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REMARKS ON RECENT PAPERS ON THE GEOLOGY OF NOVA SCOTIA.

(From a Paper communicated to the Nova Scotian Institute of Natural Science, by J. W. Dawson, LL.D., F.R.S., &c.)

The following remarks have reference to two papers by the Rev. D. Honeyman, D.C.L., Curator of the Provincial Museum, Halifax, published in the Transactions of the Nova Scotian Institute of Natural Science, Vol. iv., Part iv., 1878. These papers are respectively entitled — "Pre carboniferous Formations of Annapolis and King's Counties," and "Nova Scotian Geology, Pre-carboniferous, Lower Carboniferous, &c." Special reference will be made to the following points: (1.) The age assigned by Dr. H. to the fossiliferous rocks of Nictaux and New Canaan and their relation to the intrusive granites of the region. (2.) The Geology of the Pre-carboniferous Rocks of the Eastern part of Nova Scotia and Cape Breton.

1. Nictaux and New Canaan.

In the first of the papers above referred to, Dr. H. very freely criticises my conclusions respecting the age of the rocks of these localities, but does not take the trouble to state what these conclusions are, so that a reader unacquainted with the facts might take it for granted that all these rocks had been referred to the Devonian system, or that no definite idea of their age had previously been given. For this reason I shall take the liberty to quote from a paper on the Silurian and Devonian Rocks of Nova Scotia (April, 1860), my actual results, which are given in nearly the same form in Acadian Geology, 2nd edition, 1868. I may premise that these results were worked out at a time when there were no railways or county maps to assist the explorer, and when the aids in determination of fossils were much less accessible than at present; and also that I have added some explanatory notes, which are included in brackets.

"The oldest fossiliferous beds seen (at New Canaan) are the fine fawn-coloured and gray clay slates of Beech Hill, in which Dr. Webster, many years since, found a beautiful *Dictyonema*, the only fossil they have hitherto afforded. It is a new species, closely allied to *D. retiformis* and *D. gracilis* of Hall, and will be described by that palæontologist under the name of *D. Websteri*, in honour of its discoverer. In the mean time I may merely state that it is most readily characterised by the cellules, which are very distinctly marked in the manner of *Graptolithus*."

"The Dictyonema slates of Beech Hill are of great thickness, but have in their upper part some hard and coarse beds. They are succeeded to the south by a great series of dark coloured coarse slates, often micaceous, and in some places constituting a slate conglomerate, containing small fragments of older slates, and occasionally pebbles of a gray vesicular rock, apparently a trachyte. In some parts of this series there are bands of a coarse laminated magnesian and ferruginous limestone, containing fossils which, though much distorted, are in parts still distinguishable. They consist of joints of crinoids, casts of brachiopodous shells, trilobites and corals. Among the latter are two species of *Astrocerium*, not distinguishable from *A. pyriforme* and *venustum* of the Niagara group, and a *Heliolites* allied to *H. elegans*, if not a variety of this species.* On the evidence of these fossils and the more obscure remains associated with them, Prof. Hall regards these beds as equivalents of the Niagara formation of the New York geologists, the Wenlock of Murchison. Their general strike is N. E. and S. W.; and to the southward, or in the probable direction of the dip, they are succeeded, about six miles from Beech Hill, by granite. They have in general a slaty structure coinciding with the strike but not with the dip of the beds, and this condition is very prevalent throughout this inland metamorphic district, where also the principal mineral veins usually run with the strike. The beds just described run with S. W. strike for a considerable distance, and are succeeded in ascending order by those next to be described."

* [These corals fortunately show their structure very distinctly when cut and polished, though from the hardness of the rock their external forms are obscure.]

"At Nictaux, 20 miles westward of New Canaan, the first old rocks that are seen to emerge from beneath the New Red Sandstone of the low country, are fine-grained slates, which I believe to be a continuation of the Dictyonema slates of Beech Hill. Their strike is N. 30 to 60 E., and their dip to the S. E. at an angle of 72°. Interstratified with these are hard and coarse beds, some of them having a trappean aspect. In following these rocks to the S.E., or in ascending order, they assume the aspect of the New Canaan beds; but I could find no fossils except in loose pieces of coarse limestone, and these have the aspect rather of the Arisaig series than of that of New Canaan. In these, and in some specimens recently obtained by Mr. Hartt, I observe *Orthoceras elegantulum*, *Bucania trilobita*, *Cornulites flexuosus*, *Spirifer rugæcosta ?* and apparently *Chonetes Nova-scotica*, with a large *Orthoceras*, and several other shells not as yet seen elsewhere. These fossils appear to indicate that there is in this region a continuance of some of the Upper Arisaig species nearly to the base of the Devonian rocks next to be noticed." [Some Lamellibranchiate and Gastropod shells in the limestone above referred to, led me to infer that some member of the Upper Silurian series not seen at Arisaig may occur here, and may represent the Salina formation of the American geologists, just as distinct Niagara fossils, not seen at Arisaig, occur in New Canaan.]

"After a space of nearly a mile, which may represent a great thickness of unseen beds, we reach a band of highly fossiliferous peroxide of iron, with dark coloured coarse slates, dipping S. 30° E. at a very high angle. The iron ore is from 3 to 4½ feet in thickness, and resembles that of the East River of Pictou, except in containing less silicious matter. The fossils of this ironstone and the accompanying beds, so far as they can be identified, are *Spirifer arenosus*,* *Strophodonta magnifica*, *Atrypa unguiformis*

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* There is in the iron ore and associated beds, another and smaller *Spirifer*, as yet not identified with any described species, but eminently characteristic of the Nictaux deposits. It is usually seen only in the state of casts, and often strangely distorted by the slaty structure of the beds. The specimens least distorted may be described as follows: General form, semi-circular tending to semi-oval, convexity moderate; hinge line about equal to width of shell; a rounded mesial sinus and elevation with about ten [to twelve] sub-angular plications on each side; a few sharp growth ridges at the margin of the larger valves. Average diameter about one inch; mesial sinus equal in width to about three plications. I shall call this species, in the meantime, *S. Nictavensis*." [It is nearly allied to the well-known *Spirifer mucronatus* of the Hamilton group.]

[now known as *Orthis hipparionyx*], *Strophomena depressa* [now usually known as *S. rhomboidalis*], and species of *Avicula*, *Bellerophon*, *Favosites*, *Zaphrentis*, &c. These Prof. Hall compares with the fauna of the Oriskany sandstone; and they seem to give indubitable testimony that the Nictaux iron ore is of Lower Devonian age.

"To the southward of the ore, the country exhibits a succession of ridges of slate holding similar fossils, and probably representing a thick series of Devonian beds, though it is quite possible that some of them may be repeated by faults or folds. Farther to the south these slates are associated with bands of crystalline greenstone and quartz rock, and are then interrupted by a great mass of white granite, which extends far into the interior and separates these beds from the similar, but non-fossiliferous rocks on the inner side of the metamorphic band of the Atlantic coast. The Devonian beds appear to dip into the granite, which is intrusive and alters the slates near the junction into gneissoid rock holding garnets. The granite sends veins into the slates, and near the junction contains numerous angular fragments of altered slate.

"Westward of the Nictaux River, the granite abruptly crosses the line of strike of the slates, and extends quite to their northern border, cutting them off in the manner of a huge dyke, from their continuation about ten miles further westward. The beds of slate in running against this great dyke of granite, change in strike from south-west to west, near the junction, and become slightly contorted and altered into gneiss, and filled with granite veins; but in some places they retain traces of their fossils to within 200 yards of the granite. The intrusion of this great mass of granite without material disturbance of the strike of the slates, conveys the impression that it has melted quietly through the stratified deposits, or that these have been locally crystallised into granite *in situ*.

"At Moose River, the iron ore and its associated beds recur on the western side of the granite before mentioned, but in a state of greater metamorphism than at Nictaux. The iron is here in the state of magnetic ore, but still holds fossil shells of the same species with those of Nictaux.

"On Bear River, near the bridge by which the main road crosses it, beds equivalent to those of Nictaux occur with a profusion of fossils. The iron ore is not seen, but there are highly fossiliferous slates and coarse arenaceous limestone, and a bed of gray sandstone with numerous indistinct impressions apparently of plants. In addition to several of the fossils found at Nictaux, these beds afford *Tentaculites*, an *Atrypa*, apparently identical with an undescribed species very characteristic of the Devonian sandstones of Gaspe [this is now known as *Leptocoelia flabellites*], and a coral which Mr. Billings identifies with the *Pleurodictyum problematicum*, Goldfuss, a form which occurs in the Lower Devonian in England, and on the continent of Europe."

It will thus be seen that I recognized, on the evidence of stratigraphy and fossils, in the district extending from New Canaan to Bear River, the following groups of rocks:—

1. The Niagara series, the Wenlock of English geologists, represented by the Dictyonema shales and the coral-bearing rocks of New Canaan. This group may be called either Middle or Upper Silurian, according to different classifications in use.

2. The Upper Arisaig series (of my arrangement, not of that subsequently advocated by Dr. H.) This is the equivalent of the Lower Helderberg series of America, the Ludlow of England, and is the upper member of the Upper Silurian as held at that time.

3. The Oriskany series, represented by iron ores, sandstones or slates. At that time the Oriskany was regarded by all as Lower Devonian. More recently some American geologists have proposed to place it in the upper part of the Upper Silurian, above the Lower Helderberg, with which its fossils have some affinity.

If I understand Dr. H., he admits the ages which I have assigned to Nos. 1 and 2 above mentioned, though, after his usual manner, without giving the slightest credit for the original discovery of the facts, but he assigns No. 3 to the horizon of the Medina sandstone, a formation older than the Niagara, and regarded as an equivalent of the Mayhill sandstone (Llandovery) of Great Britain. The first reason assigned for this opinion is one based on mineral character, "I at once recognized the Mayhill sandstone," &c. On this I may merely remark that any geologist who would profess to distinguish at sight the Oriskany sandstone from the Medina sandstone would be more characterised by boldness than prudence. The stratigraphy of the district is confessedly somewhat obscure, and I fail to find in Dr. H.'s paper any new light tending to the inversion of the section as it was understood by me many years ago. The fossils must in this matter furnish the most reliable information, and in this department unfortunately Dr. H. merely gives lists of genera, most of which have a very wide range, and which prove nothing, unless the species can be determined with accuracy. In this, however, there is some difficulty. The specimens are usually merely casts, they are much distorted, and from the hardness of the rocks they can usually be procured only in fragments. When in the region, I collected very diligently, and have since carefully studied my collections, and compared them with fossils of various portions of the Upper Silurian and Devonian ; but though I have arrived at much more definite determinations than those given by Dr. H., I have hesitated to publish detailed lists. It is now necessary, however, to go into details, and I trust I can show to the satisfaction not only of palæontologists but to that of any student who possesses a geological text-book, that Dr. H.'s conclusions on this subject are wholly illusory.

The following list refers to my collections from the Nictaux ore and the neighbouring beds, and from Moose River and Bear River, on approximately the same horizon :—

1. *Zaphrentis*, a large species with deep calyx ; but a cast merely, and therefore not determinable specifically.—Nictaux.

2. *Favosites*. General form and size of cells similar to those of *F. cervicornis*, Ed. and Haime ; tabulæ continuous and very close.—Nictaux and Bear River.

3. *Pleurodictyum problematicum*, Goldfuss. Cast of a large specimen.—Bear River.

4. *Stenopora*. A branching species with very fine cells.

[Of the above corals No. 3 is characteristically Devonian. The others are found in association both in the Upper Silurian and Devonian.]

5. *Strophodonta magnifica*, Hall. A large Strophodonta, resembling, as far as the specimens admit comparison, the above species, characteristic of the Oriskany.—Nictaux and Bear River. Dr. H. somewhat disingenuously writes of *Strophodonta* as if it were a characteristically Clinton genus. In point of fact, of 56 species of this genus catalogued by Miller in his American Palæozoic fossils, 43 are found in the Oriskany and overlying formations, and only three as low as the Clinton and Niagara, while no species whatever is known in the Medina.

6. *Strophomena rhomboidalis.* Fragments from Nictaux.

7. *Spirifer arenosus*, Hall. This characteristically Oriskany species is so abundant at Nictaux, that though the specimens are imperfect, I think its recognition certain. It is found also at Bear River.

8. *Spirifer arrectus*, Hall, or allied, also an Oriskany species. —Nictaux.

9. *Spirifer Nictavensis.* This is the most abundant species in the Nictaux ore, some specimens of which are crowded with it, and it is also found at Bear River. It is very nearly allied to the well known *Spirifer mucronatus* of the Devonian. It is perhaps still nearer to *S. Gaspensis* of Billings from the Gaspé sandstone; and no Spirifers of this type are known to extend so low as the Medina.—Nictaux and Bear River.

10. *Orthis hipparionyx*, Hall. A characteristic Oriskany shell, apparently represented by casts of the interior.—Nictaux.

11. *Leptocelia flabellites*, Hall. This little shell is abundant at the base of the Devonian in Gaspe, and the same or a very similar species is found at Nictaux and Bear River.

12. *Rensselæria ovoides*, Eaton. A very characteristic Lower Devonian species at Gaspe and elsewhere.—Nictaux.

13. *Megambonia*, very near to the Oriskany species *M. lamellosa*, Hall.—Nictaux.

14. *Avicula*, a large species of the type of the Oriskany species *A. textilis*, but too imperfect for determination.—Nictaux.

15. *Tentaculites*, not distinguishable from *T. elongatus*, Hall, of the Lower Helderberg.—Bear River.

16. I group together a *Platyceras* very near to an Oriskany species, a *Bellerophon* and an *Orthoceras*, found at Nictaux.

Fragments in my collection indicate several other species; but the above I hold to be amply sufficient to prove that the beds in which they occur are approximately of the age of the Oriskany sandstone, and cannot possibly be so old as the Clinton formation. I may notice in farther evidence of the facts stated above, that slates very near to the ore-bed hold Upper Arisaig (Helderberg) species, so that there appears to be a passage from the Lower Helderberg to the Oriskany, which would be quite natural; whereas the juxtaposition of Lower Helderberg and Medina fossils could take place only by extensive faulting or the absence of all the intermediate formations. It is also to be observed that independently of the determination of species, the whole aspect of the fauna of the Nictaux iron bed, in its abundance of large ribbed spirifers, of large strophomenoid shells, and of great lamellibranchiate species, is different from that of the Medina, and on the contrary reminds an observer forcibly of the Oriskany sandstone of Gaspé and of western Canada. I shall show in the sequel that it is also distinct from that of the Upper Silurian red hematite of Pictou.

It should, however, be distinctly understood, that, in so far as I have held Devonian rocks to exist at Nictaux and Bear River, the upward extension of such rocks is limited to the Oriskany sandstone, and should any one hold that this formation may be included in the Upper Silurian, I have no objection; though I think that on physical grounds and by virtue of its close relationship with the overlying formations, it has quite as good claims to be correlated with the Lower Devonian.

The question which has been raised respecting the age of the granite, can only be discussed profitably on the ground. My notes of many years ago assure me, however, that I have traced the Lower Devonian beds into contact with the granite in such circumstances as prove the later date of the latter, and there are now in my collections specimens showing the gradations from the fossiliferous to the altered strata, including some which hold Oriskany fossils, but have assumed an incipient gneissic structure, and were penetrated by granite veins. It is further to be observed that the age assigned by me to these granites accords with the fact that in Nova Scotia the formations older than the Carboniferous are more or less in an altered and disturbed condition, and that granite debris does not occur as a prominent ingredient in our formations till the Lower Carboniferous age. In the district in question, the thick beds of granitic sandstone in the Lower Carboniferous near Wolfville and Lower Horton, afford a good illustration. I hope that this interesting district may soon be surveyed and mapped by the officers of the Geological Survey, when we may expect to have more light thrown on this subject. In the meantime I would caution geologists against accepting the somewhat crude deductions of the paper referred to, more especially as this question affects our conclusions as to the age of the auriferous veins of the Atlantic coast, and as to the correlation of the intrusive granites of Nova Scotia with those of other parts of Eastern America.

2. Pre-carboniferous Rocks of Eastern Nova Scotia.

The second paper, above referred to, is of a character so autobiographical, contains so little that is new in a scientific point of view, and deals so unceremoniously with the reputations of nearly all who have worked in the geology of Nova Scotia, that it is difficult to criticise it without being personal. I shall endeavour, however, to avoid this, and to confine myself to the geological questions involved.

