. Though the evidence on the composition of the post-Cambrian dykes is exceedingly meagre as yet, yet it points uniformly in the one direction — that of a community of origin.

69–76. Aplite (fine grained granite). ?"Ox-bow Reef," first rock next granite.

A granular mixture of orthoclase, quartz and secondary epidote. Occasional zircons, a little magnetite. Orthoclase tends to be idiomorphic. No plagioclase observed.

This is a peripheral phase of an orthoclase granite. It would be an interesting point if the Devonian granites should prove to be prevailingly orthoclase granites, as the post-Laurentian ones at St. John are certainly dioritic granites [called syenite and granite in Reports of the Geological Survey of Canada].

72–15. Felsite—Between the granite quarry and Vanwart's.

Fine grained, rather basic igneous rock, with lath-shaped feldspars, partly plagioclase; a few phenocrysts, light and dark, but entirely altered so that they are not recognizable. A little quartz in the groundmass.

This may possibly be a dyke or extreme peripheral phase of the granite, but I could not say on the evidence. It appears originally to have been a fine-grained trachytic rock, with a good deal of plagioclase. I expect that a good deal of information as to their origin may be had from some of those unexamined crystalline rocks at the borders of the Devonian granites. They should present a class of contact phenomena considerably different from those of the post-Laurentian granites.

ARTICLE IV.

TIDAL PHENOMENA OF THE ST. JOHN RIVER AT LOW SUMMER LEVEL.

BY A. WILMER DUFF, M. A.

(Read March 2nd, 1897.)

I. Free and Forced Vibrations.

The waters of the earth have two somewhat different kinds of motion. There are, first, the steady motions, such as the Gulf Stream, caused ultimately by the heat which we receive from the sun. Secondly, there are motions of vibration, including waves of various kinds and tides. This second class also admits of an important sub-division. Firstly we have those motions of vibration whose rates are determined merely by the properties of water (especially its mass) and by its weight, or the force which the earth exercises on it; these motions being analagous to the motion of a pendulum, whose rate is determined by its length and the earth's attraction. This kind of vibratory motion we may call the *free* or natural vibrations of the water. But there is a second class of motions of vibration whose rates are determined by the motions and attractions of bodies beyond the earth, especially the moon and sun. These motions we may call the *forced* or artificial vibrations of water masses. When we speak of tides, we are inclined at first to think of them as merely forced vibrations; but, in reality, the forced vibrations give rise to free vibrations and the two kinds of vibration are quite inseparably mixed up in tidal phenomena. For instance, the highest authority on tides (Lord Kelvin) regards the tides of the English Channel as mostly a free vibration of the water, see-sawing or teetering about a line passing from Portland to Havre; and William Ferrel (probably

the chief authority in America) thinks that the tides of the deep water of the North Atlantic may be an eastward and westward swinging motion, like the "wish-wash" of water in a wash-bowl. In one case only have we a motion of vibration that belongs to one only of these two classes, namely, the case of moderate sized lakes; for their motions are nearly altogether free vibrations, and it is only in very great lakes that forced vibrations can be discovered; for instance, the tides of Lake Michigan only amount to between two and three inches.*

II. Tides in Rivers.

Remembering this distinction between free and forced vibrations, let us apply it to the case of a river. Are there any forced vibrations in rivers; that is, any motions produced by the direct attractions of sun or moon on the waters of the rivers? Reason will be adduced later for believing that, in the case of the St. John river at least, there is nothing such; but it cannot be denied that in the case of a very large river like the Amazon, whose course is directly east and west, there may be such a direct forced vibration. But there is in most rivers that enter the ocean a *secondary* forced vibration; that is, a fluctuation of the level of their waters produced by a periodical rise and fall of the level of the ocean at the mouth. This distinction is sometimes put in this form, that there is no true tide in the St. John river, only a "backing-up;" but such a way of putting it is hardly justifiable. It is true that as the level of the water at the mouth rises, the speed of the stream must decrease, and as there is still practically the same supply of water from the parts of the river farther up, the level must in consequence rise progressively up stream. This is what is meant by a "backing-up." But there is also a flow of salt water up stream for a considerable distance from the mouth, a flow that differs in no respect from the flow of water up the Bay with the incoming tide. Now we have seen that we cannot limit the word tide to direct forced vibrations

* T. D. Graham, Vol. xiv., A. A. A. S., 1860.

only, for there is none such anywhere; nor can we limit the word tide to cases in which forced vibrations and free vibrations are mixed, for it is probable that in the Bay of Fundy itself we have mostly, if not altogether, a free motion of the water, started no doubt by the forcible motions imparted to adjacent parts of the Atlantic. Tides are in fact those forced motions or free motions which may be traced back ultimately to the attractions of sun and moon. And in this sense it is evident that the rise and fall in a river is a true tide. Thus the tides in the River St. John are a mixture of a "backing-up" and a flow of salt water upwards, but this flow of salt water never extends to anything like the distance at which the "backing up" is perceptible. Along with these motions we have complications produced by wind effects and barometric effects. I am aware that some points in this account may be disputed, but I shall attempt to justify the statements in the course of what follows.

III. The River St. John.

It will be necessary to state briefly a few of the physical features of the river which seem of most importance in the present connection. We shall only be concerned with the last ninety miles of its length. Just above Springhill (ninety miles from mouth) rapids occur. From Springhill to the mouth of the Belleisle, the general course of the river is between east and south-east, and the river is comparatively shallow and sluggish. Below this comes the Long Reach, a straight clear part of the river, the general direction of which is south-west. This ends at Westfield and the river again takes a southerly direction, enlarging greatly to form Grand Bay and receiving on the east the waters of the Kennebecasis, a large, wide tributary. Below Grand Bay, the river greatly contracts at the Narrows, expands again at Indiantown, then contracts again and meets with short "rapids" and then rushes through a short and very narrow gorge (only one hundred yards wide) into St. John harbour. The term "Falls," often applied to this outlet, more properly belongs to rapids above the outlet. The occurrence of islands is of impor-

tance. From Springfield to Oromocto few occur, from Oromocto to Oak Point they are large and numerous, and below Oak Point there are but few.