The first attempt, after Dr. Gesner's Geology of 1836, to deal with the complexities of the older rocks in Eastern Nova Scotia, was made nearly thirty years ago, in a paper on the Metamorphic and Metalliferous Rocks of Nova Scotia, published in the Journal of the Geological Society in 1850; a very imperfect attempt, no doubt, but still a step of progress, and one involving much hard labour under very difficult circumstances. Before preparing the paper, I had examined lines of section from Pictou to the Atlantic coast, and had collected fossils at Arisaig and on the East River of Pictou. In this paper, the "shales, slates and thin-bedded limestones of Arisaig" were referred to the Silurian system, on the evidence of their fossils, as were also the similar rocks occurring on the east side of the East River of Pictou. I was obliged, however, to add that specimens taken to England by Sir C. Lyell, with whom I had visited the East River in 1842, had been referred by palæontologists there to the Lower or Middle Devonian age, and that Prof. Hall, the best American authority on these fossils, appeared to lean to a similar conclusion.

The cause of this doubtful position of the matter is easily explained, without attaching any blame to the eminent geologists above named. At that time the line of separation of the Devonian and Upper Silurian was not very clearly defined; and indeed it may be said yet to be in some uncertainty, since it is only within a few years that it has been proposed to transfer the Oriskany sandstone to the Upper Silurian, and in the latest classification of the Gaspé series by the Geological Survey of the Dominion,* no less than 880 feet of shales and limestones are designated as "passage beds" between the two. In addition to this, the fossils from the Nova Scotia beds were to a large extent different from those both of the New York series and of England,

* Billing's Palæozoic Fossils, 1874.

so that their general facies only could be compared, many of them were in an imperfect state of preservation, and our whole collections were not large.

Matters remained in this state until the preparation of my Acadian Geology, published in 1855, when it became very desirable to obtain some clearer light on the subject, and accordingly considerable collections of the fossils were made and sent to Prof. Hall, and to palæontological friends in England, in the hope that these difficulties might be cleared up. But up to the time of the publication of the book, and for some time thereafter, no aid came from either quarter. In these circumstances, being convinced that some of the lower fossiliferous beds must be Silurian, and supposing that some of the upper beds were Devonian, but having no means of separating them, I included both under one chapter, and placed over the few fossils I ventured to figure, the title "Devonian and Upper Silurian."

On my removal to Canada in 1855, I at once availed myself of access to the collections of the Geological Survey, and of the advice of Mr. Billings in the arrangement of my collections, and sent further specimens, along with a number of species communicated to me by Dr. Honeyman, the late Dr. Webster of Kentville, the late Dr. Harding of Windsor, and Mr. Hartt of Wolfville,* to Prof. Hall; and in 1859 I received from him the series of descriptions of the Nova Scotia Upper Silurian fossils published in 1860 in the Canadian Naturalist, and which really constituted the "first step" in the palæontology of these difficult rocks. The only credit that the gentlemen above named or the writer can claim is the collection of materials; and Nova Scotia owes a debt of gratitude to the New York Palæontologist for his gratuitous labours in our behalf, at a time when he was pressed with many and engrossing occupations. It was at this time, and while I was in correspondence on the subject with all the friends in Nova Scotia above named, and with Prof. Hall, that, in advance of the latter gentleman's full report, I sent to the Nova Scotia Literary and Scientific Association a communication, in which I referred to the labours of all these gentlemen, and stated the results arrived at as follows:—"At Arisaig and other places in the East, where

* Afterwards Prof. Hartt of Cornell, and the head of the Survey of Brazil; a very able geologist, too early removed by death, and who worked most successfully in the geology of New Brunswick and Nova Scotia.

the older rocks come out from beneath the Carboniferous system, we have a series of shaly and calcareous beds, consisting of two members. The Upper, and more calcareous and fossiliferous of the two, is of the same age with the Lower Helderberg of the New York geologists and the Ludlow of the English geologists. The Lower, more shaly and containing Graptolites, may be as old as the Clinton, the Upper Llandovery of England." In the following sentences the occurrence of similar fossils on the East River and at Earlton is indicated, and the several ages of the New Canaan and Nictaux series already stated are referred to. This paper was written in the summer of 1859, and was published in a Halifax newspaper, I suppose, in the winter of the same year. It appears that Dr. Honeyman had previously, in a paper which he calls his "debut" in writing on Nova Scotia geology, and dates April, 1859, asserted the Upper Silurian age of the Arisaig series, and on this ground has based very large claims with reference to Nova Scotia geology. I have not a copy of this paper, and do not remember its contents, if indeed I ever saw it; but on his testimony I have, both in my paper of 1860 and in the 2nd edition of Acadian Geology (page 566), acknowledged his prior publication, feeling, however, that the credit of establishing the age of these rocks on a firm basis belonged to Hall, and that Dr. H.'s reiterated assertion of his claims, coupled with sneers at my "supposed Devonian age" of these rocks, was, to say the least, in very bad taste. In truth, what we required at that time was not a mere opinion from any local geologist as to the age of these rocks, but a careful comparison by a palæontologist of the wide experience of Hall.

Here intervenes an unfortunate circumstance, on which Dr. H. dilates with evident pleasure, though he perfectly well knows the true explanation of it. In the masterly description of the Pictou coal-field by Logan and Hartley (Reports of Geological Survey, 1869), one of the most thorough geological investigations ever made in Nova Scotia; by some unexplained oversight, these authors referred to the older rocks, east of the East River, as Devonian, and gave my authority for this; although in my paper of 1860 and again in 1868 in Acadian Geology, I had described these rocks as Upper Silurian. Immediately on noticing this error, I mentioned it to Sir William, but this was not till after the publication of the Report. The rocks in question were not within the direct scope of Sir William's work at the time, and were merely incidentally noticed, but I know that he regretted the error very much, though of course as I had, eight or nine years before, abandoned all idea of these rocks being Devonian, I could not be blamed for it.

Another point raised in the paper now in question, is the use of the terms *Upper Arisaig* and *Lower Arisaig*, a point perhaps of no great geological importance, but of some consequence since the abuse of those names has tended to cause confusion. Dr. H. calls this a " new division introduced in the second edition of the Acadian Geology, 1868," but it was really introduced in my paper of 1859 above quoted, and this Dr. H. has himself admitted in the Journal of the Geological Society, vol. xx, p. 233, though it seems now to have escaped his memory. The reasons for this division were as follows. The term " Arisaig series" is a useful local name for the peculiar development of the Upper Silurian in Eastern Nova Scotia. The results of Prof. Hall showed that the fossils were referable to the Clinton and Lower Helderberg, without the intervention of any distiuct representative of the Niagara limestone, and as the lower and upper members were somewhat distinct in mineral character, it seemed the most natural course to divide the series into Lower and Upper. Dr. H., who had an opportunity of showing his fossils to the late eminent palæontologist Mr. Salter, gives on his authority a more minute subdivision into five members. This will be found discussed in Acadian Geology, I trust in a fair spirit, and the relations of the two arrangements pointed out. But more recently Dr. H. has thought proper to change the name of the whole Arisaig series as before understood, to " Upper Arisaig," and to include as " Lower Arisaig" rocks which he regards as Laurentian. This is objectionable, not only as interfering with established and useful names, but as extending local terms to a degree which no other geologist can possibly accept. It amounts in fact to calling the whole Eozoic and Lower Palæozoic by the local name " Arisaig series." For these reasons I shall continue, as heretofore, to use the terms Upper and Lower Arisaig for the subdivisions of the Upper Silurian as represented at that place.

Another question raised in this paper relates to certain rocks at Lochaber, in which Dr. H. affirms that he found fossils of the genus *Petraia*, which I had informed him belonged to the genus *Zaphrentis*, and thereby misled him as to their age. The specimens referred to were sent to Montreal in 1860, along with a paper by Dr. H., which was read before the Natural History Society, and I was requested by him to give some opinion as to their age and nature, which I did, after consulting the late Mr. Billings, and added a note on the subject to Dr. H.'s paper when it was published. Some time afterwards I was surprised to find Mr. Salter's authority cited in direct opposition to mine, with the usual flourish of trumpets as to a great mistake discovered and exposed. On re-examining the fossils, which still remain in my collection, I could not change my opinion of their nature; and never having had an opportunity to compare notes with my poor friend Salter, one of the soundest palæontologists of our time, and who has on more than one occasion done us good service in determining difficult fossils, as the pages of Acadian Geology show, I have not yet had any solution of the mystery, and have not complained of this, though I felt that I had received a poor return for an intended service. The fossils themselves are however of some interest. They consist of two turbinate corals from Lochaber, one from Marshy Hope, one from Doctor's Brook, and one from French River, with a few other species from Lochaber. These corals are in the form of mere impressions, in which state it is not always easy even to distinguish genera. Still, in the deep fossette, the character of the septa, and the traces of the horizontal tabulæ, they all have the characters of *Zaphrentis* rather than *Petraia;* except one from Lochaber, which which can scarcely be anything other than a *Heliophyllum.* The other fossils from Lochaber are a *Stenopora* similar to one found at Arisaig and East River, *Strophomena rhomboidalis*, an *Orthis* resembling *O. elegantula*, and shells resembling *Pentamerus* and *Atrypa*, but not well preserved. The *Zaphrentis* from Doctor's Brook resembles *Z. Stokesii*, a species of Niagara age. That from Marshy Hope seems different, and in its form and deep cup resembles the *Z. rugulata* of Billings from the Gaspé limestones. These might fairly belong to the Lower Arisaig series, and possibly to the lower part of it. The French River specimen is merely a cast of the exterior and quite undeterminable. But the Lochaber species seems different, having a shallow cup, with deep fossette, and from its association with *Heliophyllum* and the other fossils, I still think it probable that it belongs at least to a higher horizon than that of the Lower Arisaig. Of course as I have not seen the specimens submitted to Salter, I cannot express any opinion as to them; but if similar to mine, I am at a loss to account for his opinion, and as the specimens in my possession seem to contradict the greater age assigned to the rocks, I have not ventured to adopt that opinion—though, up to this time, without taking any notice of Dr. H.'s references to my supposed mistake.*

Another point in which I find I am at issue with Dr. H. is the age of the great iron ore bed of "Webster's" or "Blanchard's" on the East River of Pictou, and which also has been traced to the eastward in Merigomish. This I have assigned to the Lower Helderberg on the evidence of stratigraphy and fossils. Of the latter large collections have been made by Mr. D. Fraser and myself in connection with the recent explorations of these ores. They appear to be of unequivocal Upper Arisaig facies, but include many new and interesting forms which I had hoped to have described ere this time, but this has proved absolutely impossible from want of leisure. They may represent a special horizon in the Upper Arisaig, or even between the upper and lower members, or their peculiarities may be the result of local conditions of deposit. Dr. H. seems to affirm that this iron ore is of the same age with that of Nictaux, and that both are of the age of the Clinton or Medina sandstone. Neither of these positions can be correct, for the fossils of the East River hematite seem closely related to those of the typical Upper Arisaig series, while those of the Nictaux ores are, as already shewn, newer than the Upper Arisaig. These two great deposits of iron ore are therefore not of the same age, and neither of them can be as old as the Clinton. Dr. H. correlates them with the Clinton ore-beds of the United States, but he omits to notice that there are also ore-beds in the Helderberg series of that country. I should not, indeed, be surprised were some of the newly opened beds at Nictaux, which I have not seen, to prove of Helderberg age, or were beds of Oriskany age to be found at Pictou. It is probable, however, that these ore-beds are less constant than some of the strata associated with them.

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* It is to be observed here that the relations of the genera *Petraia* and *Zaphrentis* are not so clearly defined as they should be. Some palæontologists of eminence reject *Petraia* altogether, and unite these corals with *Cyathophyllum*, and the limits of the genus *Zaphrentis* are differently understood by different authorities. Still there are certain forms, by whatever name known, which are, in our American geology, characteristic of certain formations, and it is by this indication that I have been guided in this case.

The remarks made by Dr. H. on the alleged Lower Silurian of Wentworth, scarcely merit criticism. It is to be regretted, for his own sake, that he has ventured to attack Mr. Billings's determination of the age of the fossils, as he has done (p. 480), and also that he has republished his section of the Wentworth cutting, in which the well-known intrusive dykes of dark diabase, so abundant in the Cobequids, figure as bedded diorites, and swell the thickness of a section which is in many respects truly "remarkable." I have not had an opportunity to examine Dr. Honeyman's collections from Wentworth; but those I have myself made, and those I have seen in the Museum of the Geological Survey, by no means warrant his determination of a Bala or Hudson River age. This subject will be found noticed in the Supplement to Acadian Geology, p. 75.

This review has extended to too great a length; but one is tempted to notice the Laurentian discoveries of the author. Dr. Honeyman, when employed by Sir W. E. Logan in 1868 in exploring at Arisaig, examined the coast east of Malignant cove, and found there the extension to the sea cliff of rocks apparently identical with that old metamorphic series which I have named the Cobequid series. These he has described as Laurentian, and quarrels with Sir W. E. Logan, Dr. Hunt and myself for failing to admit this age. My own justification is,—first, that, as Dr. H. admits, there is no good evidence from stratigraphy or fossils to prove this great age; and secondly, that after somewhat extensive studies of Laurentian rocks, I have been unable to see any resemblance between the typical rocks of this age and the so-called Laurentian of Arisaig, the Cobequids and southern Cape Breton. All these rocks I hold, for reasons stated in the Supplement to Acadian Geology, to be probably either Lower Silurian, Cambrian or Huronian. Dr. H. repeatedly taunts me with affirming these rocks, and even those of St. Anne's in Northern Cape Breton, to be Devonian; and goes so far as to relate an anecdote (p. 453) which would seem to show that so late as 1867 he had retailed this fiction to Sir Wyville Thomson, in connection with specimens of *Eozoon* stated to have been obtained in these rocks. Lest the same practical joke should be played on others, it may be well to say that I have never seen anything resembling *Eozoon* from St. Anne's, and that I am not aware of ever having supposed the crystalline rocks of that promontory to be Devonian. In reality, after much study of specimens, and after revisiting in

1877 some of the most instructive sections in Nova Scotia, I fail to perceive any good lithological evidence for the Laurentian age of any of the older rocks of the Province, except some of those in Northern Cape Breton, and notably those of St. Anne's mountain, which have, apparently on good grounds, been referred to this age by the late Mr. Hartley and Mr. Fletcher.

One word as to the geological map in 'Acadian Geology,' which notwithstanding its imperfections, needs no apology, when its nature as a mere preliminary and imperfect sketch, the result of private effort and not of a regular survey, is fairly considered. The materials do not exist for a detailed map of the older formations of Nova Scotia. They are being slowly accumulated by the labours of the Geological Survey of the Dominion; but I do not expect to live to see them complete. Dr. H.'s criticisms, which are so microscopic as scarcely to allow for the accidents of printing, would be unfair, if applied to a map on this scale, even had I been employed to make a regular survey of the country, and had many years been spent in the work. They are specially objectionable when applied to a work executed without public aid; and when proceeding from a man who has enjoyed opportunities of official employment not accorded to me.

Note.—Since writing the above, I have received Volume "F" of the Report of the Second Survey of Pennsylvania, relating to the "Fossil Iron Ore Beds" of Middle Pennsylvania. In this report, bedded iron ore deposits are described as occurring in the Clinton, Lower Helderberg, Oriskany, Corniferous and Marcellus, so that they range, as I believe they do in Nova Scotia, from the Middle of the Upper Silurian to the Lower Devonian inclusive. The principal deposits in Pennsylvania are in the Clinton, Oriskany and Marcellus. In Nova Scotia only small layers are known to me, at Arisaig and East River, so low as the Clinton, and the principal deposits seem to be Lower Helderberg and Oriskany. The analogy is thus sufficiently close, beds of the age of the Marcellus not having been recognised in Nova Scotia.

I have used the term "Devonian" in the above paper; but, owing to the doubts and controversies respecting the Devonian rocks of England, I greatly prefer the term "Erian," derived from the great development of the typical rocks of this age on the shores of Lake Erie.

THE STRATIGRAPHY OF THE QUEBEC GROUP AND THE OLDER CRYSTALLINE ROCKS OF CANADA.

By Alfred R. C. Selwyn, F.R.S., F.G.S.,

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I propose in this paper to state as briefly as possible the conclusions I have arrived at from examinations made in the field during the seasons of 1876 and 1877 with the object of satisfying myself, before publishing the geological map of the Eastern Townships, respecting the much-discussed questions of the structure and the age of the rocks in the region on the south-east side of the St. Lawrence, extending from the Vermont, New Hampshire and Maine boundaries north-easterly to Gaspé. I shall also make some remarks on the results of the work of the Geological Survey in connection with the stratigraphy of the Laurentian rocks on the north side of the St. Lawrence valley and the conclusions at which they seem to point.

In some respects my views are in accordance with those of others, while as regards some points they are I believe new. Whether they eventually prove correct or otherwise, I can say that they have been arrived at solely upon and after careful consideration of the evidence and the facts collected by myself and colleagues, and without any bias or pre-conceived ideas, which, had I allowed these any weight, would have led to conclusions entirely different.

All who have taken any interest in Canadian geology are aware that the whole of the region referred to has been described by the Canadian Geological Survey as occupied by only four great formations or groups of strata, which in descending order are: —

1. Devonian.
2. Upper Silurian.
3. Lower Silurian.
4. Laurentian.

No. 3 includes:

a. Utica slates.
b. Hudson River or Lorraine Shales.
c. Trenton limestone.
d. Bird's-eye and Black River limestone.
e. The Quebec group and its equivalents, Chazy and Calciferous.
f. Potsdam.

Subdivision *e*. the Quebec group, is the one about which so much discussion has arisen and so many different opinions have been expressed. Indeed so varied have these been that it is now almost impossible to suggest anything which some one has not already suggested, but most of these opinions have been advanced on palæontological, mineralogical or theoretical grounds, without any study of the actual stratigraphy in the field. According to the latest determination, by the geological corps, under my predecessor Sir W. E. Logan, the Quebec group is divided into three conformable formations, viz. in decending order:—

The Sillery.
The Lauzon.
The Lévis.

These have been supposed to occupy the whole of the region lying south of the St. Lawrence between the great St. Lawrence and Champlain fault and the Upper Silurian overlap, notwithstanding the very diverse mineralogical, palæontological, and physical conditions under which they appear in different parts of the area. The base and the summit of the middle division, which was only introduced in 1866, has been supposed to be characterised by copper ores, dolomites and serpentines, and it would really seem that in mapping the structure the presence of any one of these has almost invariably been made to determine the limits of this division. It is not, however, my object now to refer to the past, or to recapitulate the opinions of others, and I shall confine myself as much as possible to a statement of my own views respecting the stratigraphy of the Quebec group.

First, then, I may say that I recognize in it three distinct groups, which in descending order may be enumerated as

1. The Lower Silurian group, Levis formation.
2. The Volcanic group, probably Cambrian.
3. The Crystalline Schist group.

No. 1 consists of a great variety of slates or shales (argillites), red, green and black; limestones, in thin bands; limestone conglomerates, sandstones and quartzites. In every part of their distribution from the Vermont boundary to Gaspé, 500 miles, they hold a large number of genera and species of characteristic Lower Silurian fossils, full descriptions of which have been given in the reports of the Geological Survey. This fossiliferous belt occupies a strip of country on the south side of the St. Lawrence, which in its widest part, in the valleys of the Chaudière and the Etchemin does not exceed twenty-five miles, and in this portion the structure presented is that of a broad crumpled and folded synclinal with prevailing south-easterly dips on the north-western side, and north-westerly dips on the south-eastern side; the characteristic Point Lévis limestone conglomerates coming up near the base on both sides. There are doubtless a number of local and unimportant overturn dips, but there seems to be no evidence whatever of a general inversion of the strata.

On the north-western side this belt is bounded by the St. Lawrence and Champlain fault, or overlap, which brings the even-bedded shales and limestones of the Hudson River or Lorraine Shale group into contact with the crumpled and twisted strata of the Lévis formation. The line of this dislocation, or unconformity—whichever it may be—has been supposed to pass in rear of the Quebec citadel. This I hold to be a mistake, and I think it can be distinctly shewn that it passes from the south-west end of the Island of Orleans under the river and between Point Lévis and Quebec; it appears again on the north shore about one mile north of Point Pizeau, passes north of St. Foy, and thence in a direct course to where it again crosses the river south-west of Cap Rouge. The entire absence of Levis fossils in the Citadel rocks is thus easily explained. I have traced this break carefully from the last-named point on the north shore of the St. Lawrence to the north-east end of the Island of Orleans, where on the beach the actual contact of the two formations is well seen, and a short distance inland we find the characteristic Levis limestone conglomerate. *Salterella* and *Archæocyathus* occur both at Point Lévis and on the Island of Orleans, and the graptolite (*Phylograptus*) shales are interstratified both above and below the limestone conglomerates. *Obolella* occurs also in shales clearly above the conglomerates and below other shales holding graptolites, and in some beds both occur together.

As regards the belt of Potsdam rocks—upper, middle and lower—which have been described in the Geological Survey Report for 1866–69, pp. 119–141, I must state, that after having carefully examined some portions of these supposed Potsdam rocks, I hold that there are no reasons whatever for separating them from the Lévis formation, either stratigraphical or palæontological. Obolella, graptolites, and fragments of other fossils, too indistinct to be determined, have been found in them.

On the south-eastern side, the fossiliferous belt is bounded by a line which, commencing on the United States boundary near St. Armand, runs on a course nearly parallel with the St. Lawrence, passing through the townships of Dunham, Brome, Shefford, Stukeley, Melbourne, Cleveland, Tingwick, Chester, Halifax and Leeds, to the vicinity of St. Marie on the Chaudière. Between St. Marie and St. Claire on the Etchemin River, the strata which I have referred to division 2 increase greatly in width, cropping out, apparently unconformably, from beneath the fossiliferous belt and separating it from division 3. The boundary we have been tracing of the Lévis formation is here suddenly deflected to a course nearly north for some sixteen or eighteen miles, viz. from St. Claire to St. Vallier, where it again turns north-east, and beyond this it has not yet been defined with certainty. It may be that this apparent unconformity is really a fault which running transverse to the strike brings the Lévis black slates and limestone conglomerates into contact with a set of strata which lithologically can not in this part well be distinguished from the typical Sillery sandstones of New Liverpool, Sillery Cove, &c., above Quebec, or from those of Acton, Roxton and Granby, which they still more nearly resemble, and which there are some reasons for supposing may occupy a similar unconformable position beneath the Levis formation. The distribution of these sandstones as indicated on the unpublished map of the Eastern Townships very forcibly suggests this idea.

Division No. 2 embraces a great variety of crystalline and sub-crystalline rocks; coarse, thick bedded, felspathic, chloritic, epidotic and quartzose sandstones, red, grey and greenish siliceous slates and argillites, great masses of dioritic, epidotic and serpentinous breccias and agglomerates, diorites, dolerites, and amygdaloids, holding copper ore; serpentines, felsites, and some fine grained granitic and gneissic rocks, also crystalline dolomites and calcites. Much of the division, especially on the south-eastern side of the axis, is locally made up of altered volcanic products, both intrusive and interstratified, the latter being clearly of contemporaneous origin with the associated sandstones and slates. The greatest development of these volcanic rocks appears to occur, as above stated, on the south-eastern side of the main axis, to which I shall presently refer, and about the summit of Division 3, of which they may perhaps be only an upward extension, as we have at present no evidence of any unconformity between these two divisions. The rocks composing it have hitherto nearly all been included in the Sillery sandstone formation, and supposed to be everywhere the highest member of the "Quebec group"; represented by a yellow color on the geological map of Canada and on the unpublished map already referred to. It appears to me, however, that neither their true stratigraphical position nor their geological characters have been correctly defined, and they have, regardless of these, been confounded and incorporated with the true Sillery sandstones, which are only a local development of thick sandstones at several horizons in the Quebec group or fossiliferous Lévis formation. At Sillery above Quebec, and at various points thence north-eastward to Gaspé, good exposures of these sandstones may be examined, and it has now been shewn that at Little Metis at Ste. Anne (the Pillar sandstones of Mr. Murray's report of 1844) and elsewhere they are characterized by graptolites and other Levis fossils, whereas in the massive red and green sandstones and slates which are associated with the volcanic rocks, and which the stratigraphy, as I think, clearly shews to be a lower unconformable formation, no fossils of any description have yet been found. Certain fucoid markings in slates near Actonvale may perhaps, however, belong to this division. Further examination will probably afford other fossils, but if so I should expect them to indicate a lower horizon than the Lévis formation, probably not far removed from that of the St. John group and the Atlantic coast series of Nova Scotia. In describing this belt of sandstones and slates which extends north-eastward from St. Claire on the Etchemin river, Sir W. Logan writes: "The area over which these strata occur commences in a point near the Chaudiere; it has been traced to the north-eastward across the Seignories of St. Mary and Joliette into St. Gervaise, and it probably extends much further. . . . . The distance between this area and its equivalent to the south is about ten miles."

" The sandstones in the two areas on the opposite sides of the Rivière du Sud are massive ; on the northern side they are often very coarse grained, and in general of a green color, while the shales which separate the masses are usually red. Very coarse beds are not so frequent on the south side, and there the red color is not confined to the shales, but characterizes the sandstones also, which are as often red as green." *

There are two other distinctions not pointed out by Sir W. Logan. The one is that fossils, *obolella* and *graptolites*, characterize the northern area, and are apparently absent in the southern area. Another is that the sandstones in the latter frequently present a peculiar schistose structure, not, so far as I know, to be seen in the true Sillery sandstones of the Levis formation, to which the northern of these two sandstone areas clearly belongs.

I shall now pass on to the consideration of Division 3, which, however, as I have already stated, may be intimately related to the preceding. The rocks composing it are chiefly slaty and schistose, and embrace a great variety of chloritic, micaceous, siliceous and magnesian strata with copper ores, also imperfect gneisses, white and gray micaceous dolomites and magnesian limestones. They constitute the main anticlinal axis of the region, which axis may be traced from Sutton Mountain, east of Lake Memphremagog, on a gently curving line, northeastward to the counties of Montmagny and L'Islet—a distance of 150 miles. Between the St.Francis and the townships of Chester and Wolfestown, a very considerable dislocation crosses the axis transversely, and the structure here is exceedingly complicated, and is rendered still more obscure by the overlapping of the Upper Silurian rocks, and by the interposition, in the magnesian belt—by a complication of faulting and unconformable superposition—of a long, narrow band of the black shales and dark earthy limestones of the fossiliferous Levis formation. Further north, however, the magnesian belt again assumes its normal relation to the overlying divisions 1 and 2. And on page 258 of the Geology of Canada, we find its course thus descrebed : " The general course of the magnesian rocks on the south side of the *synclinal* is, however, pretty well determined by a band of dolomite occasionally passing into serpentine, which has been traced from the

* Geology of Canada, p. 258.

13th lot on the line between Chester and Halifax to the Chaudière, near the line between St. Mary and St. Joseph." The synclinal spoken of is a purely theoretical one, and if we lay the above described line down on the map, it will be found to cross diagonally not only this Sillery synclinal, but likewise the Lauzon and the Lévis formations, as shown on the map; while, on the other hand, it runs entirely parallel with the line which, without any previous knowledge of the above quoted description, I had myself carefully traced on the ground, in 1867, as the upper limit of the magnesian belt and division 2, and the unconformably overlying fossiliferous Lévis formation.

The gneissic mica schists of Sutton Mountain are probably the deepest exposed portion of this great anticlinal. To the north-east, between the county of l'Islet and the Trois Pistoles River, the rocks of the anticlinal have not been traced. They will, however, doubtless be found to continue till they pass beneath the overlapping Upper Silurian strata which on the Rimouski River are stated to rest directly on the fossiliferous Levis formation. Rocks which clearly belong to the upper part of the division, with associated traps, emerge from beneath the Upper Silurian all along the northern shore of Matapedia Lake, and I think it will be found that they extend thence into the Shickshock Mountains, which on the north are flanked by the Lévis fossiliferous rocks, and on the south by strata of Upper Silurian age. The investigation of the structure of these mountains presents a fine field for any active and enterprising geologist.

The copper ores of the region under consideration, to which too much importance has, I think, been attached, in determining the limits of the divisions of the Quebec Group, appear to me to belong to two distinct periods, and to occur under conditions almost, if not quite, as distinct as they do in the Huronian and "Upper Copper-bearing" rocks of Lake Superior. Those of the first period belong to the crystalline, magnesian schist group, and occur both in beds and in lenticular layers parallel with the stratification, and also in veins cutting the strata transversely, but in no case accompanied by intrusive crystalline rocks. The Harvey Hill mine, the Viger mine and the Sherbrooke mines are examples of this mode of occurrence. Those of the second period seem to be cheifly confined to the rocks of Division 2, but occur also within the limits of the Lévis fossiliferous belt. They are in almost every instance more or less closely associated with certain highly crystalline rocks: diorites, dolerites, amygdaloids and volcanic agglomerates, with bands of white, grey and mottled dolomites and calcites which have much more the appearance of great lenticular, vein-like, calcareous masses than of beds belonging to the stratification. No traces of organic forms have been found in them, and yet many of them are scarcely more crystalline than certain Devonian and Carboniferous limestones in which fossils are abundant. The Acton mines, and the numerous openings that have been made in searching for copper ore in that vicinity and in the neighbouring townships of Roxton, Milton, Wickham and Wendover, may be cited as instances of this second class. And it certainly appears as if the copper ore in these upper divisions were in some way connected with the intrusion or segregation of the crystalline rocks which everywhere accompany it. In any case, I think, there are very few who would agree with Dr. Hunt in the general proposition that the diorites and serpentines of the Quebec group are of sedimentary origin, and the amygdaloids altered argillites; and, unless all contemporaneously interbedded volcanic products are to be considered as of sedimentary origin, the Quebec group might be said to present some of the most marvellous instances on record of "*selective metamorphism.*" But whether this is so or not, there seem to be no good grounds for assigning either an age or an origin to the cupriferous diorites, dolerites, and amygdaloids of the Eastern Townships different from that of the almost identical rocks of Lake Superior, which Dr. Hunt* states have been shewn to overlie *unconformably* the Huronian and Montalban series, but which at Keeweenaw Point are stated by Professor Pumpelly† to rest *conformably* on the Huronian; and Prof. Pumpelly justly remarks that "the question would still seem to be an open one, whether the cupriferous series is not more nearly related to the Huronian than to the Silurian." The same may certainly be said of the cupriferous rocks of the Eastern Townships. Brooks does not, in his paper ‡ quoted by Dr. Hunt, give any very conclusive reasons for his change of views since 1872, and writes altogether as if the question of the unconformable superposition of the copper-bearing rocks on the Huronian were still undecided; and so late as 1877. Professor

* 2 G. S. of Penn., Special Report on Azoic Rocks and Trap Dykes, § 458.

† Geo. Survey of Michigan, Vol. I, 1873.

‡ Am. J. of Sc., Vol. XI, 1876, pp. 206-207.

Roland Irving writes: the unconformity between the Huronian and the upper copper-bearing rocks "*is not certainly proven*."*

A very considerable amount of careful investigation and laborious work in the field is yet required before the indicated divisions can be correctly delineated on the map. The two maps exhibited shew respectively the supposed distribution of the old divisions of Levis, Lauzon and Sillery, and that of the new divisions (so far as they have been determined), which I now propose to adopt. These latter have at least the advantage of simplicity; they also obviate the necessity of invoking any of the numerous almost impossibilities in physical and dynamical geology which are required to explain the previous theory of the structure, and they are, moreover, very closely in accord with the views entertained by Professor Hitchcock as regards the general succession of the formations in the adjoining States of New Hampshire and Vermont.

Laurentian.—I shall now make some observations on the results of the recent work of the Survey in unravelling the complications of the stratigraphy of the older "*crystallines*" on the north side of the St. Lawrence Valley. Since 1866, Mr. H. G. Vennor, of the Geological Corps, has been occupied in a careful examination of the stratigraphical relations of the Laurentian rocks. His observations, commencing in Hastings county, north of Lake Ontario, have now extended across the Ottawa River, eastward, to Petite Nation and Grenville, embracing a band of country 200 miles in length, with an average breadth of 55–60 miles. Throughout this tract of country, Mr. Vennor has followed and mapped, in all their windings and convolutions, the great series of Laurentian limestone bands first investigated and described by Sir W. E. Logan, in the years from 1853 to 1856, more particularly in the Grenville region, and in 1865, by Mr. Macfarlane, in the Hastings region. The results and conclusions of all these earlier examinations are given in detail in the Geological Survey Reports. And these shew that the classification then adopted by Sir W. E. Logan was regarded by him as provisional. (See Note, p. 93, G. S. R., 1866.)