IV. Points to be Ascertained.

While the St. John offers no such striking phenomena as the Petitcodiac and other streams near the head of the Bay of Fundy, yet, when its great size and remarkable outlet and the striking tides of St. John harbour are considered, it should, from the tidal standpoint, be one of the most interesting of rivers. A comprehensive study of its tides at various representative points should tells us: (1) The difference of time between high water and low water at such points and high water and low water at St. John. (2) The proportion which the range of tide bears to the corresponding tide at St. John. (3) The nature of the tidal rise and fall. (4) The effects of varying cross-section, depth, presence of islands and tributaries on the extent and time of tide. (5) The effect of the remarkable outlet. (6) The effect of varying depth of river with changing seasons on the preceding. (7) The effect of winds. There is at present practically no information, at least in print, to be had on any of the above points. To get anything like complete data, on even one of the above points, would demand much time and patience. What follows can only pretend to be somewhat disjointed information on nearly all of the above heads. It must be remembered that all of the following notes were made at low summer level. Towards the end of the summer of 1896 the river fell to a very low level. To fix the level by a semi-permanent reference point, on August 9th I found mean water level of Fredericton to be twenty-four feet two inches below the south-west corner of the west pier of the iron railway bridge. From the levellings of the New Brunswick railway, Mr. Moses Burpee found that a certain reference point at Fredericton was forty-four feet ten inches above mean sea-level at St John. Prof. Dixon has kindly aided me by levelling from Mr. Burpee's reference point to the corner of the pier mentioned, and finding the latter to be three

feet four inches lower than Mr. Burpee's reference point. From this I deduce that the south-west corner of the west pier of the bridge is forty-one feet six inches above mean sea-level at St. John; and that on August 9th the mean water level at Fredericton was fourteen feet four inches above the mean sea level at St. John. These figures may be of some future use for reference, and they are given for what they may be considered worth. Exception may be taken to the use of railway levellings for such a purpose, but other data are not to be had at present. I am indebted to Dr. Harrison, of the University of New Brunswick, for Mr. Burpee's figures.

V. Tide Gauge Used.

For the purpose of the following work I used a self-recording tide gauge of a simple type designed by myself and made with the assistance of Mr. H. White of Fredericton. As a description may be of use to others I give the following brief account of it. It consisted of a float to rise and fall with the water and a vertical drum driven by a clock, the parts being so arranged that a pencil attached to the float traced a curve on a sheet of paper wrapped around the rotating drum. The details and dimensions were as follows:

The float consisted of a cylindrical can plain at the top and with a conical lower end, the lower end being loaded with shot to give the float greater stability in the water. The diameter of the can was five inches and its length without the conical end five inches, with the conical end seven and a half inches. A brass tube was soldered axially through the can. Through the tube a brass rod passed loosely so that the float might slide up and down the rod as an axis. This axis was clamped in the frame-work of the machine, so that it might be removed and cleaned. Above the rod came the rotating drum, a cylinder of wood twelve inches long and three inches in diameter. The upper end of this made friction connection with a spring clock by means of a small axial rod fastened to a brass plate which was screwed to the wooden drum. The lower

end rested on a spring by means of a similar axial rod having a conical point which turned with very little friction in a conical hole in a brass plug attached to the spring. The purpose of the spring was to keep the cylinder pressed tightly against the clock. A long springy piece of brass was soldered by its lower end to the side of the float and its upper end carried a pencil which pressed lightly against the cylinder. It is easily seen that surface waves might move the float and so obscure the tidal record; hence the whole instrument was enclosed in a long, narrow, vertical box which leaked slightly at the bottom. Thus the water level in the box changed with the slow rise and fall of the tide but surface waves had no effect. The machine was held at the proper level in the water by being solidly clamped to an iron stake driven in the ground.

In preparing for an observation, a sheet of white paper was wrapped around the cylinder. The cylinder was then put in place and the pencil arranged so as to press against it. The exact time of beginning and ending the record being noted, the time corresponding to any particular point on the curve could be deduced after the paper was removed.

VI. Curves Obtained at Springhill.

The first point at which this instrument was used was immediately above the rapids above Springhill on July 21st and 22nd. The line traced in twenty-four hours indicated a fall of thirteen-sixteenths of an inch, but differed by less than one-sixteenth of an inch from a straight line, indicating that absolutely no tides are propagated above these rapids, at least along the right bank. The next point chosen was just below the rapids, about a quarter of a mile above the Springhill hotel. A twenty-seven hour record was taken on July 23rd and 24th. This showed in a remarkable way an effect frequently afterwards noticed, the great influence of wind. From 6.30 p. m. to 9 p. m. of the 23rd, a strong wind blew down stream, and during this time the pencil traced almost a straight line. At 10.30 it rose about a quarter of an inch, and then fell smoothly to low water at 3 a. m., and rose to

high water at 8 a. m.; the range from high water to low water being four and a half inches. The instrument was then removed to be slightly altered, and at 8 p. m. of July 28th it was replaced at the same point, and thenceforward a continuous record was obtained until August 6th. This would have given eighteen high waters and seventeen low waters, were it not for the fact that the weather, which, until the 31st, was calm, suddenly became stormy, with winds of as much as twenty miles an hour from the north-west, that is, from nearly exactly up-stream. These were sufficient to totally obliterate the ordinary tidal rise and fall and give curves whose ragged irregularities represented faithfully every variation in speed and direction of wind. In the complete record which accompanies this I may point especially to 7 p. m. of the 4th, 8 a. m. of the 5th, 1 p. m. of the 30th, and 1 a. m. of the 2nd. The corresponding wind velocities, kindly supplied by Dr. Harrison, have for comparison been placed at the top of the record. A curious hump in the curve at 10 p. m. of the 5th was explained by a sudden gust of wind which, Dr. Harrison informed me, was indicated by the recording wind gauge just at that time. These facts are interesting as indicating the very great effect which wind has on water in a somewhat confined basin. The effect would, of course, be still more marked in the case of lakes. This is of interest in connection with the other paper (on secondary undulations) presented to the Society.

The smoothness of the curves in calm weather is of importance as indicating that we have at Springhill no true forced vibration of the water, produced directly by lunar influence, but only a free derived waved started by the rise and fall at St. John. A mixture of both would give irregularities in the curve.

VII. Time and Amount of High Water at Springhill.

In the curves obtained at Springhill, there are in all twelve fairly well marked high waters, the others being unreliable on account of wind disturbances. Of these, six were obtained during very calm weather and six others during windy weather. From the former, Table I has been calculated. Column 2 gives the

range of tide at Springhill, 3 the range of tide at St. John, 4 the percentage of the St. John tide that reaches Springhill, 5 the difference between the time of high water at Springhill and high water at St. John, 6 the difference of the time of low water at Springhill and low water at St. John. The times of high water at St. John were obtained from the records of the Kelvin Recording Tide Guage, for access to which I have to thank

TABLE I.

Time and Amount of Tide at Springhill.

Date.	Range at Springhill.	Range at St. John.	Percentage at Springhill	Difference of times of H.W. at Springhill and St. John.	Difference of times of L. W. at Springhill and St. John.
July 23	4.5 in.	22.1 ft.	1.70	9 h.—19m.	11h.—49m.
28	3.94 "	20.4 "	1.61	9 h.—15m.	11h.—18m.
29	4.12 "	20.0 "	1.72	9 h.—18m.	10h.—57m.
30	4.25 "	20.6 "	1.72	9 h.—30m.	11h.— 3m.
30	3.62 "	19.6 "	1.54	9 h.—15m.	10h.—45m.
31	3.32 "	18.1 "	1.52	9 h.—20m	.....
Mean	3.96 in.	20.1 ft.	1.63	9 h.—20m.	11h.—9m.

TABLE II.

Time and Amount of Tide at Springhill.