Thus, at the commencement of Mr. Vennor's investigation in 1866, it was supposed that the limestones and calcareous schists of Tudor and Hastings holding eozoon, together with certain

* Am. J. of Sc., Vol. XIII, 1877.

associated dioritic, micaceous, slaty and conglomerate rocks, were a newer series than those already examined and described by Sir W. E. Logan, and they were accordingly designated, in the report published in 1870, the *Hastings series*, and it was further supposed, from its apparent stratigraphical position and from certain lithological resemblances, that it might be of Huronian age. The gradual progress of the work, however, from west to east has now, I think, conclusively demonstrated that the Hastings group, together with the somewhat more crystalline limestone and gneiss groups above referred to, form one great conformable series, and that this series rests quite unconformably on a massive granitoid gneiss—the gneiss 1*a* of Sir William Logan's Grenville map, published in 1865, in the Atlas to the Geology of Canada. I wish it to be understood that I have not personally examined this region, and I am therefore expressing the views of Mr. Vennor, from which, however, I have no reason to dissent.

Of the actual distribution of this lower or "Ottawa" gneiss very little is at present known with certainty, though it probably occupies very extensive areas from the eastern shores of Lake Winnipeg to Labrador. And between these same localities there will doubtless yet be found many large areas of the so-called Norian System. The first suggestion of this unconformable Upper Laurentian series, which, it seems to me, is intimately connected with the Hastings and Grenville series, appears to occur in the supplementary chapters to The Geology of Canada, 1863, pages 838-839; but the evidence there given by no means proves the subsequent assumption of this unconformity; while the careful descriptions by Sir W. Logan, both in the supplementary chapter above cited and likewise in chapter III, shewing the intimate association and interstratification of the orthoclase gneisses, quartzites and crystalline limestones with these supposed unconformable Upper Laurentian anorthosites, much more strongly favor the supposition that they are part and parcel of the great crystalline limestone series.

The exhaustive History of the labradorite rocks by Dr. Hunt, in the volume already cited,* while giving much valuable and interesting historical information, does not advance us a single step beyond the position taken by Sir W. E. Logan, in 1863, as regards their true stratigraphical relations. In not one of the

* 2nd G. S. of Penn., Special Report on Azoic Rocks and Trap Dykes.

several areas where they are known to occur in Canada, have they yet been mapped in detail, and even their limits, as indicated on the geological map, are more or less conjectural. This appears to be likewise the case as regards the areas where they have been noticed in Essex and adjoining counties in New York State and in New Hampshire, where Professor Hitchcock shews that they rest unconformably on the upturned edges of the "Montalban" gneisses,* leading to the conclusion that the gneisses of the White Mountains are older than the "Norian," whereas Dr. Hunt, solely, I believe, on mineralogical considerations, supposes these same "*Montalban*" gneisses to constitute a system newer than the Huronian. Here then, as in the Hastings region, we find theory and experience at variance. But the question suggests itself, may we not have labradorite rocks belonging to systems younger than Laurentian? Dr. Hunt refers (§ 318), to the valuable chemical and microscopic examination of these rocks in Essex county, New York, by Mr. Albert Leeds, the results of which are given in the *American Chemist*, March, 1877; but Mr. Leeds does not appear to have studied the stratigraphy of the region, and his general conclusions are stated as follows:

"That these norites are a stratified rock but have undergone a metamorphosis so profound as to have caused them to be regarded by Emmons and earlier observers as unstratified. The dolerites which are formed of the same constituent minerals, and are of the mean specific gravity of these norites, have probably been formed from a portion of these stratified deposits, by deeply seated metamorphic action and have further modified and greatly tilted the superposed rocks in the course of their extrusion."

Prof. James Hall in 1866† has stated his conclusions that the limestones of Essex and adjoining counties in New York State "do not belong to the Laurentian system either lower or upper." The facts, on which a part of this conclusion is based, viz. the unconformity of the Laurentian limestone series to the lower orthoclase gneisses agree with those of Mr. Vennor, and there is, I think, but little doubt that all these crystalline limestone groups—that is those of Essex and St. Lawrence Counties, U. S.

* Geology of New Hampshire, Vol. II, pp. 217-218.

† A. J. of S. Vol. XII, p. 298.

and Rawdon, Grenville and Hastings in Canada—are parts of one great series, and at present I see no evidence for excluding from this series the associated Norian rocks. Whether the series as a whole will eventually retain the name Upper Laurentian or whether it will be found to be more convenient to designate it Huronian System does not much signify.

We can, however, confidently state that this series occupies an unconformable position between a massive gneiss formation below and unaltered Potsdam or Lower Silurian rocks above, and this may likewise be stated respecting the stratigraphical position of the typical "Huronian series" of the Georgian Bay, which together with its close proximity to the western-most known exposures of the crystalline Laurentian limestone series which we now know, extends from Parry Sound to Lake Nippising, and includes some Labradorite gneiss, renders it very probable that a connection will eventually be traced out between even these supposed greatly different formations, similar to that now, as already stated, proved to exist between the Hastings and Grenville series.

Prof. Hall in his note already referred to, states that the Labradorite formation is "associated" with bands of crystalline limestone, and further on that the limestones do not belong to either the upper or lower Laurentian. He does not however say what the upper Laurentian he alludes to is, though in another paragraph we find it stated that the "lower Laurentians are succeeded by massive beds of Labradorite," which we may infer are considered upper Laurentian, in which case there would seem to be, in New York State two sets of Labradorite rocks, one associated with the limestones which are "altogether newer than Laurentian," and another massive and representing upper Laurentian. There is, however, so far as I am aware, no evidence of this being the case in Canada. If it is admitted—which, in view of the usual associations of Labrador feldspars, is the most probable supposition—that these anorthosite rocks represent the volcanic and intrusive rocks of the Laurentian period then also their often massive and irregular and sometimes bedded character and their occasionally interrupting and cutting off some of the limestone bands as described by Sir W. Logan, is readily understood by any one who has studied the stratigraphical relations of contemporaneous volcanic and sedimentary strata, of palæozoic, mesozoic, tertiary and recent periods. Chemical and microscopical investigation both seem to point very closely to this as the true explanation of their origin. That they are eruptive rocks is held by nearly all geologists who have carefully studied their stratigraphical relations. But I am not aware of any one having suggested that they are the products of volcanic action in the Laurentian or perhaps lower Huronian epoch; doubtless, as Mr. Leeds says "*profoundly metamorphosed*" as of course they would be from having suffered all the physical accidents which have resulted in producing the associated gneisses quartzites, dolomites, serpentines and schists.

When we recall the names of Dahl. Kerulf and Torrell in Norway, Macculloch and Geike in Scotland, Emmons, Kerr, Hitchcock, Arnold Hague, and others in America, all of whom consider these norites as of eruptive origin, we may well pause before accepting Dr. Hunt's conclusions respecting them, and that they should often appear as "bedded metamorphic rocks" (the opinion expressed respecting those of Skye by Prof. Haughton of Dublin) is quite as probable as that we should find the mineralogically similar dolerites occurring in dykes and bosses and in vast beds interstratified with ordinary sedimentary deposits of clay, sand, etc.

In conclusion I may say that I fail to see that any useful purpose is accomplished, in the present stage of our knowledge of the stratigraphical relations of the great groups of rocks which underlie the lowest known Silurian or Cambrian formations, by the introduction of a number of new names such as those proposed by Dr. Hunt for systems which are entirely theoretical, in which category we may in my opinion include the Norian, Montalban, Taconian and Keeweenian. These, one and all, so far as known, are simply groups of strata which occupy the same geological interval, and present no greater differences in their physical and mineralogical characters than are commonly observed to occur both in formations of the same epoch in widely separated regions, and when physical accidents, such as contemporaneous volcanic action or subsequent metamorphism have locally affected the general character and aspect of the formation within limited areas.

No better instances of such differences could be cited than the Mesozoic and Carboniferous formations of British Columbia and those of the same periods in Eastern America, and the Silurian and Cambrian formations of Australia, Europe and America.

It seems to me that the well-known and recognized names

Laurentian
Huronian
Cambrian and Silurian

—with the introduction, where found desirable, to denote some local break, of the terms upper, middle and lower—meet all present requirements so far as systems are concerned.

Unfortunately in Canadian geology, hitherto the stratigraphy has been made subordinate to mineralogy and palæontology, and as the result we find groups of strata which the labours of the field geologist during the past ten years have now shewn all to occupy a place between Laurentian and Cambrian, assigned to Carboniferous and Upper Silurian in New Brunswick and Nova Scotia, to the peculiar palæontological Lévis group and its subdivisions Lauzon and Sillery in the Eastern Townships; and to lower and upper Laurentian, Huronian, lower Silurian and Triassic on the north side of the St. Lawrence valley and around Lake Superior. The same system of mineralogical stratigraphy is now further complicating and confusing the already quite sufficiently intricate problem by the introduction of the new nomenclature I have referred to, and in some cases these names are applied regardless of and in direct opposition to well ascertained stratigraphical facts. A similar unfortunate instance of *palæontological* stratigraphy is found in the history of the Quebec group; and especially in the late introduction in it of the belt of supposed Potsdam rocks, about which I have already stated my opinion.

In the reconstruction of the Geological map of Eastern Canada, —and in this I include the country from Lake Winnipeg to Cape Breton and Labrador—rendered necessary by the present state of our knowledge, I should propose to adopt the following divisions of systems to include the groups enumerated:

I. Laurentian: To be confined to all those clearly lower unconformable granitoid gneisses in which we never find interstratified bands of calcareous, argillaceous, arenaceous and conglomeratic rocks.

II. Huronian: To include 1. The typical or original Huronian of Lake Superior and the conformably—or unconformably as the case may be—overlying upper copper-bearing rocks.
2. The Hastings, Templeton, Buckingham, and Grenville groups.
3. The supposed upper Laurentian or Norian.
4. The altered Quebec group as shewn on the map now exhibited, and certain areas not yet defined between Lake Matapedia and and Cape Maquereau in Gaspé.
5. The Cape Breton, Nova Scotia and New Brunswick, pre-primordial sub-crystalline and gneissoid groups.

III. Cambrian: In many of the areas especially the western ones, the base of this is well-defined by unconformity, but in the Eastern Townships and in some parts of Nova Scotia it has yet to be determined. The limit between it and Lower Silurian is debatable ground upon which we need not enter.

The apparent great unconformity of the Nipigon group to the Huronian around Lake Nipigon may perhaps be explained by our having here the deep-seated parts of an ancient volcanic crateriform vent greatly denuded and the crater now occupied by the waters of the lake. The eruptions from this crater may have commenced in the Huronian epoch and been continued at intervals even up to the Triassic period; but in the meantime we have no evidence of any of the eruptions being newer than Cambrian. One point I wish particularly to insist on is that great local unconformities may exist without indicating any important difference in age, especially in regions of mixed volcanic and sedimentary strata, and that the fact of crystalline rocks (greenstones, diorites, dolerites, felsites, norites, &c.,) appearing as stratified masses and passing into schistose rocks, is no proof of their not being of eruptive or volcanic origin—their present metamorphic character is as the name implies a secondary phase of their existence, and is unconnected with their origin or original formation at the surface.

(Read before the Natural History Society, 24th February, 1879.)

NOTES ON THE GLACIATION OF BRITISH COLUMBIA.

By George M. Dawson, D.S., Assoc. R.S.M., F.G.S.,
of the Geological Survey of Canada.

While engaged in geological work in British Columbia during the seasons of 1875 and 1876 many points bearing on the glacial period, or epoch of extreme cold and great accumulation of ice which immediately preceded the present condition of affairs, came under notice. The regions more particularly examined during these years were in the interior of the province south of the 54th parallel of latitude, and about the Strait of Georgia on on the coast. Journeys of a more hurried character in other parts of the country enabled me, however, to extend the general conclusions arrived at so as to embrace the greater part of the area of the province. These proved to be of considerable interest, and important particularly in doing away with the apparently anomalous absence of traces of general glaciation on the Pacific slope, a hypothseis based on certain statements rather loosely made, which were afterwards extended to an area greater than they were at any time intended to cover. My observations above referred to, were embodied in a communication presented to the Geological Society, forming an extension to the coast of the Pacific of investigations formerly carried, in the vicinity of the 49th parallel, across the width of the great plains from the Laurentian axis to the Rocky Mountains.* This paper has been printed with a map and illustrations in the Quarterly Journal of the Society.†

In a country with such pronounced physical features as British Columbia, the solution of the problems offered by the traces remaining to us of the glacial period, is by no means so simple as in less rugged districts, and it becomes necessary to keep clearly in view the chief outlines of its orography, and to endeavour in the field and at the time of observation to bring before the mind the various possible causes of each particular phenomenon.

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* Quarterly Journal Geological Society, Vol. XXXI, p. 603.

† Ibid, Vol. XXXIV, p. 89.

British Columbia may be described as including the whole width of a certain portion of the Cordillera region of the continent. The Rocky Mountains, properly so called, form the boundary between the belt of the Cordilleras and the great plains to the east. The south-eastern flank of this system is defined by a remarkably deep and straight valley, in which lie considerable portions of the courses of the largest rivers of the country. Beyond this valley to the south-west, is a second and broader mountain region, called by various names in different parts of its length, but which may be designated as the Selkirk or Gold Range. Many of the summits of these mountains are scarcely less in altitude than these of the Rocky Mountains, which frequently surpass 9000 feet. Nearly parallel to these two great ranges is the Coast or Cascade Range, in which the average altitude of the higher peaks may be stated as between 6000 and 7000 feet. A fourth range may be traced in a partially submerged condition, in the mountains of Vancouver and the Queen Charlotte Islands. Between the Coast Range and the Selkirk or Gold Range lies the great Interior Plateau of British Columbia. This represents the interior basin included between the Sierra Nevada and Rocky Mountain ranges in better known regions to the south. It has an average width of 100 miles, and a mean elevation of about 3500 feet. Its height on the whole increases to the south, while northward it falls gradually towards the cluster of great lakes, and the low country of the Peace River Valley. It is now dissected by deep and trough-like river valleys, into most of which water standing at 3000 feet above the present sea-level would penetrate; and though in some places pretty level and uniform, it is generally when broadly viewed only that its true character is apparent. The north-western end of this plateau appears to be blocked by a high mountainous country formed by the coalescence of the three great ranges about latitude 55° 30′; while nearly coincident with the 49th parallel, is a second irregularly transverse mountainous zone, which is however traversed by several great river valleys, of which that of the Okanagan in longitude 119° 30′ is the most important.

The general conclusions arrived at as to the glacial phenomena of the country as quoted from the paper above referred to are as follows :—

1. The character of the rock-striation and fluting on the south-eastern peninsula of Vancouver Island shows that at one time a great glacier swept over it from north to south. The glacier must have filled the Strait of Georgia, with a breadth, in some places, of over 50 miles, and a thickness of ice near Victoria of considerably over 600 feet. Traces of the glacier are also found on San Juan Island and the coast of the mainland.

2. The deposits immediately overlying the glaciated rocks, besides hard material locally developed, and probably representing *moraine profonde*, consist of sandy clays and sands, which have been arranged in water, and in some places contain marine shells. These, or at least their lower beds, were probably formed at the foot of the glacier when retreating, the sea standing considerably higher than at present.

3. Observations in the northern part of the Strait of Georgia, and the fjords opening into it—where the sources of the great glacier must have been—show ice-action to a height of over 3000 feet on the mountain-sides. The fjords north of the Strait of Georgia show similar traces. Terraces along the coast of the mainland are very seldom seen, and have never been observed at great elevations.

4. In the interior plateau of British Columbia, there is a system of glaciation from north to south, of which traces have been observed at several localities above 3000 feet. Subsequent glaciation, radiant from the mountain-ranges, is also found.

5. The superficial deposits of the interior may be classified as unmodified and modified. The former, representing the boulder-clay, hold many water-rounded stones, with some glacier-marked, and occurs at all heights up to over 5000 feet. The latter characterize nearly all localities below 3000 feet, and are most extensively developed in the northern low country, where they appear as a fine white silt or loess.