Date.	Range at Springhill.	Range at St. John.	Percentage at Springhill	Difference of times of H. W. at Springhill and St. John.	Difference of times of L. W. at Springhill and St. John.
Aug. 3	4.06 in.	16.25 ft.	.....	9h.— 9m.	10h.—45m.
4	4.32 "	14.55 "	.....	9h.—28m.	11h.—10m.
4	4.19 "	16.4 "	.....	9h.—20m.	11h.—55m.
5	2.87 "	15.0 "	.....	9h.—36m.	11h.—50m.
5	3.00 "	15.0 "	.....	9h.—1 m.	11h.—13m.
6	.....	18.0 "	.....	9h.—5 m.	11h.—20m.
Mean	.....	15.9 ft.	.....	9h.—16m.	11h.—22m.

Mr. D. L. Hutchinson. Table II is similar to Table I, except that it is calculated from the less reliable results obtained during windy weather. The following are the more important points brought out by these tables:

(1) The Time of High Water at Springhill. Just at high water or low water at any place the level changes very slowly. Hence it is difficult to be quite certain of the exact moment of change. Remembering that this remark applies to both the St. John and the Springhill records, the close agreement among the results of column 5, which gives the interval between high water at Springhill and high water at St. John, must be considered very satisfactory. The mean interval is nine hours and twenty minutes, the greatest divergence from the mean is ten minutes, and the next greatest five minutes. The "probable error" is only one and a half inches. The second series being made in windy weather, do not agree so well among one another, but give a mean of nine hours and sixteen minutes, differing by less than one per cent from the preceding. The mean tidal range at St. John was twenty feet in Series I and sixteen feet in Series II. Hence the former results may be taken as fairly representative of spring tides and the latter as neap tides. The mean tidal range is twenty-five per cent greater in Series I than in Series II, and yet the time of passage of high water from St. John differs by less than one per cent. We seem justified in concluding that the interval between high water at St. John and high water at Springhill is practically independent of the tidal range. This should be remembered in connection with the results obtained at other points on the river.

(2) Amount of Tide at Springhill. From Series I we see that when the mean range of tide at St. John is twenty feet, that at Springhill is four inches or 1.63 per cent or about one-sixtieth of the range at St. John. Moreover, the range at Springhill is (allowing for wind disturbances) proportional to that at St. John. This is otherwise evident from the principle of the superposition of small motions.

(3) *Time of Low Water at Springhill.* From Table I it is seen that low water at Springhill occurs on an average eleven hours and nine minutes later than low water at St. John. Hence it takes low water one hour and of rty-nine minutes longer to travel from St. John to Springhill than it does high water. This is shown in another way by the shape of the Springhill curves. It will be noticed that in all cases the curves are steeper on one side of high water than on the other, the tide rises faster than it falls, so that a low water always comes closer to the succeeding high water than to the preceding. In fact, the average time from low water to high water is only five hours and seventeen minutes, while that from high water to the next low water is seven hours and seven minutes. This relative delay of low water is due to one of the differences between wave motion in a shallow river and wave motion on the ocean. In the former the more elevated parts of a wave always travel faster than the less elevated or the depressed parts. In fact, if v be the velocity of any part of a wave whose elevation above the mean level is h, and if H be the depth of the river

$$v = c\left(1 + \frac{3}{2}\frac{h}{H}\right)$$

In this, c is of course the value of v, for parts of the wave for which h is zero ; that is, for parts of the wave midway between crest and trough. In the parts of the wave below mean water level h is negative. Hence v is greater for the crest than for the trough ; that is, greater for high water than for low water. Thus low water keeps lagging farther and farther behind the high water ahead, and approaching the high water behind. This process may go so far that the front of the tide wave becomes nearly vertical and then we have a bore as in the Seine, Petitcodiac and many other rivers.

With this greater steepness of the front of the tide wave another peculiarity is often developed. The rear slope of the wave may first become straight and then actually recurved. This is hardly shown in any marked degree on the St. John River, although the rear slope sometimes approximates to a

straight line. The depth of the river decreases too gently and uniformly to show these more marked features often shown in tidal rivers.

VIII. Form of Tide Wave at St. John.

While the change of form referred to in the preceding is a well known feature in rivers, I do not know that attention has ever been called to the fact that the same thing may happen even in large bays like the Bay of Fundy. It occurred to me to examine carefully the tide record at St. John to see if low water

Table III.

Delay of Low Water at St. John.

Time from H.W. to L. W.	Time from L. W. to H.W.	Delay of L. W.	Time from H.W. to L.W.	Time from L.W. to H.W.	Delay of L. W.
hrs. min.	hrs. min.	min.	hrs. min.	hrs. min	min.
6 — 25	6 — 10	7.5	6 — 10	6 — 5	2.5
6 — 20	6 — 5	7.5	6 — 30	6 — 2	14.0
6 — 33	5 — 59	16.0	6 — 11	6 — 12	—0.5
6 — 10	6 — 0	5.0	6 — 22	6 — 3	9.5
6 — 13	6 — 9	2.0	6 — 30	6 — 0	15.0
6 — 33	5 — 57	18.0	6 — 15	6 — 0	7.5
6 — 25	5 — 55	15.0	5 — 16	6 — 6	5.0
6 — 33	5 — 53	20.0	6 — 18	6 — 2	8.0
6 — 15	6 — 0	7.5	6 — 23	6 — 5	9.0
6 — 18	6 — 0	9.0	6 — 23	6 — 0	11.5
6 — 24	6 — 3	10.5	6 — 22	6 — 5	8.5
6 — 18	6 — 10	4.0	6 — 30	5 — 58	16.0
6 — 13	6 — 7	3.0	6 — 30	6 — 10	10.0
6 — 18	6 — 12	3.0	6 — 25	6 — 2	11.5
6 — 8	6 — 7	0.5	6 — 28	6 — 17	5.5
6 — 13	6 — 20	3.5	6 — 18	6 — 10	4.0
6 — 22	6 — 10	6.0	6 — 20	6 — 2	9.0
6 — 18	6 — 10	4.0	6 — 13	6 — 5	4.0

Mean delay, 8 min.

falls exactly midway between two high waters. Table III gives the time from high water to low water and from low water to

high water for all the tides in a month whose exact time of high water to low water could be read accurately enough to be the basis for an estimate. Out of the thirty-six complete tides there recorded, thirty-four show a greater length of time from high water to low water than from low water to high water. The mean delay of low water is eight minutes, or the time from high water to low water is on the average sixteen minutes greater than the time from low water to high water. It should be noted that this delay of low water in St. John harbour is not due to the fact that the harbour is at the mouth of a large river; this would tend to have exactly the opposite effect. For, shortly before low water would naturally occur, the inflow from the river neutralizes the outflow into the bay and thus causes the tide to turn earlier or the low water to come earlier. On the other hand, the upflow into the river just before high water would occur neutralizes the inflow from the bay and so causes high water to occur earlier. Now if high water and low water were thus hastened equally, there would be no change in the time from high water to low water or from low water to high water. But since on the whole there is a greater downflow from the river than upflow into it, it is clear that the river must hasten low water in the harbour more than it hastens high water. Hence we may conclude that did the river not exist, the delay of low water in the harbour would be slightly greater than eight minutes. No doubt part of this delay must occur whilst the tide is passing from Mispec Point inward. How much of it occurs during the passage of the tide up the bay must remain an open question.