6. The interior is marked with shore-lines and terraces from the present sea-level up to 5270 feet, at which height a well-marked beach of rolled stones occurs on Il-ga-chuz Mountain.

7. Moraines occur in great numbers. Some of the moraine-like accumulations may have been formed in connexion with the north-to-south glaciation. Most of those now seen, however, mark stages in the retreat of glaciers towards the various mountain-ranges. The material of the moraines resembles that of the boulder-clay, but with water-rounded stones even more abundant.

8. The sequence of events in the interior region has been :—glaciation from north to south, with deposit of boulder-clay; formation of terraces by lowering of water-surface, accompanied or followed by a warm period; short advance of glaciers from the mountains contemporaneously with formation of lower terraces; retreat of glaciers to their present limits. Glaciation of Vancouver Island may have occured during both the first and second cold periods, or during the second only.

9. If the north-to-south glaciation has been produced by glacier-ice, it must have been either (*a*) by the action of a great northern ice cap (against which grave difficulties appear), or (*b*) by the accumulation of ice on the country itself, especially on the mountains to the north. In either case it is probable that the glacier filled the central plateau, and, besides passing southward, passed seaward through the gaps and fjords of the Coast Range. The boulder-clay must have been formed along the front of the glacier during its withdrawal, in water, either that of the sea, or of a great lake produced by the blocking by local glaciers of the whole of the valleys leading from the plateau, to a depth of over 5000 feet.

10. If general submergence to over 5000 feet be admitted, the Japan current would flow strongly through Behring's Strait, and over part of Alaska, while arctic ice-laden water, passing south across the region of the great plains, would also enter the central plateau of British Columbia, accounting for the north-to-south glaciation and simultaneous formation of the boulder-clay.

To these conclusions the facts met with during the continuation of the geological work in 1877 and the past summer, enable some very interesting additions to be made, all which tend to show that the opinions previously formed are in the main correct.

The region examined in 1877 embraced the southern portion of the Interior Plateau, with portions of the Coast and Gold Ranges. Evidence of the north to south glaciation above referred to, were found in a number of additional localities, on the higher parts of the sonthern portion of the plateau, and traced to a height, on Iron Mountain at the junction of the Rivers Nicola and Coldwater, of 5280 feet. These observations, with those of former years, cover a portion of the Interior Plateau over three hundred miles in length, and show that the ice pressed onward over the southern portion of the plateau to, or even beyond the line of the 49th parallel, notwithstanding the generally mountainous character of that part of the region. Travelled boulders and stones rounded by water action are found at like heights with the striation, occurring even at the summit of Iron Mountain ; and over the greater portion of the region, from the eastern slopes of the elevated land of the coast ranges, is spread a covering of drift material, more or less abundantly charged with erratics, and where not modified by water action subseqnent to its deposition, to be referred to the boulder clay. Terraces, or "benches," are in many places in this part of the province shewn in wonderful perfection, rising tier above tier from the bottoms of the valleys, till they are found in a more or less wasted state encircling the higher portions of the plateau remote from the river-courses. These in several places exceed 3500 feet in altitude above the level of the sea, but none so high as that previously observed on Il-ga-chuz Mountain, in the northern part of the province, were found.

In the valleys connected with the Thompson, and especially about Kamloops Lake and the valley of the South Thompson above Kamloops, but also in the great Okanagan Valley, and forming small outlying patches for some distance up the Similkameen, is a remarkable horizontally-stratified deposit of white silt, in the form of terraces. These are evidently remnants of a sheet of similar material, which has at one time formed the floor of these wide trough-like valleys. In composition it resembles the white silts of the Nechacco Basin, but occurs at a different horizon, reaching a maximum height, so far as ascertained, of about 1700 feet above the sea. In origin it is probably like that of the Nechacco, a deposit from the turbid waters of glaciers at a time when the ice still had a considerable extension from the various mountain ranges, and general depression of the land, or the damming up of the valleys gave rise to a system of winding water-ways—lakes or fjords—which occupied the main depressions of the surface. The heads of these valleys, in the flanks of the Gold Range, still hold long and deep lakes, on the banks of which drift deposits appear to be scarce and the white silts are not found. I refer in this connection particularly to the system of valleys occupied by the Shuswap Lakes. It appears not improbable that at the time the white silts were laid down the portions of the valleys now held by these lakes were filled with glacier ice, and that eventually a rather rapid dissolution

tion occurring, the beds of the glaciers were left as hollows to become lakes. Whether any of these are true rock-basins can not be determined, as the material flooring the lower portions of the wide valleys is altogether detrital. A moraine appears to lie across the valley at the lower end of Little Shuswap Lake.

Explorations along the coast of British Columbia, and more especially in the Queen Charlotte Islands, during the past summer, have developed additional interesting details bearing on the glacial period. These have not yet been worked up, but the main points are as follows. The great glacier which filled the Strait of Georgia, overriding the south-eastern extremity of Vancouver Island, may be attributed with greatest probability tr the earlier and more intense period of glaciation. Its motion was from north to south, but whether this indicated a general glaciation of the coast in that direction, or was due entirely to the contour of the land, was not known. It was evident that had any polar ice-cap or southward-moving glaciating ridge of ice been the agent, it must also have followed the wide sound separating the north-western end of Vancouver Island from the mainland, in a south-eastward direction. This has not occurred, but, on the contrary, a glacier equally massive with that of the Strait of Georgia has poured out of this sound north-westward, sweeping over the northern portion of Vancouver and adjacent islands. From a point nearly opposite the middle of Vancouver Island, where the channels separating it from the continental shore are most contracted, the ice has flowed south-eastward, forming the Strait of Georgia glacer, and north-westward as that of Queen Charlotte Sound.

North of Vancouver Island, wherever looked for in the proper situations, marks of heavy glaciation are found in all the channels and fjords, to the southern extremity of Alaska where my observations terminated, though a coast-line similar in its general features, and doubtless characterized by the same signs of a former glaciation, extends far to the north-westward. The glacier ice has not only filled the narrow fjords to a great depth, but passing westward has occupied the wider straits which separate the outer islands of the group which fringes the coast.

In the Queen Charlotte Islands, parted widely from the mainland, traces of local glaciation only, due to ice accumulating on its own mountain system, are found. The northern shore of these islands is however strewn with erratics which may have come from the mainland. Along the eastern shore of Graham Island, a long line of cliffs displays deposits of clays and sands similar to those previously described as occurring in the southern part of Vancouver Island. Many of the beds contain boulders and some hold marine shells of the species found in the deposits just referred to, with occasional fragments of wood.

Quite recently, a great addition to our knowledge of western geology has been made by the publication by Clarence King of the volume of his series on the fortieth parallel, devoted to systematic geology. In this the quaternary period is treated at some length, and in a comprehensive manner, enabling comparisons to be drawn between the condition during the glacial period of that part of the Cordillera system included in British Columbia, and its southern continuation in the vicinity of the fortieth parallel.

King has failed to find any evidence of a great southward-moving ice-mass, or general glaciating agent, and no sheet of boulder-clay covers the region; the superficial deposits being either directly due to the descent of torrents from the mountains and high lands, or to the rearrangement of these by water action in lakes. Two great sheets of water which have been called Lakes Lahontain and Bonneville, spread widely in the high plateau region between the Sierra Nevada and the Rocky Mountains. Local glaciers were, however, extensively developed, coming down to altitudes of 2000 to 5000 feet above the sea in the Sierra Nevada, which was exposed to the moisture-bearing winds of the Pacific, but seldom reaching below a height of 7000 to 8000 feet in the dryer eastern ranges. These constitute the local expressions of the general change which further north produced great ice-fields, but at no time was more than about one-thirtieth of the area embraced in the fortieth parallel survey covered with ice.

The most interesting point established by King, however, is the existence of two periods of moisture and flooding of the lake basins, alternating with two of extreme drought, the latter of which still continues. The evidence of these is found both in the relative arrangement of the stratified and unstratified materials of the old lake bottoms, and in the chemical character of the deposit from their waters. These periods of great precipitation are correlated with great probability with the two epochs of glaciation proved in British Columbia. King, however, adopts extreme views as to the power of glaciers in eroding valleys, attributing most of the canons of the region he has examined to their action. He draws attention to the V-shaped gorges which become U-shaped in their upper reaches, and supposes that the former were cut out by flood waters accompanying and following the first period of glaciation, while in the latter we have the unaltered work of the glaciers of the second period, stating that the work of erosion in these valleys has been absolutely trivial since the glaciers left them. It is also advanced in support of these views that many if not most of the canons of which the age can be determined, have been cut out since Pliocene times, and that in the surfaces of the Archæan masses which must have stood out as islands during long geological periods, nowhere shew the junction of newer formations with them, to follow other than broad rounded curves.

To this theory of the origin of canons and mountain-valleys, it may be objected that whatever be the case in the fortieth parallel area, vast post-glacial erosion and the formation of deep valleys and gorges since that period have elsewhere been discovered; that glaciers are never now found to exert such active erosive power, and that the idea that so sluggish and inert a portion of a glacier as its *névé* should produce the great amphitheatrical valleys or cirques of the central mountain regions, seems inconceivable. Further, the post-pliocene age of the canons, supposing it to be correctly assigned to them in all cases, may mean nothing more than that the progressive elevation of the plateau area by which the cutting down of canons may be explained, was most active about that time. Canons and fjords are in any case rather exceptional phenomena, they occur only, on any hypothesis, in regions long raised above the sea level, and the chances that such features should be preserved during a depression of the land and afterwards brought to light in the particular portions of the lines of contact of newer and older rocks exposed by denudation, are exceedingly small.

ON SOME POINTS IN LITHOLOGY.

By Prof. James D. Dana.

(From the American Journal of Science.)

I. On some of the characters employed in distinguishing different kinds of Rocks.

Lithology is a department of Geology, rocks being the material in and through which geological problems are presented for study. The true aim of the science of lithology is to describe the kinds of rocks mineralogically and chemically, and to note down their distinctions in such a manner as shall best contribute to the objects of geology; and these latter objects include, as regards rocks, the origin of the minerals and mineral associations, constituting or occurring in rocks; the origin of the rock masses and their relations to other geological phenomena; and the origin of all changes or transformations that have taken place in rocks in the course of the earth's physical development. Geology, chemistry and mineralogy have each to be considered in determining the proper distinctions between the kinds of rocks. Should lithology make much of mere difference in texture, or in ingredients that are present only in minute proportion, geology might rightly say that, for such a purpose, these points are of small importance compared with the nature or composition of the mass.

The defining of rocks is attended with special difficulties on account of their mutual transitions. From granite down they are, with very few exceptions, mixtures of minerals, as much so as the mud of a mud bank. They graduate into one another by indefinite blendings, as the mud of one mud bank graduates into the mud of others around it. In fact a large part of the crystalline rocks were once actual mud beds or sand beds; and even part of the eruptive rocks may have been so in their earlier history. Strongly drawn limits nowhere exist. Rocks are hence of different *kinds*, not of different *species;* and only those mixtures are to be regarded as *distinct kinds* of rocks which have a sufficiently wide distribution to make a name important to the geologist. Other kinds have to be classed as *varieties*, if worthy of that degree of recognition.

In the following pages I propose to consider the value of some of the distinctive characters which are generally accepted at the present time in defining certain kinds of rocks.

1. "*Older*" and "*younger*."—The distinctions "older" and "younger" often applied to a number of kinds of eruptive rocks, seem to imply that the earth has generated different *kinds* of rocks as it has grown old. The terms have reference, however, to only one epoch of abrupt change—that between the cretaceous and tertiary, "older" signifying pre-Tertiary, and "younger" Tertiary or later in date. It is of eminent importance to geology to know definitely whether this epoch was one of great change in the earth's ejections, and an epoch so marked that the rocks on one side of the time-boundary are deserving generally of different names from those of the other; for thus lithology, judging from some recent works, as well as older, has seemingly decided. Some examples of the "older" kinds are *dioryte*, *diabase*, and a large part of *felsyte*; and some of the "younger" are *propylyte*, *doleryte* or *basalt*, and *trachyte*. The value of the distinction may be learned from a comparison of the rocks of one of these series with the rocks of the other.

First as to *diabase* and *doleryte*. Typical diabase consists according to the descriptions, of labradorite and augite, with some magnetite or titanic iron; and so does doleryte. Diabase, to a large extent, is a crystalline-granular rock, so is doleryte. Diabase was formerly supposed to be peculiar in containing chlorite, but it is now proved, as asserted by Rosenbusch, that chlorite is not an essential characteristic, so that diabase may be chloritic or not; and the same is true of doleryte. Old diabase was described as differing from the younger rock doleryte in containing no glassy portions or grains among the crystalline grains; but this is also set aside by later observations, and Rosenbusch accordingly divides diabase into (1) massive granular diabase, (2) diabase-porphyrite, and (3) glass-bearing diabase; and corresponding subdivisions are as good for doleryte. Thus in chemical composition, in mineral composition, in texture, in the presence or absence of chlorite, in the presence or absence of glassy portions, the two rocks are identical. Analyses of "diabases" from the Archæan to the Tertiary, and of "dolerytes" of subsequent time, have shown that material of essentially the same composition, has been ejected in all geological ages, as has been well urged by Allport and others. The analyses might be cited; but this is not necessary, since in mineral composition typical diabase and doleryte are admitted to be identical.

The facts as regards these two rocks, then, give no foundation for the idea of such a transition epoch in rock-making at the close of the Cretaceous period. And if not, it is bad for geology to have such epithets as "younger" and "older" treated with so great distinction.

Again: the difference between *dioryte* ("older") and *propylyte* ("younger") is not in the chemical or mineral composition of the rocks; and hence, whatever difference there be is only in texture and is, therefore, of little geological value. Again, *felsyte* and *trachyte* are rocks of one and the same chemical and mineral constitution. Ordinary felsyte consists of orthoclase, or orthoclase and oligoclase with sometimes disseminated hornblende or quartz; and the same is precisely the constitution of some kinds of trachyte. They differ in aspect, and feel differently under the fingers, and still some varieties of felsyte differ from ordinary trachyte only in having the disseminated orthoclase crystals not translucent, a difference of very small value mineralogically, and not less so geologically.

The rock of certain felsitic dykes in Canada and Vermont, Paleozoic in age, is called trachyte by T. Sterry Hunt in the Canada Geological Report, because of the essential identity with that rock; and Mr. G. W. Hawes, in his New Hampshire Report, says (p. 187), of New Hampshire's "orthoclase-porphyry," "Were it not that the feldspar is opaque othoclase, instead of clear sanidin [that is, glassy orthoclase] one would immediately think of trachyte on examining these rocks." Moreover, Messrs. E. Reyer and Suess, eminent geologists of Vienna have shown that trachyte occurs in the Euganean Hills of Cretaceous and Jurassic age, as well as of Tertiary. Further, there are felsytes among the "younger" rocks of the globe, that is, among the products of volcanoes, where there is no trachyte; and, on the other hand, trachyte sometimes graduates indefinitely into felsyte. The facts show, consequently, that orthoclase rocks, or orthoclase and oligoclase, have been erupted from Paleozoic time onward, and that the distinctions found in some of the latest kinds are superficial: a little rougher surface, more translucency in the feldspar, and some glass at times among the crystalline grains; but nothing that has any geological weight. While then it may be well to retain the names of trachyte and felsyte, on account of the obvious external differences and the wide extent to which the two varieties of rock are distributed over the earth's surface, the epithet "younger" as applied to trachyte and some felsyte can subserve plainly no good use. The essential chemical identity of the "older" and "younger" rocks is further exhibited in the fact that the hornblende-bearing rock *labradorite-dioryte*, called one of the "older," has the same ultimate constitution as the augite-bearing rocks, "older" and "younger," called diabase, doleryte and basalt. This fact emphasizes the great truth, that the rock-making materials of former times are the same as those of recent.

During and since the Tertiary era more subaerial volcanic eruptions have taken place than in any one ancient period; but there were also many then. As to fundamental differences between the materials ejected by the "older" and "younger" world there appear to be none which are of essential importance. *Glass or no glass* is made an important criterion; but glass is simply a result of comparatively rapid cooling, and alone indicates no essential differences in the melted mass.

Dropping the adjectives "younger" and "older" would require the dropping of the distinctive names based on them, unless some better reason exists for retaining them.