IX. Results at other Points on River.

The observations made at other points are given in Table IV and summarized in Table V. These tables show at Springhill, Fredericton, Oromocto, Gagetown, Oak Point, Westfield and Indiantown, (1) the mean spring-range (it being assumed that the spring-range at St. John is twenty-seven feet); (2) how much later high water is at each point than at St, John; (3) how much low water is delayed compared with high water. The last

column of Table V seems to show that between Indiantown and Oak Point the low water is delayed over twenty minutes compared with high water; between Oak Point and Oromocto low water travels as fast as high water, and between Oromocto and Springhill low water again loses half an hour.

TABLE IV.

Place.	Date.	Tide in Inches.	St. John Tide in feet.	Percentage of St. John Tide.	H. W. later than at St. John.	L. W. later than at St. John.
					hr. min.	hr. min.
Fredericton...	July 24	5.3	22.1	2.0	8 — 39	10—17
	Aug. 21	5.6	19.5	2.4	8 — 47	10—49
	" 22	6.1	22.1	2.3	8 — 59	10—3
Oromocto....	" 10	6.6	24.5	2.2	8 — 0	8—48
	" 11	7.9	25.7	2.6	7 — 55	8—24
Gagetown ...	" 11	9.1	25.1	3.0	5 — 42	6—20
	" 12	9.6	25.5	3.1	5 — 37	6—13
Oak Point ...	" 12	12.0	25.2	4.0	3 — 18	3—57
	" 13	13.8	24.6	4.7	3 — 11	4—7
Westfield	" 14	18.5	23.5	6.5	2 — 26	3—18
	" 14	.....	23.6	... ..	2 — 32	.....
Indiantown	" 31	16.0	16.6	8.0	2 — 2	2—5

TABLE V.

Place.	Distance from Indiantown.	Mean Spring Range.	Mean Percentage of St. John Range.	H. W. later than at St. John.	Delay of L. W.
				hr. min.	min.
Springhill	90	5.2	1.6	9 — 20	55
Fredericton	83	7.1	2.2	8 — 45	49
Oromocto	73	7.8	2.4	7 — 57	20
Gagetown	48	9.7	3.0	5 — 40	24
Oak Point...	25	13.9	4.3	3 — 15	24
Westfield.....	10	21.0	6.5	2 — 30	24
Indiantown	0	25.9	8.0	2 — 2	0

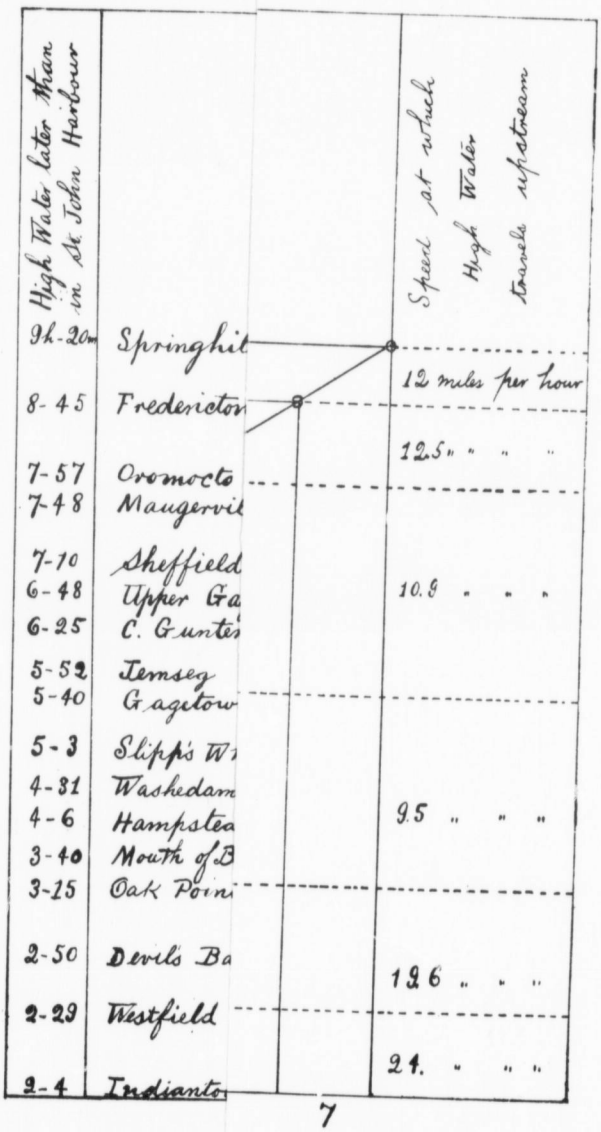
X.—Rate of Progress of High Water up River.

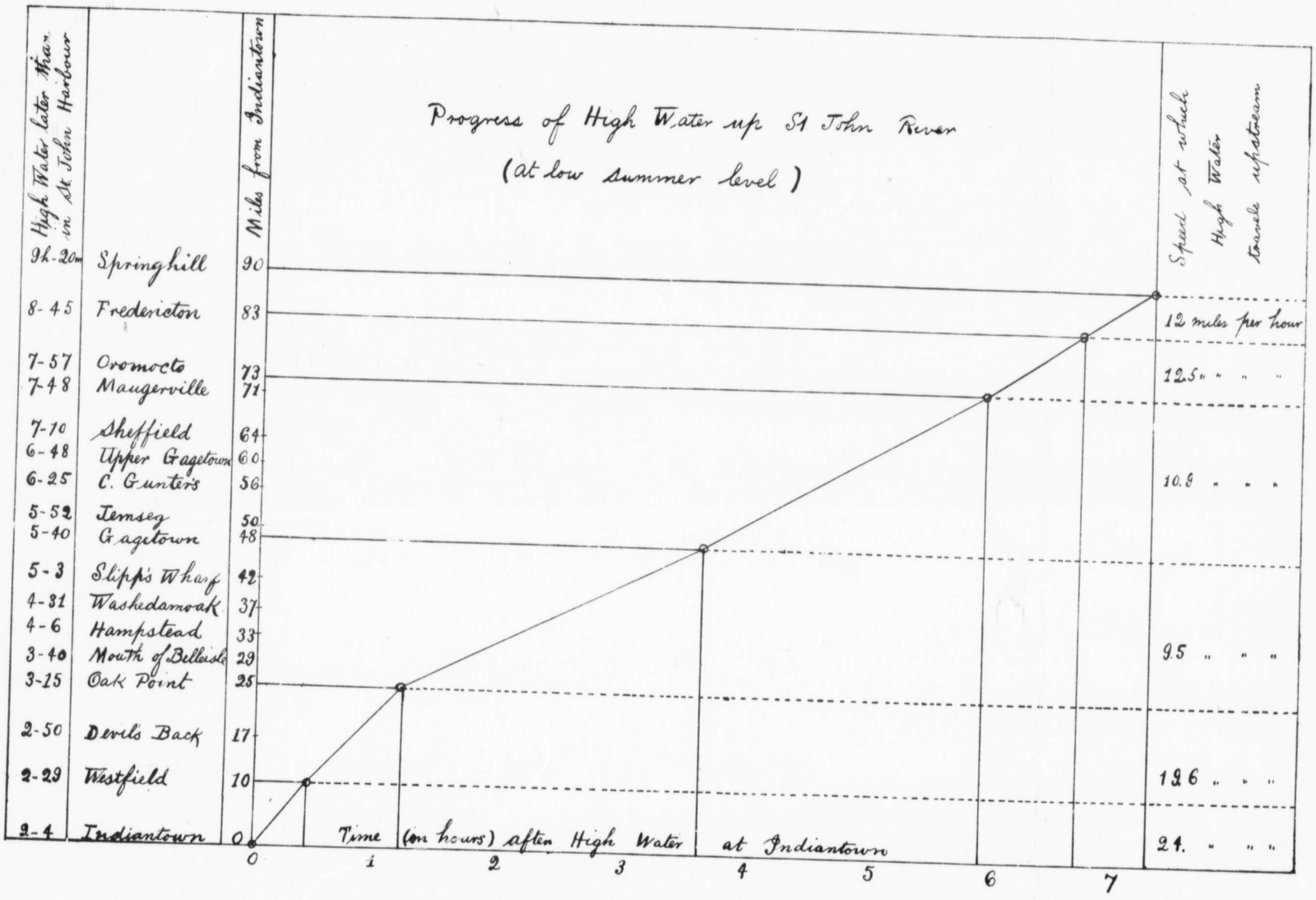
To show the speed with which high water travels up river I have plotted the results on cross section paper. Indiantown is taken as origin or starting point. Times after high water at Indiantown are represented by horizontal lines or abscissæ, and the distances which high water has progressed in those times are represented by vertical lines or ordinates. The points on this chart corresponding to the seven stations of observation are joined by straight lines. The slope of this broken curve at any point represents the speed of the high water at that point. This shows at a glance that, whereas the speed is much less between Oak Point and Oromocto than it is between Indiantown and Oak Point, it increases again between Oromocto and Kingsclear. In fact the average speed of high water is:

Between Indiantown and Oak Point — 20 miles an hour.
" Oak Point and Gagetown — $9\frac{1}{2}$ " "
" Gagetown and Springhill — $11\frac{1}{2}$ " "

It is interesting to compare this with the fact, stated in the preceding section, that the delay of low water is greatest between Indiantown and Oak Point, and between Oromocto and Springhill, but is at least very small between Oak Point and Oromocto. Again both of these statements seem connected with the fact noted earlier that it is between Oak Point and Oromocto that islands are numerous and greatly interrupt the course of the river. Hence we seem justified in concluding that irregularities and obstacles in a river retard the progress of high water, but do not delay low water as compared with high water.

I have also plotted a curve representing how the amount of tide from point to point of the river varies with the distance from Indiantown. Excepting the highest point, Springhill, the points lie roughly on an exponential curve, indicating that each mile produces roughly the same percentage decrease of tidal rise. This would seem almost obvious beforehand, and need hardly be discussed further.


High Water later than in St. John Harbour
Speed at wreck
High Water
towards upstream
9h-20m
Springhil
8-45
Frederictor
12 miles per hour
7-57
Oromocto
12.5 " " "
7-48
Maugervil
7-10
Sheffield
6-48
Upper Ga
10.9 " " "
6-25
C. Gunte
5-52
Jemseg
5-40
Gagetow
5-3
Slipp's W
4-31
Washedam
4-6
Hampstea
9.5 " " "
3-40
Mouth of B
3-15
Oak Poin
2-50
Devils Ba
12.6 " " "
2-29
Westfield
2-4
Indianto
21. " " "


Progress of High Water up St John River
(at low summer level)
High Water later Mean in St John Harbour
Miles from Indiantown
Speed at which High Water travels upstream
9h-20m Springhill 90
8-45 Fredericton 83
12 miles per hour
7-57 Oromocto 73
7-48 Maugerville 71
12.5 " " "
7-10 Sheffield 64
6-48 Upper Gagetown 60
6-25 C. Gunter's 56
10.9 " " "
5-52 Jemseg 50
5-40 Gagetown 48
5-3 Slipp's Wharf 42
4-31 Washedamoak 37
4-6 Hampstead 33
3-40 Mouth of Belleisle 29
9.5 " " "
3-15 Oak Point 25
2-50 Devils Back 17
2-29 Westfield 10
12.6 " " "
2-4 Indiantown 0
Time (in hours) after High Water at Indiantown
0 1 2 3 4 5 6 7
21. " " "

XI. Time of High Water at any Point on River.

The broken curve connecting times of high water at the seven points of observation and their distances from Fredericton enables us, given the distance of any point whatever from Indiantown, to find how much later high water occurs at that point than at St. John. We have only to find the point on the curve whose ordinate is the distance from Indiantown, then the abscissa of that point is the time its high water occurs later than

Table VI.

Time of High Water at various points.

Distance from Indiantown.	Name of Place.	H. W. later than H. W. in St. John Harbor.	Intermediate Points.
		hrs. min.	
0	Indiantown.		
10	Westfield.	2 — 4	
17	Pitt's Landing, (Devil's Back).	2 — 29	To column 3 add 3 minutes per mile
25	Oak Point.	2 — 50	
29	Mouth of Belleisle, (Palmer's Point).	3 — 15	
33	Hampstead.	3 — 40	
37	Mouth of Washademoak.	4 — 6	
42	Slipp's Wharf.	4 — 31	
48	Gagetown	5 — 3	
50	Jemseg, mouth of Grand Lake.	5 — 40	
56	Charles Gunter's.	5 — 52	To column 3 add 5 minutes per mile
60	Upper Gagetown.	6 — 25	
64	Sheffield.	6 — 46	
71	Maugerville.	7 — 10	
73	Oromocto.	7 — 48	
83	Fredericton.	7 — 57	
90	Springhill.	8 — 45	
		9 — 20	

the time of high water at Indiantown. Now a knowledge of the exact time at which high water may be expected at any point is (at least so residents along the river frequently informed

me) a matter of considerable importance especially as regards setting nets for fishing, getting grounded vessels afloat and other such practical purposes. Hence, although my motive in this enquiry has been purely scientific interest, I have thought it worth while to give in Table VI the interval between high water in St. John harbor and high water at seventeen points of importance on the river. This table, together with a McMillan's Almanac, will enable a resident on the river to anticipate high water quite as accurately as a resident in St John can at the present time; for the figures in Table VI cannot be more than ten or twelve minutes in error, probably much less, and this is a smaller amount than the error incident to the prediction of high water in St. John harbor at present. It may be well to repeat that this table applies to either spring or neap tides during low summer level. It remains to be seen whether it will apply to the river when full, in the spring or early summer. I think it can be safely predicted that the difference will not be great; for, while the greater speed of the water will naturally retard the progress of high water, the greater depth of the river will cause a wave, whether up or down, to travel with greater speed; and the two effects, depending on the same cause, will tend to neutralize one another. This, however, is a point that should be settled by observations in springtime.