If diabase is not distinct from doleryte in some important way besides that of time of eruption, the name *diabase* (the newer of the two) is unnecessary. In fact, the rocks are not distinct in external characters any more than in chemical or mineralogical. The rock of the Giant's Causeway was pronounced diabase on microscopic grounds when its geological age was unknown; but it has since been proved to be Miocene Tertiary; and now, although just as much diabase in constitution as before, it becomes, on the "younger" and "older" scale, doleryte or basalt.

Some of the differences attributed to difference in age may be due to differences in origin—that is, to the rock's being metamorphic in one case, and eruptive in another. There are distinctions of this kind of great interest yet to be followed out; and they may sometimes have a sufficient geological value for recognition in distinct names, although this may not be generally the case.

2. *Foliated or not.*—Some rocks are described as having foliated pyroxene or foliated hornblende, that is, diallage, pseudohypersthene or smaragdite as the characterizing ingredient. The question here is whether the distinction of *foliated* or *not foliated*

is of sufficient importance to be used as a distinction among kinds of rocks. In the *first* place, it is trivial as a crystallographic distinction. *Secondly*, although mineralogy once made much of the distinction, it now makes little of it. *Thirdly*, it is not sustained by the analyses of the varieties of foliated pyroxene—diallage and the wrongly called hypersthene being essentially identical in composition with common augite of eruptive rocks, and the smaragdite, with other crystallized hornblende. This is shown in any work giving full lists of analyses of minerals, and is well understood; yet the introduction here of a few of the analyses may not be superfluous. Nos. 1 to 5 are of diallage and pseudo-hypersthene, and 6 to 8 of augite crystals from Etna and Vesuvius.

	SiO_2	Al_2O_3	FeO	MnO	MgO	CaO	H_2O	
1. Florence, *Diall*	53·20	2·47	8·67	0·38	14·91	19·09	1·77	=100·49 Köhler.
2. Piedmont, *Diall*......	50 05	2·58	11·98	—	17·24	15·63	2·13	= 99·61 Regnault.
3. Graubündten, *Diall*..	49·12	3 04	11·45	—	15·33	18·54	1·46	= 98.94 v. Rath.
4. Harzburg, *Hyp*.......	52·34	3·05	8·84	—	15·58	19·18	0·66	= 99·65 Streng.
5. Neurode, *Hyp*........	53·60	1·99	8·95	0·28	13·08	21·06	0·86	= 99·82 v. Rath.
6. Etna. *Augite Cryst*....	50·55	4·85	7·96	—	13·01	22·29	—	= 98·66 Kudernatsch.
7. Vesuvius "	50·90	5·37	6·25	—	14·43	22·96	—	= 99·91 Kudernatsch.
8. Vesuvius "	49·61	4·42	9·08	—	14·22	22·83	—	=100·16 Rammelsberg.

The mineralogical and chemical differences are thus too slight to make the distinction of any lithological importance, and this importance can be sustained, if at all, only on geological considerations.

The particular rock, in the description of which the character stands prominent, is that called *Gabbro* in Germany. It is well known that this Italian word was the provincial name originally of common serpentine. Ferber, in his "Briefe aus dem Wälschland" (Letters from Italy), written in the years 1771, 1772, and published in 1773, describes so well the rock near Florence, that we cite briefly from him. He first says, in a letter from Florence, of Dec. 11, 1771 (in which he gives scientific notes on the minerals and rocks of the regions), that the Gabbro of the Italians, occurring in Italy, Tuscany and Genoa, is identical with the serpentine of Saxony. Then, in another of May 23, 1772, he repeats the statement and describes particularly, and with scientific precision, the gabbro of Mt. Impruneta, near Florence, and mentions the occurrence in it of a talky, micaceous mineral, which affords, he says, a powder greasy to the touch (the diallage), and also amianthus. He then adds that "in *horizontélen* Schichten in den Gabbro-Bergen um Impruneta findet sich der sogenannte *Granitone*, welcher aus weissen Feldspat, der an einigen Stellen Kalchspatartig ist und mit Säuren brauset, etwas grünlichtem silberfarbigen würflichten Glimmer, und grünlicher Serpentin-Erde, besteht:" a description that distinguishes the gabbro from the granitone. Further, he says that some of the granitone consists of the "white feldspar in large parallelopipeds and green gabbro-earth, without the micaceous mineral."

The word *Gabbro*, as it is now used (and was so first by von Buch, in 1810), is applied to the *granitone*, the associate of the Italian gabbro; but, besides this, to rocks consisting of foliated pyroxene (sometimes called hypersthenite), and cleavable labradorite, the idea of *foliated* standing out prominently; and also to an eruptive diabase-like or doleryte-like rock, in which the augite happens to be *foliated*. In this last variety, as the analyses show, there is evidently no foundation whatever for separating the rock from other labradorite-augite eruptive rocks. Granitone is the same as *euphotide*, a rock distributed at intervals along the Alps from Savoy and Isère, in France, through Piedmont, to the valley of the Saas, north of east of Monte Rosa, and the Graubündten, occurring also in Silesia and on the island of Corsica, and found commonly associated with serpentine. Its chief characteristic is—not its *foliated* diallage or smaragdite (either of which is usually a mixture of hornblende and pyroxene), but its consisting largely of the compact jade-like material called *saussurite*; for it would be the same rock, essentially, whether the hornblende and pyroxene were distinctly foliated or not; and, in fact, in part of it the texture is aphanitic, and nothing foliated is distinguishable. Saussurite has a close relation to some of the feldspars in its constituents, it being essentially a soda-lime-alumina silicate; and still, as has long been recognised, it is not a feldspar. This has been rightly sustained by the fact of the high density, which is over 2·9 (2·9 to 3·4) in saussurite, and less than 2·765 in the feldspar group.

It is further proved by its occurrence occasionally under the crystalline forms of a triclinic feldspar, but with a fine granular or aphanitic structure; thus having, instead of the cleavage structure belonging to the feldspar, a feature belonging to a pseudomorph. In such cases it was once feldspar; but some change has come over it that has resulted in a molecular transformation, affecting both the crystalline character and the density. Saussurite appears to cover a group of minerals, like feldspar. *One* kind is between anorthite and zoisite in composition, though differing from both in the soda and magnesia, and from all feldspars in its not having the feldspar-ratio between the silica and soda. A *second* has the composition of labradorite; and a *third* the composition nearly of oligoclase. A *fourth*, from Corsica, analysed by Boulanger, is a lime-alumina silicate, like anorthite and zoisite. The saussurite group, with density between 2·9 and 3·4, runs nearly parallel with the feldspar group. The first is *Saussurite*, Th. de Saussure having named thus the Lake Geneva variety, after his father, in 1806; the third is *Jadeite;* and the second may be called, from one of its localities, *Genevrite.*

The following are the analyses of three prominent kinds, and of normal anorthite, labradorite and oligoclase.

	Si_2	Al_2O_3	Fe_2O_3	FeO	MgO	CaO	Na_2O	K_2O	ign	
1. L. Geneva	43·59	27·72	2·61	——	2·98	19·71	3·08	——	0·35	= 100·04 Hunt.
2. L. Geneva	45·34	30·28	——	1·37	3·88	13·87	4·23	——	0·71	= 99·68 Fikenscher.
3. Schwartzwald......	42·64	31·00	——	2·40	5·73	8·21	3·83		3·83	= 97·64 Hütlin.
II.										
4. Mt. Genèvre	49·73	29·65	——	0·85	0·56	11·18	4·04	0·24	3·75	= 100 00 Delesse.
5. Silesia	50·84	26·00	2·73	——	0·22	14·95	4·68	0·61	1·21	= 101·24 v. Rath.
6. Silesia	51·76	26 82	1·77	——	0·35	12·96	4·61	0·62	0·68	= 99·57 Chandler.
7. Unst	52·21	29·64	0·48	——	0·26	12·43	4·00	0·44	0·11	= 99·56 Heddle.
8. Unst	53·14	29·99	0·25	——	0·21	12·29	3·86	0·47	0·21	= 100·42 Heddle.
9. Durance	56·12	17·40	7·79	——	3·41	8·74	3·72	0·24	1·93	= 99.35 Delesse.
III.										
10. *Jadeite*, China......	59·17	22·58	——	1·56	1·15	2·68	12·93	*tr.*	——	= 100.07 Damour.
11. " Switz......	58·89	22·40	——	1·66	1·28	3·12	12·86	0·49	0·20	= 100 63. Fellenberg.
12. " "	58·28	21·86	——	2·41	1·99	2·53	13·97	——	——	MnO 0·22. Fellenberg.
13. Normal anorthite ..	43·1	36·9	——	——	——	20·0	——	——	——	= 100
14. Normal labradorite.	52·9	30.3	——	——	——	12.3	4·5	——	——	= 100
15. Normal oligoclase ..	61·9	24·1	——	——	——	5·2	8·8	——	——	= 100

Specific gravity of 1, 3·227; of 2, 3·3-3·4; of 3. 3·16; of 4, 3·10; of 5, 2·998; of 6, 2.74; of 7, 2.95; of 8, 2 954: of 9, 2.923: of 10, 3.33-3.35: of 11, 3·32; of anorthite, 2·66-2·763; of labradorite, 2 67-2·76; of oligoclase, 2·56-2·72.

To No. 9, add Cr_2O_3 0·51, and to 11, ZnO 0.73. Nos. 10 to 12 are only known worked into ornaments, but the kind may yet be found in the Alps. No. 5 has the specific gravity of labradorite and was therefore that species, a mineral that would be present where the crystallization took place without, or with only partially, the conditions needed to produce saussurite. No. 9 is of the globules of the "Variolite of Durance," a rock associated with euphotide.

Boulanger's saussurite, from Corsica, is near *zoisite* in composition and density (G.=3·18), as stated by T. S. Hunt, who referred all true saussurite to zoisite confirming his view by his analysis above), and the part near labradorite to that of feldspar. Damour obtained for *jadeite* the ratio 1 : 2 : 6.

The relation to the feldspar group indicates the occurrence of special geological circumstances, which turned feldspathic material into saussurite. The circumstance that determined the crystallization or metamorphism may have produced, in its incipient stage, soda-lime feldspar; but it ended in making a large *part*, or the *whole*, saussurite. Moreover the hornblende has been shown to be, in part at least, pseudomorphous after pyroxene; so that the foliated ingredient bears like evidence of this mode of origin. Consequently saussurite rocks not only differ molecularly from any labradorite or feldspar rock, but are indications of peculiar geological operations on a large scale; and this connected with other differences, makes it desirable to distinguish such rocks by a special name. The saussurite and not the *foliated* mineral is the chief ingredient on which the distinction rests.

Euphotide is therefore a different rock from any, consisting of *cleavable* labradorite and pyroxene or hornblende, both on mineralogical and geological grounds. The *foliated* condition of the latter constituent is not reason enough for overlooking the more fundamental differences. As the name *gabbro* has covered rocks of so different kinds, lithology would be freer of ambiguities without it.

The true labradorite-and-pyroxene rock of Scandinavia, the Adirondacks, British America, and other regions, sometimes called *Noryte*—the third kind of gabbro—has the chemical and mineralogical constitution of diabase or doleryte. But it differs from these in its granitoid aspect and geological relations, and is of metamorphic origin; and as it is of wide geographical distribution, geology seems to require for it a distinct name, and *noryte* is an appropriate one.

The pyroxene, though generally foliated, is not always so. When, in place of pyroxene, there is *true* hypersthene, a mineral of different composition and character, as at St. Paul's, Labrador, the rock is then rightly called *Hypersthenyte*, and this name is so used by Zirkel.

3. *Porphyritic Structure.*—Porphyry naturally took the position of a species in the mineralogy of the ancients. But it is now well known, and generally admitted, that the porphyritic structure is largely due to conditions attending the former temperature and cooling of the rock-mass, and distinguishes only varieties. But still it is usual to find dioryte divided, for its primary subdivisions, into ordinary dioryte and dioryte-porphyry;

diabase into granular diabase and diabase-porphyry or diabase-porphyrite; felsyte into felsyte and felsyte-porphyry; and so on, as if the porphyritic structure were deserving of first prominence in the question of division into varieties, even greater than mineral constitution; and sometimes it is even made the basis of a distinct kind of rock. But, *first*, this porphyritic feature is only one grade in the crystalline condition, and is of no more value as regards rock-distinctions than other grades.

Secondly, it is of far less importance in this respect than any variations in chemical or mineral compositions, such as are made the basis of other varieties.

Thirdly, it has often little stability in a rock-formation; for transitions in a dioryte from porphyritic dioryte to non porphyritic are often found to take place at short intervals, laterally as well as vertically; and so it is with other porphyritic rocks.—Within three miles west of New Haven, Connecticut, a labradorite-dioryte undergoes many such transitions in intervals of a few rods, illustrating the little value of the distinction based merely on this condition in the feldspar. Half a dozen miles farther west there is porphyritic granite which graduates, *in a few yards* at some points, into porphyritic gneiss (the crystals of orthoclase, two inches long and three-fourths of an inch broad) and this last graduates near by into ordinary gneiss; and gradations from porphyritic to ordinary gneiss are very common in the region. Such facts make it evident that the porphyritic structure is a characteristic of little relative importance; that a porphyritic variety may have rightly a place on a level with other ordinary varieties, but never above one based on variations in composition. The porphyritic structure is an easy character to observe; but this is not an argument in its favor that science can entertain. Such names as *felsite-porphyre*, *amygdaloporphyre*, *granito-porphyre*, *melaporphyre* (this last signifying "black porphyry") and others (abbreviated sometimes to felsophyre, amygdalophyre, granophyre, etc.) have high authority. But they seem to belong rather to books on polished stones than to scientific works on lithology.

The occurrence also of the augite of an eruptive rock in distinct crystals, or of quartz in double pyramids, and other similar cases, can have nothing more than a small *varietal* value. The criterion—crystals or not—is sufficient to distinguish only varieties in mineralogy; and lithology can rightly make no more of it.

(*To be continued.*)

NOTES ON CANADIAN FERNS.

[Having particular reference to the discovery of *Aspidium Lonchitis* at Gaspé in 1875.]

By Jno. B. Goode, Esq.

(*Read before the Natural History Society, Montreal, Jany. 27th*, 1879.)

The mounted specimens which I have now the pleasure of exhibiting to the members of this Society, represent thirty-five of the species indigenous to the Provinces of Ontario, Quebec, New Brunswick and Nova Scotia combined, leaving some eight to ten species to complete the list of the Ferns of these Provinces.

Many of the specimens now before you, were collected at Gaspé last July, in the neighbourhood of Grande Grève, which is rather rich in ferns, some of the rare species being there found in abundance.

Asplenium viride. This species was first discovered in Canada, by the late John Bell, M. D. It was found in Gaspé in the summer of 1863, since which I have found it in abundance at Grande Grève, where it can be seen in perfection, growing in the seams of the limestone ridges, in shady, cool aspects.

Pellæa gracilis is not rare there, and appears to thrive in the immediate vicinity of the sea, similar in this respect to the *Asplenium marinum* on the western coast of England; it thrives best in damp, rocky fissures, or caverns in the shore cliffs, so close to the sea, that in rough weather it must receive a liberal sprinkling of spray. This fern, I may mention, is one of the most difficult to establish in cultivation, and, consequently, although a very pretty one, is rarely or never seen in greenhouse collections.

Asplenium marinum, to which reference has just been made, has been reported on the coast of New Brunswick, on one occasion. I may say that my diligent researches on the Gaspé coast were unsuccessful, and, I think, before accepting it as a Canadian species, it should be found in other localities.

Aspidium aculeatum, var. *Braunii.* A beautiful and rather rare fern; is common in certain localities at Gaspé, preferring cool, shady woods on eminences, or slopes.

Aspidium Lonchitis, or Holly Fern of the Old Country. This species I discovered at Grande Grève in 1875, previous to which the only known locality, I believe, was Owen Sound, where plants had been found, in 1859, by the Rev. Professor Hincks.

I again found it in the neighbourhood of Grande Grève, last summer, where my specimens were collected. It is a very handsome fern, but losing much of its beauty when in cultivation; throwing out a circle of rich, shining, green and narrow lanceolated fronds, often two feet in length; it appears to thrive luxuriantly amongst the weathered, broken limestone rocks, that have fallen from the heights above and become mixed with the fallen leaves. Evidently perfect drainage for the roots is essential to a vigorous growth, combined with a cool, breezy atmosphere, with a northerly to easterly aspect. I have transplanted some roots of this fern, as well as Asplenium viride and Asplenium aculeatum, to suitable situations on our own mountain, and hope there will be opportunities of seeing them in their early, brilliant spring beauty.