XII. Effect of Narrow Outlet of River.

The most important tidal effect due to the remarkably narrow outlet of the river is the great delay of high water at Indiantown—two hours very closely,—although Indiantown is only a mile from the harbour. As the water rises in the harbour it must attain the level in the river above the rapids before much rise can occur at Indiantown. After that, as the supply of water from the harbor and bay is unlimited, while the large basins above Indiantown have a great capacity, the narrow outlet under the bridge is totally inadequate to keeping the levels above and below equal, so that for two hours after the water has reached its maximum level at St. John, and has

begun to fall, it is still running up river. At low water the converse happens, that is, the level at Indiantown keeps falling nearly until the part below the rapids has been filled up to the level above the rapids. It seems, however, not a little remarkable that the delay is so exactly the same for high water and low water. This account must be admitted to be very imperfect, as I had very little time for exact observations, except as regards the time of high water and low water at Indiantown.

XIII.—Tidal Currents.

In the preceding I have not paid any attention to the currents which form so important a part of tidal phenomena. The subject is one of great complexity in such a river as the St. John. Two remarks may however be made.

First it is rather a common mistake to suppose that there must exist a flow of saltish water as far up the river as tides can be detected. Two grounds are sometimes advanced for this view. The first is that a tide means a flow of water and there must be a flow of water as far up as there is a tide. This statement is true, but the deduction is unsound; for a tide, whether in a river or on the ocean, is a wave, and a wave may pass on for thousands of miles while the water at any place only makes short excursions, going forwards as the crest of the wave passes by, and backward as the trough passes. No one would claim that the water at the mouth of the Bay of Fundy travels the whole way to the head with the tide, for if so a vessel could float that distance in one tide. The second ground sometimes advanced is that there must, by the principles of hydrostatics, be salt water as far up steam as the point at which the bed of the river is on a level with the mean level of salt water at the mouth of the river; and that hence up to the head of the tides there will be an undercurrent of salt water up and an overcurrent of fresh water down. But it is impossible that two such layers should co-exist for a hundred miles without mixing. Again in many rivers such as the Amazon, La Plata, and Forth it is known that the tides extend a long distance further up than the point at which the level of the

bed of the stream is the mean water level at the mouth.* But even without this the evidence is complete; for I have obtained specimens of water from both surface and bottom at Fredericton and Indiantown at high water and their specific gravities reduced to 0° C. I find to be

Fredericton,	Surface water, ...	1.0005
	Water from bed, ...	1.0003
Indiantown,	Surface water, ...	1.0054
	Water from bed, ...	1.0109

Thus to within one-fiftieth of one per cent the water at Fredericton has the same density at surface and bottom. Even at Indiantown the process of mixing of salt water and fresh water is well advanced, for the density of the surface water is raised to 1.0054, and that of the bottom is lowered from about 1.026 which is the average density of sea water to 1.0109. When the diffusion has proceeded thus far even at Indiantown, it is evident that the tide will not have progressed many miles up river before the mixing is practically complete. How far salt water actually does travel up stream cannot be stated. It has been known as far as Gagetown.

As regards the amount of tidal current, I may note that on the morning of Monday, August 4th, I saw at Oromocto a log float one and a quarter miles up stream in the main channel in two and a half hours. That was at high water of a spring tide. That it was an unusual amount of up-current was evident from the extent to which it seemed to puzzle a ferryman. Also at Fredericton on Aug. 22nd, at 4 p. m., I observed a feeble current up. A careful examination of this whole question would be of great importance in such discussions as to whether the discharge of sewage into the river below Fredericton could affect the waterworks above the city.

In conclusion I wish to express my indebtedness to Mr S.W. Kain and Mr. Percy G. Hall, of the Natural History Society, also to Mr. Thomas Loggie, of Fredericton, Professor Davidson, of Fredericton, and Mr. E. T. P. Shewen, of St. John, besides the gentlemen previously mentioned, all of whom have been so kind as to supply me information or assistance.

* See Young's General Astronomy, p. 477. Airy's Article, Tides and Waves—Ency. Metropolitana.

Bibliography of Scientific Publications Relating to the Province of New Brunswick other than those contained in the Bulletins of the Society, 1897.

By Samuel W. Kain.

Lists similar to the one here given will be found in Bulletins XIII–XIV. They contain titles from 1890 to December, 1896. The present list contains titles from January, 1897, to June, 1897.

GEOLOGY.

Matthew, G. F.—The Oldest Siphonotreta. *Geological Magazine*, No. 392, New Series, Decade IV, Vol. IV, No. 11, pp. 68–71, February, 1897.

Some Features of the early Cambrian Faunas. *Report of the British Association for the Advancement of Science*, 66th meeting at Liverpool, 1896; pp. 785–787.

Some Features of the early Cambrian Faunas (Abstract). *Science*. New Series, V, pp. 254–256, February, 1897.

What is the Olenellus Fauna? *American Geologist*, Vol. XIV, No. 6, pp. 396–407, June, 1897.

Simonds, Frederick W.—Professor Charles Fred. Hartt, M. A. A tribute. *The American Geologist*, Vol. XIX, No. 2, pp. 69–90. February, 1897.
(Portrait and list of Prof. Hartt's writings).

PHYSIOGRAPHY.

Ganong, W. F.– On the Heights of New Brunswick Hills, *St. John Daily Sun*, May 10th, 1897.

On the Colors of the Waters in New Brunswick. *St. John Globe*, May 15th, 1897.

Dalhousie and St. Andrews—a Coincidence. *Daily Sun*, (St. John, N. B.,) June 4th, 1897.

Duff, A. Wilmer.—*Seiches* on the Bay of Fundy (Abstract). *American Journal of Science*. Fourth Series, Vol. III, No. 17, pp. 406–412. May, 1897.

THIRTY-FIFTH ANNUAL REPORT

OF THE

COUNCIL OF THE NATURAL HISTORY SOCIETY

OF NEW BRUNSWICK.

The Council of the Natural History Society beg leave to submit the following report for the year now ending:

MEMBERSHIP.

The Society has added to its roll thirty-six members, viz.:

Honorary (Professor John E. Marr)	1
Ordinary	14
Associate	16
Honorary Associate	2
Corresponding	3
Total,	36

Our membership now consists of:

Life Members	7
Honorary Members	4
Ordinary Members	61
Corresponding Members	36
Associate Members	57
Honorary Associate Members	2
Total	167

While a very satisfactory increase has been made, we look for still greater additions when citizens realize that it is their duty as well as privilege to assist in the support of a public institution such as ours.

During the year the Society has lost through death two patrons, one ordinary and one corresponding member.

Sir Samuel Leonard Tilley was patron during his two terms as Lieutenant Governor of the province, and an ordinary member up the time of his death, which occurred last June. In his death the Society sustained the loss of one who took a great interest in its

work, while the community in which he lived, and the Dominion at large, lost the services of a wise and enlightened statesman.

Honorable John James Fraser, who held the office of patron during the short term of his Lieutenant Governorship, died at Genoa, where he had gone for the benefit of his health.

In the death of Alex. Munro, C. E. (Port Elgin), and William F. Bunting, we lost members of long standing.

FINANCE.

The Treasurer makes the following statement:

Balance from 1895,	$ 61 74
Government grant,	125 00
Fees collected,	109 00
Interest on investment,	144 00
Bulletins sold	2 00
Donation (J. W.)	2 00
Dividend Botsford Estate	10 00
Dividend Maritime Bank	3 38
	$457 12
Expenditure	450 68
Balance	$6 44

LIBRARY.

The Library has grown rapidly,— the result of a greatly extended exchange list. We have thus been able to provide for our members the latest information in many branches of research; and while we cannot say that full use of this opportunity has been made, the advantage still exists for those who are interested in scientific progress.

The Lords Commissioners of Her Majesty's Treasury have presented to the Society a complete set of the "Challenger" Reports, which will be of great value to our members.

As practically nothing has been done lately in cataloguing the library, we trust that our next librarian, with his assistants, will be able to give the time necessary to perform this important work.

PUBLICATIONS.

Bulletin XIV has been published. It contains articles by G. W. Gesner, G. U. Hay, and W. F. Ganong. Arrangements have been made to reprint Bulletin III, which has long been out of print. Several copies of Bulletin I having been secured, the Society will soon have a number of complete sets of Volume I.

LECTURES AND ESSAYS.

Eight regular meetings were held when the following papers were read :

1896.

Feb. 4. The Old Meductic Fort. By Rev. W. O. Raymond. (Published in Collections N.B. Historical Society. Vol. 1, No. 2, pp. 221-272, 1 map, 2 pl., 1896.)

Mar. 3. Some results of the "Challenger" Expedition. By Geo. F. Matthew.

April 7. (1) Life of Dr. Abraham Gesner. By G. W. Gesner. (Published in Bulletin XIV.

(2) The Tantramar Marsh. By Geo. J. Trueman.

May 3. (1) Notes on two Shrews new to New Brunswick. By Philip Cox. (Published in Bulletin XIV.)

(2) Recent Additions to the List of New Brunswick Fishes. By Philip Cox. (Published in Bulletin XIV.)

(3) Addresses on the "Challenger" Expedition. By Geo. F. Matthew, Samuel W. Kain and H. G. Addy.

June 2. (1) Adaptations of Plants to Reproduction, including Locomotion of Pollen. By W. F. Ganong. (Published in Bulletin XIV.)

(2) The Outlet-Delta of Lake Utopia. By W. F. Ganong. Published in Bulletin XIV.

(3) On Artesian Wells. By Geo. F. Matthew.

(4) The Pottery of the Cliff-Dwellers. By Samuel W. Kain.

Oct. 6. Wild Berries of New Brunswick. By Walter S. Butler.

Dec. 1. The Restigouche — With Notes on its Flora. By Geo. U. Hay. (Published in Bulletin XIV.)

1897.

Jan. 5. (1) The Oldest Siphonotreta. By Geo. F. Matthew. (Published in Geological Magazine.)

(2) The Cambrian System in the Kennebeccasis Valley. By Geo. F. Matthew.

(3) Upon Temperature-Measurements with the Thermophone in Clear Lake. By W. F. Ganong. (Published in Bulletin XIV.)

The following elementary lectures were delivered:

1896.

Jan.	Eygpt. By Emma C. Fiske.
Feb.	The Microscope. By Dr. W. W. White.
Mar.	On Plants. Geo. U. Hay.
Apr.	On Birds. Philip Cox.
Sept.	Habits of Birds. W. Albert Hickman.

MUSEUM.

The birds have received considerable attention from Messrs. W. A. Hickman and Alfred Morrisey. Dr. Philip Cox, John Moser and W. A. Hickman made use of the museum in their work last summer.

The archæological collection in Case No. 1 was re-arranged and catalogued, and further reforms in the labelling are contemplated. The Committee on Archæology report several accessions. The Field Columbian Museum sent twenty-three pieces of prehistoric pottery in exchange for Devonian fossils; the Director of the U. S. National Museum sent a collection of casts of prehistoric weapons, ornaments, etc., and Judge DesBrisay of Bridgewater, N. S., donated some fragments of pottery from Nova Scotia.

GEOLOGY.

The report of the Committee on Geology describes some researches made by the Messrs. Matthew in the Cambrian rocks of the Long Reach and Kennebecasis Valleys.

BOTANY.

The Botanical Committee report that a preliminary list of the New Brunswick mosses had been prepared by Mr. John Moser which will be published in the Bulletin at an early date.

A number of flowering plants new to the province were found by W. F. Ganong and G. U. Hay in their trip down the Restigouche. These were published in Bulletin XIV.

ECONOMICS.

The Council have drawn the attention of the Department of Public Works of Canada to the desirability of establishing in the Dominion a plant for creosoting timber. The creosoted timber used in the construction of public works in the Maritime Provinces is at present imported from the United States at large expense. The process, too, by which this timber is treated is not reliable, and the Department has been recommended to

adopt the Boulton process. A paper on this subject by E. T. P. Shewen, Esq., C. E., which was read before the Society has been published by the Public Works Department in the Report of 1896.

GENERAL.

Two field meetings were held—one at Ingleside, the summer residence of President Hay, the other at Red Head, the summer residence of Vice-President H. G. Addy. Both were largely attended. The first had a decided advantage in point of weather; the second was rendered less pleasant by heavy rains which set in shortly after luncheon and continued all the afternoon.

In September last, Dr. Geo. F. Matthew attended the meeting of the British Association at Liverpool, G. B., where he read a paper on the Early Cambrian Faunas. On his return the Society tendered him a reception which was much enjoyed by the members and their friends. The Council take this opportunity to express their hearty appreciation of the work done by the associate members on this occasion. Nothing could exceed the energy with which the ladies entered into the room improvements, while the arrangements for refreshments were made with a degree of care which contributed greatly to the success of the reception.

The Council desire to thank the St. John press for the free insertion of notices and reports of meetings; and those who contributed papers during the year.

This report would be incomplete if we failed to express the hope that in the future we should possess rooms in which we could exhibit our collections to better advantage and extend the scope of our work. We have now nearly reached our greatest capacity, and we cannot hope to add much to our collections until our (at present utopian) new building has become a reality.

In conclusion, the Council draws your attention to the fact that the past year has been a remarkable one in many respects. Never before have the field meetings been so largely attended; the accessions to the library and membership exceed in importance those of any other year; the Museum has had many noteworthy additions; while to be represented at meetings of the British Association as this Society was last year, would be an advantage to any organization engaged in the study of Natural History.

Respectfully submitted,

PERCY G. HALL,
Secretary.

DONATIONS TO THE LIBRARY, 1896.