The foregoing are the only rare ferns I have found at Grande Grève. *Aspidium spinulosum* there presents several beautiful forms, as shown in the specimens before you.

Pellæa atropurpurea. For this specimen I am indebted to the kindness of Mrs. Roy, of Owen Sound, where I believe it is sparingly located. I found this fern in 1875, on the cliffs overhanging the whirlpool at Niagara, on the American side; but last year, I found it on the Canadian side, and in the most frightfully dangerous-looking places, on the perpendicular sides of high calcareous rocks, which had become partially detached from the main rocks, and were slowly moving, preparatory to a final plunge into the turbulent river beneath. Its dark, tough, wiry roots penetrate the smallest fissure, and thrive with less soil than any other fern with which I am acquainted. No doubt the great amount of humidity from the falls and rapids helps to counteract the want of root nourishment, the atmosphere being constantly filled with light particles of moisture; otherwise, I think they would be burnt up, being exposed to the scorching sun. I have never seen this species in any other locality.

Aspidium fragrans. For the present fine specimen I am indebted to the Rev. Robert Hamilton, of Grenville, who collected it on one of the mountains in that locality. It is a rare species, growing in the seams or fissures of limestone rocks, into which its strong wiry roots penetrate, and possesses a most pleasant perfume, almost equalling the sweet-scented violet. It thrives only indifferently well in cultivation.

Camptosorus rhizophyllus, or Walking Leaf. This specimen was contributed from Hemmingford; it is found on Isle Jesus, on large, mossy boulders, and throughout Quebec and Ontario. This species is the only one of our Canadian ferns which possesses the property of forming new plants from the rooting of the attenuated extremities of the old fronds, and in this manner travels over the face and sides of the rocks.

Asplenium Trichomanes. This fern, so common to collectors in the Old Country, appears to be rare in Canada, the only places I have found it being at the rapids below Niagara Falls, and at Bolton Springs, in the Townships, where I collected the fine specimen now exhibited, last summer. I have transplanted some roots of this neat and pretty fern to our own mountain.

Dicksonia punctilobula. This fern is very beautiful in its early stages, and emits, while drying, a strong odor, like sweet hay. I have not yet found it on the Island of Montreal; but it is very common in the Eastern Townships, especially at Knowlton, opposite Rockwood, Boscobel, and other places. Its creeping rhizomes push vigorously in every direction, soon forming immense clumps.

Botrychium gracile. The specimens of this pretty dwarf species were found at Gaspé, last summer. I have never seen it elsewhere.

Our Montreal mountains and their surroundings contain a very fair share of ferns. I have collected twenty-five species there, twenty-four of which were seen last summer, the following being a list:

Polypodium vulgare, -	- abundant on N. E. side, amongst loose rocks.
" phegopteris,	- N. E. base.
" dryopteris,	- luxuriates on well-rotten stumps, in shady woods.
Struthiopteris germanica,	- in swamp, S. E. side Mount Royal Cemetery.
Pteris aquilina, - -	- dry, open spots.
Adiantum pedatum, -	- very abundant off Mt. Royal Cemetery avenue.
Asplenium angustifolium	- rather rare; grows on N. W. side Mt. Royal Cemetery.

Asplenium thelypteroides, -	western side Mt. Royal Cemetery.
Asplenium filix fœmina, -	in rich damp woods; common.
Woodsia Ilvensis, - -	on exposed rocks, top of mountain overlooking the city.
Cystopteris bulbifera, - -	abundant on N. E. slope of the mountain, beyond Sir Hugh Allan's.
Cystopteris fragilis, - -	in rocky seams or cracks, in shade.
Aspidium thelypteris, - -	swamp between Cemeteries.
Aspidium Noveboracense, -	between Cemeteries; turns nearly white in autumn.
Aspidium spinulosum, - -	swamp between Cemeteries.
Aspidium cristatum, - -	" " "
Aspidium marginale, - -	common on rocky slopes; shade preferred.
Aspidium acrostichoides, -	back of Sir Hugh Allan's and behind Cemetery; is getting scarce.
Onoclea sensibilis, - -	common in wet places.
Osmunda regalis, - }	swamps top of mountain and Smith's swamp.
Osmunda Cinnamomea, }	
Osmunda Claytoniana, - -	Smith's swamp.
Botrychium lunarioides, -	dry open spot top of mountain, back of the Redpath property.
Botrychium Virginicum, -	rich woods, westerly side.
Aspidium Goldianum, - -	have not found for some years; was formerly on the northern and western mountain.

Other species than the forgoing have been reported as found on the mountain, but are now probably extinct.

NOTES ON ELEPHANT REMAINS FROM WASHINGTON TERRITORY.

By J. T. Donald, B.A.

The molar now before us forms part of a collection of elephant remains found at Hangman's Creek in the south-western part of Washington Territory. The entire collection numbers over 300 pieces, supposed to represent at least six individuals.

These remains were found in a bog, at a depth of twelve feet below the surface. It is thought the same locality, on careful search, would yield more bones.

It is with a portion of this collection—found in a position to indicate that it probably belonged to the same individual—we are concerned. The principal bones of this portion are, a lower jaw, a pelvis, the first lumbar vertebra, a left scapula, and a horn or tusk. The lower jaw is nearly perfect, and contains the two molars in a good state of preservation. Its length on the outer curve is thirty-six inches; shortest line from posterior summit of condyle to mandibular extremity, twenty-two and one-half inches. Distance between condyles, fourteen inches; distance between outer sides of condyles, twenty-two inches; height of symphysial gutter, four inches; width of same, three inches.

The pelvis weighed when exhumed one hundred and thirty-five lbs. The following are some of its measurements: transverse measurement of sacrum within the arch, ten and one-half inches; distance from symphysis pubis to summit of pubic arch, thirty inches; distance from sacrum to pubis, twenty inches; direct diameter of acetabulum, seven and one-half inches. The transverse superior diameter of the lumbar vertebra with processes is ten inches; its vertical diameter, exclusive of spinous processes is nine and one-half inches; height of spinous process, six and one-half inches; greatest breadth of same, two and one-quarter inches.

The scapula weighed when taken from the earth forty pounds. Its extreme length is forty and one-half inches; its width twenty-five and a-quarter inches. The extreme width to base of spine of posterior spinous fossa, is nineteen and a-half inches.

The horn or tusk weighed when exhumed one hundred and forty-five lbs. Its length on outer curve is one hundred and twenty inches. Depth of conical opening at base, twelve inches; circumference at base, nineteen and one-half inches; circumference two feet from base, twenty-two inches. This horn curves somewhat obliquely in about two-thirds of a circle, being more oblique near the point, as if worn. A small portion of the base appears to be wanting.

Can we refer these remains, or any part of them, to any known species of elephant? In the 'Canadian Naturalist' for the year 1863, page 135, there is a description by the late Mr. Billings, of an elephant's lower jaw, found in a cutting on the Great Western Railway near Hamilton. This jaw is referred to *Eulephas Jacksoni* of Briggs and Foster.

Calling the jaw now under consideration, A. and that described by Mr. Billings, B. we can tabulate the measurements of the jaws as follows:

	A	B
	ins.	ins.
Shortest line from posterior extremity of condyle to mandebular extremity	$22\frac{1}{2}$	23
Greatest width of jaw	25	22
Length of symphysis along median line	5	$5\frac{1}{2}$
Width of symphysis	3	$2\frac{1}{8}$

The similarity of the dimensions of the two jaws thus shown, leads us to regard the two as belonging to the same species.

The study of the molar before us, which is similar to those contained in the jaw just mentioned, strengthens this belief. Calling our molar A. and that described by Mr. Billings B. we can tabulate dimensions as follows:

	A	B
	inches.	inches.
Greatest length of tooth	12	$18\frac{1}{2}$
" width "	$3\frac{1}{4}$	$3\frac{1}{4}$
Length of crown	$8\frac{3}{4}$	11
Number of plates in tooth	20	26

In A. *sixteen plates* are brought to view in a surface of *seven and one-half inches*. In B. *nine worn plates* occupy a length of *four inches*, thus giving in each case a little less than one-half inch to each plate; a strong point in favor of the identity of species in the remains represented by the two molars.

Among the remains for which the species *E. Jacksoni* was proposed was a horn or tusk. A comparison of this with the horn belonging to the W. Territory collection also favors the view that the latter is referable to *E. Jacksoni*. Calling the tusk belonging to the remains for which the new species was formed, B. and the one from W. Territory, A. we can make the following table:

	A	B
Weight of tusk	145 lbs.	180 lbs.
Length on outer curve	120 ins.	129 ins.
Circumference at base...............	19½ "	20 "
" two feet from base	22 "	22 "

The remains on which the species *E. Jacksoni* was founded, were discovered in a "deposit accumulated just after the close of the northern drift period, and while the river terraces were in process of formation." Other elephant remains, found at Zanesville, Ohio, in 1852, described by Prof. J. Wyman in the proceedings of the American Association for 1857, and referred to *E. Jacksoni*, were found in what is called "valley drift." This drift is composed "of loam, sand and gravel filling up the original valley of the stream that had been excavated out of the palæozoic rocks." Tne remains described by Mr. Billings, and now in the museum of the Geological Survey, were taken from strata "apparently formed just after the close of the upper drift period, and belonging to the well-known lake ridges and terraces." The remains from Washington Territory were taken from a bog representing, most probably, a drift deposit filling up a former valley and, therefore, in all probability, corresponding in geological age to the deposits whence the specimens of *E. Jachsoni* above mentioned were obtained.

On comparing, therefore, as we have just done, the elephant remains from Washington Territory with bones referred by three different authors to *E. Jacksoni*, and taking into consideration the probable identity in geological age of the several deposits yielding these remains, we are led to the belief that the elephant remains represented by the molar before us belonged to an individual of the species *Elephas Jacksoni* of Messrs. Briggs and Foster, and that this individual lived either immediately anterior to the appearance of man, or just after his advent upon this planet.

But this question still confronts us: Were the peculiarities upon which *E. Jacksoni* was proposed of sufficient importance to warrant the formation of a new species, or were they only of varietal value?

Of this Mr. Billings seems to have been uncertain, for he says,* "Should it be admitted that *E. Jacksoni* is distinct from *primigenius*, etc., etc."

Again, Prof. Boyd Dawkins, in a paper read before the Geological Society,† speaking of the mammoth, says: "The animal ranged over the whole of North America, fr m the frozen cliffs of Eschscholtz Bay as far south as the Isthmus of Darien—the *Elephas americanus* of Leidy and the *E. Columbi* of Falconer (*E. Texianus*, Owen) being mere varieties of the same sort as those observable in the European mammoths, founded merely on the relative width and coarseness of the plates composing the grinders; while the *E. Jacksoni* of Billings merely supplies a slight variation in the form of the lower jaw.

In the light of all the evidence thus adduced, I think we may finally refer the elephant remains of Washington Territory, represented by this molar, to *E. primigenius*, var. *Jacksoni*.

PROCEEDINGS OF THE NATURAL HISTORY SOCIETY OF MONTREAL.

The first meeting of the Natural History Society for Session 1878–79 was held in the rooms of the Society on the evening of Monday, October 28th. Principal Dawson occupied the chair.

A paper was read by Dr. Harrington on apatite and the minerals associated with it in the region north of the Ottawa which has recently attracted so much attention. The general similarity between the apatite-bearing veins of this district and that of Ontario was referred to, and also the striking parallelism between the constituents of the deposits here and in Norway. The minerals occurring in the Norwegian veins, as enumerated by Broegger and Reucsh,‡ are apatite, kjerulfin, quartz, orthoclase, albite, oligoclase (and albite, so-called Tschermakite), esmarkite, aspasiolite, scapolite, pyroxene, enstatite, hornblende, phlogopite, chlorite, talc? tourmaline, titanite, rutile, specular iron ore, titanic iron ore, magnetite, chalcopyrite, pyrrhotite, pyrite and calcite. In the Ottawa region the following have

* Can. Nat. and Geol., Old Series, Vol. VIII, p. 144.

† Quart. Journal Geol. Soc., Vol. XXXV, p. 145.

‡ Zeitschrift der Deutschen Geol. Gesellschaft, XXVII., s. 646.

been observed: apatite, quartz, orthoclase, albite, scapolite, pyroxene, hornblende, phlogopite, chlorite, prehnite, tourmaline, titanite, rutile? hematite, chalcopyrite, pyrrhotite, pyrite, calcite, fluorite, epidote, garnet, zircon, wilsonite, chabazite, sphalerite, molybdenite, graphite, galena. Of the minerals in the latter list several have not before been mentioned as constituents of the apatite-bearing veins of Canada.

Attention was called to the occurrence of interesting pseudomorphs of hornblende after pyroxene. The crystals are often of considerable size, and in some cases only partially, in others completely, converted into an aggregation of little hornblende prisms, constituting a sort of uralite. The change, so far as observed, begins at the surface of the pyroxene crystal and extends inwards. Other pyroxene crystals are interesting on account of the inclusions which they contain; scales of mica, for example, being sometimes arranged approximately parallel to the faces of the crystal. Some fine zircons have been obtained; one crystal from the township of Templeton being no less than $4\frac{1}{2}$ inches long, and the faces of the prism an inch across. The usual combination is ∞ P.P. 3P. 3P3. The hydrous silicate called chlorite in the above list is a dark green foliated mineral with a specific gravity of 2·61. It contains 12·5 per cent. of water, and is evidently a member of the chlorite group. The supposed albite has not been analysed, but from its physical and blowpipe characters there can be little doubt as to its being that mineral.

Principal Dawson then spoke of apatite from a geological point of view. He said the substance was a constant ingredient of the bones of all the higher animals. In answer to this demand we find it very widely distributed in nature, generally however, in small quantities. But in the Laurentian region it appears in large quantities, very irregularly distributed. As to the origin of the Laurentian apatite there are two theories. One is that it has been accumulated by animals which have passed away and left no trace of their structure. The other is that we have in the Laurentian rocks an original deposit of the mineral. He was, however, inclined to hold the former view, and thought there might yet be found some traces of the organisms of which it once formed a part.

During the evening specimens of the minerals mentioned by Dr. Harrington were handed round and carefully examined. A vote of thanks being tendered the President and Dr. Harrington, the meeting closed.

The second meeting was held on the evening of Monday, Nov. 25th.

Dr. T. Sterry Hunt addressed the meeting on "Geological notes of a summer tour in Europe." Among other things he called attention to the fact that European geologists were coming more and more to regard Canada as the land of the typical Eozoic rocks. He also stated that the animal structure of Eozoon was now pretty generally admitted by European scientists.

The third meeting was held on the evening of Monday, Jan. 27th. A. R. C. Selwyn, Esq., F.R.S., occupied the chair in the absence of Principal Dawson.

Six new members were elected, after which Dr. Edwards announced the subjects and dates of the Sommerville lectures for the present winter.

Mr. John B. Goode then read a paper on Canadian ferns, to illustrate which he exhibited his fine collection of native ferns. This paper we publish in full elsewhere. Mr. J. W. Tayler presented the Society with an Esquimaux bow and six arrows obtained from a settlement on the west coast of Davis Straits. The donor called attention to the fact that ancient sculptors represent the classic bow formed in the same manner as this; and that Apollo is represented as bearing an *ivory* bow constructed on the same principle. The bow is made of three pieces of reindeer horn, bound together with deerskin thongs. It is strung in the reverse way of its curve, an impetus being given the arrow, not from the spring of the horn, but from the elasticity of the thongs which bind the pieces together. The arrows are tipped with iron and winged with feathers of the Ger-Falcon.

Mr. Caulfield then exhibited the insects taken at St. Jerome on 1st June last, the Society's field-day. With one or two exceptions all are found in Montreal and vicinity. The following is a list:

COLEOPTERA.

Cicindela sexgutta, Fabr.	Aphodeus fimetarius, Linn.
" purpurea, Oliv.	Dichelonycha elongtula, Schon.
" vulgaris, Say.	Corymbites cylindriformis, Herbst
Calosoma calidum, Fabr.	Photinus curruscus, Linn.
Plutynus cupripennis, Say.	Tetropium cinnamopterum, Kirby.
Agonoderus pallipes, Fabr.	Asemum atrum, Esch.