Donor's Name.	Residence.	Work.
Lords Commissioners of Her Majesty's Treasury		"Challenger"
Trustees British Museum	London.	Reports, 50 Vols.
Royal Society	do	Guides.
Royal Colonial Institute	do	Proceedings.
Geological Society	do	Journal.
Director Royal Gardens	do	Abs. of Proceedings.
Manchester Geological Society	Kew	Bulletins.
Biological Society	Manchester	Proceed and Trans.
Liverpool Geological Society	Liverpool	do
Marine Biological Association	do	do
Belfast Naturalists' Field Club	Plymouth	Journal.
Natural History Society	Belfast	Ann. Rep't and Proc.
Royal Society of Canada	Glasgow	Proceedings.
Ottawa Field Naturalists' Club	Ottawa	Proceed. and Trans.
Department Inland Revenue	do	Ottawa Naturalist.
Department Indian Affairs	do	Bulletins.
Entomological Society of Ontario	do	Annual Report.
Hamilton Association	London, Ont.	Can. Entomologist.
Natural History Society	Hamilton	Journal.
Historical and Scientific Society of Manitoba	Montreal	Can. Record of Scien.
Nova Scotia Institute of Natural Sciences	Winnipeg	Report.
University of Toronto	Halifax	Proceedings.
Canadian Institute	Toronto	Quarterly.
Toronto Public Library	do	Transactions.
Astronomical and Physical Society	do	Report.
Geo. F. Matthew	do	Transactions.
Scientific Association of Trinidad	St. John, N.B.	Pamphlets.
H. P. Woodworth	Port of Spain	Proceedings.
Australian Museum	Perth, W. A.	Reports.
Australian Assoc. for Advancement of Science	Sydney, N.S.W.	Report.
Linnæan Society of N. S. W	do	Report, Vol. VI.
New Zealand Institute	Elizabeth Bay	Proceedings.
U. S Bureau of Ethnology	Wellington, N.Z	Proceed. and Trans.
U. S. Geological Survey	Washington	Reports.
U. S. Fish Commission	do	Reports and Bulletins
U. S. National Museum	do	do
U. S. Dep't of Agriculture (Botanical Division)	do	Reports and Proc.
U. S. Coast and Geodetic Survey	do	Bulletins.
Smithsonian Institution	do	Report,
University of California	do	Report.
University of Michigan	Berkeley, Cal.	Bulletins.
Cornell University	Ann Arbor	Report,
Tufts' College	Ithaca, N. Y.	Bulletins.
Johns Hopkins University	Tuft's Col, Mass	Studies.
Amherst College	Baltimore	Circulars.
Leland Stanford, Jr., University	Mass.	Bulletins.
Boston Society of Natural History	Palo Alto, Cal.	Proceedings.
Essex Institute	Boston	Bulletins.
New York Academy of Sciences	Salem	Transactions.
New York Microscopical Society	New York	Journal.
Linnean Society of New York	do	Abstract of Proceed.
American Museum of Natural History	do	Report,
Linnæan Society of New York	do	Abstract of Proceed.
Natural Science Association of Staten Island	do	Proceedings.
Rochester Academy of Natural Sciences	New Brighton	do
Iowa Academy of Sciences	Rochester, N.Y	do
	DesMoines	do

DONATIONS TO THE LIBRARY.—*Continued.*

DONOR'S NAME.	RESIDENCE.	WORK.
Academy of Natural Sciences	Tacoma	Proceedings.
California Academy of Sciences	San Francisco	do
Wisconsin Academy of Arts, Sciences and Letters	Madison	Transactions-
Colorado Scientific Society	Denver	do
Cincinnati Society of Natural History	Cincinnati	Journal.
C. G. Lloyd	do	Plates.
Missouri Botanical Garden	St. Louis	Annual Report.
Prof. J. Walter Fewkes	Boston	Pamphlets.
Field Columbian Musenm	Chicago	Publications.
W. H. Holmes	do	Report.
Public Museum	Milwaukee	Pamphlets.
H. Forir	Belgium	do
Societe Geologique du Nord	Lille	Memoirs.
Societe Scientifique du Chili	Santiago	Artes.
Comite Geologique du Russie	St. Petersb'g	Memoirs and Bul'tins
Imperial Academy of Sciences	do	Bulletins.
Geological Institute of Upsala	Upsala	do

PURCHASED.

Ancient Indian Pottery of Marajo. C. Fred Hartt.
Pottery of Mound Builders. J. W. Foster.
Pottery from Vermont. G. N. Perkins.
Ancient Art of the Province of Chiriqui. W. H. Holmes.
Pottery of the Ancient Pueblos. W. H. Holmes.
Origin and Development of Ceramic Art. W. H. Holmes.
On Shell-Heaps (In New Brunswick). James Fowler.

DONATIONS TO THE MUSEUM, 1896.

Jan.	CAPTAIN BROWN.—Five large fossil bones from phosphate beds of Charlestown, S. C.
	One large Shark's tooth from same locality.
Feb.	MRS. MARY DIMOCK.—Minerals and foreign shells.
April.	DUNCAN LONDON, Lakeville Corner, N. B.—Fragments of Indian Pottery from Maquapit Lake.
	Two stone arrowheads.
	JOSHUA P. CLAYTON, ESQ.—Fortification Agate.
May.	MRS. WM. R. RUSSELL.—One jar containing fruit and leaves of nutmeg tree from Java.
	MISS ANNIE L. BARTON.—Ivory nut from East Indies.
	JOHN V. ELLIS, JR.—Large Moth with Cocoon.
	MRS. WM. BOWDEN.—One stone celt, one war axe.
	FIELD COLUMBIAN MUSEUM, Chicago.—Twenty-three specimens pre-historic pottery. (Exchange.)
July.	U. S. NATIONAL MUSEUM, Washington, D. C.—Collection of pre-historic implements (105).
	FRED. J. MCNAUGHTON.—Collection of Carboniferous fossils from Joggins Mines.
	JOSEPH I. NOBLE.—Egg of Loon.
Sept.	E. T. P. SHEWEN, ESQ., C. E.—Block of Freestone from Shediac, N. B.
	E. J. ARMSTRONG, ESQ.—Specimen of Asbestos.

Officers and Committees of the Natural History Society for 1897.

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Vice-Presidents—William Murdoch, C. E., H. G. Addy, M. D.
Treasurer—Robert Matthew, Esq.
Secretary—Percy G. Hall, Esq.
Curators—Geo. F. Matthew M. A., D. Sc., LL. D., F. R. S. C., Samuel W. Kain, A. Gordon Leavitt.
Librarian—William Gilchrist, Esq.
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Delegate to the Royal Society of Canada—Professor A. Wilmer Duff, M. A.

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Geology—G. F. Matthew, L. W. Bailey, G. J. Trueman.
Ornithology—A. Gordon Leavitt, Alfred Morrisey, W. A. Hickman.
Botany—G. U. Hay, James Vroom, Mrs. Wm. Bowden, Mrs. H. G. Addy.
Archæology—Samuel W. Kain, Frank E. Holman, R. Matthew.
Library—Wm. Gilchrist, R. Matthew, Mrs. G. U. Hay, Mrs. W. Frank Hatheway, Miss E. McBeath.
Rooms—H. G. Addy, R. Matthew, W. Murdoch, J. E. Wilson, Mrs. G. U. Hay, Mrs. F. E. Holman.
Finance—R. Matthew, J. Roy Campbell, W. Frank Hatheway.
Press—Samuel W. Kain, P. G. Hall, A. L. Calhoun.

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