Arrisodactylus discoideus, Dej.
" baltimorensis, Say.
Laccophilus maculosus, Germ.
Silphx peltata, Cates.
Attagenus megatoma, Fabr.
Ips fasciata, Oliv.
Cytilus varius, Fabr.
Onthophagus latebrosus, Fabr.
Aphodeus fosser, Linn.
Acmacop proteus, Kirby.
Lema trilineata, Oliv.
Labidomera trimaculata, Fabr.
Doryphora decemlineata, Say.
Galernca sagitturiæ, Gyll.
Disynyca alternata, Herbst.
Melandryœ striata, Say.
Hylobius confusus, Lac.
Tricalophus alternatus, Say.

LEPIDOPTERA.

Papilio Turnus, Linn.
" Asterias, Fabr.
Pieris rapæ, Linn.
Colias plilodice, Godart.
Pyrameus cardui, Linn.
" Attulanta, Linn.
Neonympha Eurytus, Fabr.
Lycæna Lucia, Kirby.
Chrysoplanus americanus, Harris.
Hesperia vialis, Edw.
Sessia diffines, Harris.
" Thysbe, Fabr.
Euchætes collaris, Fitch.
Eufidonia notataria, Pack.
Lozogramma defluata, Walk.
Tetracis lorata, Grote.

Mr Whiteaves remarked that of the plants found at St Jerome, four were rare species and had not yet been found on the Island of Montreal.

The chairman made some remarks in reference to the Paris Exhibition, and the Canadian Exhibit which excited wonder and surprise in the numerous visitors from all countries. Special mention was made of the gold octahedron, the huge mass of plumbago, the pyramid and tunnel of coal, and the representation of Canada's lumber wealth. The latter was a timber frame supporting a section of an immense British Columbian pine, placarded "This tree was at least 150 years old when Columbus discovered America."

Views of the Canadian Exhibit and pamphlets showing Canada's natural productions were passed round during the evening and carefully examined.

The fourth meeting was held on the evening of Monday, Feb. 24th. Principal Dawson occupied the chair. There was a large attendance of members and friends. The evening was spent in hearing a paper from A. R. C. Selwyn, Esq., F.R.S., director of the Geological Survey, on "The Stratigraphy of the Quebec Group and the older Crystalline Rocks of Canada," with a discussion on the same. Mr. Selwyn's paper, which we publish in this issue, was illustrated by maps, sections and specimens. A hearty vote of thanks was tendered to him for his able and exhaustive paper.

MISCELLANEOUS.

THE MOUND BUILDERS OF THE WEST.

Dr. Schultz, M.P., sends us the following, originally communicated by him to the *Free Press.*

"Sir,—Permit me through your columns to correct some of the current absurd rumors as to results obtained from excavations recently made for me in the county of Lisgar. Those of your readers who may have had occasion to travel the river road running through that county, will doubtless have noticed the circular elevation between it and the Red River, which occurs about three miles below St. Andrew's Rapids. From the river face of this mound the earth has, from time to time, fallen, and the bones and ornaments disclosed led to the conjecture that it was used as a place of sepulture for the dead of a race far more ancient than the "Ojibways" and "Crees" who lately, or the Assiniboine branch of the "Dakotahs" who formerly, occupied this country.

This mound is one of a group of half a dozen in the vicinity, which are interesting as being farthest north of any of the works of that curious mound-building race, who. for purposes of defence, sepulture, or worship, built the primitive earthworks which are found along the banks of the chief rivers from the Gulf of Mexico to the great lakes. From recent excavations, accidental disclosures, the observations of that careful observer, Hon. Donald Gunn, as well as excavations made by the Commandant at Fort Pembina last year, I am disposed to believe the mounds in this country to be all sepulchral in character, and to have been built by a race who came from, or at least bartered with, people of the far south, who possessd the art of making pottery, but had no acquaintance with the metals, a race of medium stature, with crania superior to that of the average Indian of to-day, and possibly to have been a smaller, weaker branch of the race, whose interesting relics of early constructive skill are found in such profusion in Ohio and Wisconsin.

The mounds here have been built near the dwellings of the builders, who employed fire to render them durable; the upper crust of the soil seems to have been removed and on the flattened clay floor an oven-shaped roof of the same material has been erected; inteuse heat being then applied gave consistency to the arched roof, and if sprinkled with sand would cause the vitreous appearance the roof and floor show. The dead, placed in rows, were in a sitting posture with the hands folded, and the face toward some cardinal point of the compass, food in earthen dishes before them, and upon them were hung their ornaments. There is, however, a curious absence of weapons, and the skulls show no sign of violence, though in the neighbouring fields stone hatchets and war clubs as well as flint arrow-heads have been found. The skeletons show no peculiarity of stature, but the crania differ widely from the Cree and Ojibway branch of the great Algonquin family now found here. The skull now before me is of average Caucasian size, and the well worn teeth show middle age as well as the nature of the food. The forehead, though somewhat narrow, is neither low nor receding, orbits well rounded, superciliary ridge low, malar bones only moderately developed, zygomatic arches slight, nasal bones prominent, occiput fairly rounded, and in other peculiarities differing from the typical Indian skull of living races. The ornaments consist of neck-laces formed of hollowed tubes of the soft stone used by the present Indians for pipes, and shells variously cut and pierced for earrings, some from their size suggesting breast ornaments. These shells are unlike anything found here, and similar ones sent by Hon. Donald Gunn to the Smithsonian Institute were of a kind fouud only on the shores of the Gulf of Mexico. The pottery, made apparently with clay of this country, was confined to simple forms, and the remains of food found in them were the bones of the beaver or some other small animal and the shells of the present river mollusks. None of this group of mounds seem to have been connected wrth others, and the surface appearance is the same with the exception, of course, that on some large trees are growing. Our own Indians have no traditions at all in regard to them, implements and ornaments are alike strange to them, and the practice of the present and preceding Indians was to dispose of their dead on elevated stages rather than to inter them.

Whence came they then, these quiet sleepers, who with fleshless palms crossed as in mute expectancy, might have slept on till the resurrection morn but for the curiosity which disturbed their rest? what has become of this mound building race, who, from the shadow of the Andes to this far north have traversed the continent? No one knows, and if in our efforts to find a solution of the problem in their tombs their spirits feel aggrieved at the desecration, they may find some comfort in the reflection that the graves of millionaires are equally unsafe in this, the day of our later and boasted civilization.

Prof. Edward S. Morse, we learn from the New York *Nation*, has written an interesting paper on the "Traces of an Early Race in Japan," which throws light on a subject hitherto wholly obscure. A race of men called Ainos are believed to have come down from Kamtchatka and to have taken possession of Japan, which they held until displaced in their turn by the Japanese from the south. Of the two races, the Ainos and the Japanese, authentic records exist; but nothing has been known concerning the ancient people whose territory was appropriated by the Ainos. The only knowledge obtained of them has been ingeniously acquired by Mr. Morse by a careful study of "shell-heaps" in all respects similar to those found along the shores of Denmark, New England, and Florida. The deposit discovered by Mr. Morse near Tokio contained pottery and broken bones, many of which were human. It is generally admitted by ethnologists that a people that has once acquired the art of pottery will always retain it; but as neither the Esquimaux, the Kamtchatdales, nor the Ainos are essentially earthen-pot-makers, these remains naturally point to the former existence of a race in Japan who preceded the Ainos. Again, both the human and the deer bones found in this shell-heap were broken in a manner to facilitate the extraction of the marrow, or to enable them to be placed in a cooking-pot, a circumstance which points to the existence of cannibalism among the people by whom the shell-heaps were made. On consulting Japanese scholars and archæologists, Mr. Morse learned that the Ainos were not only not cannibals, but were of an especially gentle disposition. The existence of an ancient race of cannibals in Japan before the occupation of that country by the Ainos is, therefore, made very probable. We hope to see another paper before long containg an account of Prof. Morse's later researches.—*Nature*.

A Gigantic Conularia of the Niagara Group of Hamilton, Ont.—In 1872, two large specimens of Conularia were found at Hamilton, Ontario, and since, a few fragments have been obtained. One of these was given to McGill College, some time since, by Dr. Spencer, of Hamilton, Ont., who has proposed the name *Conularia magnifica*. The larger of these two specimens measures nine inches in length, and at aperture about seven inches in width, gradually tapering to a rounded apex about an inch broad. The shell is flattened, but shows one of the quadrangular pyramidal sides, which is entire, and marked by a medial depression throughout the length ; on either side portions of two other sides are shown. The entire side shows a width, at greatest end, of four and three-fourths inches, gradually tapering to a rounded axis, where the converging edges meet at an angle of about 30 degrees. The surface is ornamented with numerous fine transverse costæ (about 50 in one-tenth of an inch towards the axis, while there are 90 in the same space towards the other end). The furrows between costæ are shallow. Numerous fine longitudinal furrows cross the costæ, leaving a papillose appearance. A complete description is promised shortly.

DEVELOPMENT OF FILARIA SANGUINIS HOMINIS, AND THE MOSQUITO CONSIDERED AS A NURSE.—Microscopists have discovered in human blood and in the blood of dogs, swarms of thread-like worms: these are the *Filariæ*. If they could grow and breed in the body in which they first appear, that body would soon die. "If, for example, the brood of embryo *Filariæ* at any one time free in the blood of a dog moderately well charged with them, were to begin growing before they had each attained a hundredth part of the size of the mature *Filaria*, their aggregate volume would occupy a bulk many times greater than the dog itself. I have calculated," says Mr. Manson, in a paper to the Linnean Society, "that in the blood of certain dogs and men there exist at any given moment more than two millions of embryos." Obviously this minute creature is a formidable parasite. Were it not that large numbers disintegrate and perish, or are voided with the secretions, having even been found in the tears, the natural function of the blood would be impossible.

Nature requires that for further development the *Filaria*, as well as other parasites, should enter some other body. Knowing that mosquitoes suck human blood, Mr. Manson made arrangements by which he captured a number of the insects which had gorged themselves on the blood of a filarious Chinaman who had been 'persuaded' to sleep in a mosquito chamber. On examining the insects by aid of the microscope, the subsequent development of the *Filaria* could be well made out : it passes through three stages, in the last of which "it becomes endowed with marvellous power and activity. It rushes about the field (of the microscope), forcing obstacles aside, moving indifferently at either end, and appears quite at home." Referring to the papillæ which, appearing at one extremity of the creature, are supposed to be the boring apparatus, Mr. Manson says : "This formidable-looking animal is undoubtedly the *Filaria sanguinis hominis*, equipped for independent life, and ready to quit its nurse the mosquito." And concerning the subsequent history of the creature he remarks that the *Filaria*, "escaping into the water in which the mosquito died is, through the medium of this fluid, brought into contact with the tissues of man, and that, either piercing the integuments, or, what is more probable, being swallowed, it works its way, through the alimentary canal, to its final resting place. Arrived there, its development is perfected, fecundation is affected, and finally the embryo *Filariæ* we meet with in the blood are discharged in successive swarms and in countless numbers. In this way the genetic cycle is completed."

It is in warm climates that the presence of these microscopic worms is most to be feared. In Brazil, Demerara, India, China, and other tropical countries, the existence of *Filaria* has been but too clearly made out, and that its presence is associated with painful and disgusting diseases, and "not improbably with leprosy itself." It is found too in Natal, in company with a noxious parasite of another kind. If, as is thought, there is some relation between the infested blood and certain epidemics, the question is one well deserving of careful study.—*Chambers's Journal.*

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ON THE ORIGIN OF SOME AMERICAN INDIAN TRIBES.

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After all the time and talent that have been devoted to the study of aboriginal American languages and antiquities, the materials collected, the societies formed for their investigation, the books written, it is disappointing to find that no one Indian tribe has been satisfactorily connected with any people of the Old World. This phenomenon is capable of explanation in one of three ways; either by the fact that the aborigines of this continent are autochthones; or, that they represent an ancient stock which has entirely disappeared from the older abodes of humanity; or, finally, by the imperfect and unscientific methods that have been employed in all attempts hitherto made to unite the populations of the two hemispheres. The first of these explanations is virtually contained in Agassiz' doctrine of Faunal Centres, no fewer than six of which he found in America. It accords with the traditions of some Indian families, for Dr. Oronhyatekha, a Mohawk, holds that all the Iroquois legends "teach that the red man was created upon this continent." Catlin, the artist and traveller, saw no necessity for showing that the aborigines of North America ever came here from any other part of the world; and Mr. Hubert Bancroft appears to hold similar views in regard to the native races of the Pacific States. The President of the Anthropological Society of Paris lately gave it as his dictum "that the Americans are neither Hindoos, nor Phœnicians, nor Chinese, nor Europeans; they are Americans." The Darwinian theory of the Descent of Man does not necessarily establish relations between the human inhabitants of the New World and those of the Old, yet Mr. W. H. Dall, in his remarks on the origin of the Innuit or Esquimaux, published in the first volume of Contributions to American Ethnology, writing from a Darwinian standpoint, is compelled to admit these relations. He says: "The fact that the home of the highest anthropoid apes is in Africa and also that of some of the least elevated forms of man; that we have none of the higher anthropoid animals, recent or fossil, in America, and none are known anywhere outside of the Asiatic and African regions, tells forcibly against any hypothesis of autochthonic people in America." The second explanation is that of Mr. Clements Markham in regard to northern, and of the Abbé Brasseur de Bourbourg in regard to southern families. The former holds that the Hyperborean Americans are the descendants of Siberian tribes, who within the historical period wholly passed over to this continent; and, according to the latter, the once civilized tribes at least of Central and South America are the remains of the mythic Atlantides, whose continent formerly extended from north-western Africa to the West Indian Islands.

Turning now to the third explanation, that, namely, which charges writers who have failed in their attempts to establish any relations between the populations of the Old World, on the one hand, and of America, on the other, with the use of imperfect and unscientific methods of investigation, it will be found thoroughly in accordance with fact. Careful and full induction is the only true, scientific method to follow in such an investigation; and this induction should regard, first of all, language in its grammatical processes and simpler verbal forms as well as in its relation to tribal, geographical and mythological nomenclature, then physical features, moral and intellectual character, religion, traditions, antiquities or arts, and manners and customs. It is not too much to say that these conditions of successful investigation have not been fulfilled in the case of the vast majority of writers on American origines. Their aim has generally been to prove the truth of a preconceived theory. Such were the attempts of Manasseh Ben Israel, Adair, Lord Kingsborough, and others, to establish the descent of the Indians from the Lost Tribes of Israel, who have lately found, on evidence as valuable, a nobler family of descendants. Such was the Welsh theory, which led Morgan Jones to find the descendants of Madoc's ill fated expedition among the Tuscaroras, and Catlin to detect them in the Mandans. Recently Mr. Lopez, in his Aryan Races of Peru, and Mr. Ellis, in his Peruvia Scythica, have devoted much learning and ingenuity to connect the civilization of the Incas with that of the Indo-European stock. Some of the relations which have been established between the American tribes and certain peoples of Africa, high Asia and the Indo-Chinese area, have been arrived at scientifically it is true, but one naturally asks for the missing link by which the Guanches of the Canary Islands, for instance, may be united with the Aymaras of Peru, or the inhabitants of Pegu, with the Aztecs of Mexico. Such hypotheses, on the one hand, and far fetched derivations, on the other, I seek to avoid in endeavouring to account for some of the American tribes as derived populations.

It is a common error to regard the Indians as members of one great division of the human family. Such a notion finds no support from a study of their languages, religions, customs, or physical and moral characteristics. It is true that most of the American languages are polysynthetic, not all however, but so varied is this polysynthetism that M. Lucien Adam, whose acquaintance with the Ural-Altaic languages specially qualifies him to express an opinion, finds it to consist essentially "in the affixing of subordinate personal pronouns to the noun, the post-position and the verb, a process which equally characterizes the Semitic languages, the Basque, the Vogul, the Mordwin and even the Magyar." To these he might have added many African, Polynesian, and Northern Asiatic tongues. As for that agglutination in connection with which polysynthesis takes place, it prevails more or less among all the branches of Turanian speech, and also in the Tagala and other Malay-Polynesian dialects. Very few American tribes justify by their complexion the name of "red-man," while outside of America may be found red Fulahs, red Kariens, red Koriaks, and many tribes of red Polynesians. In Canada the best known native stocks are the Algonquin and the Wyandot-Iroquois. The external resemblance between these two families arises from similar conditions, necessitating similar appliances and modes of life. Before they were subjected to the influences of civilization, in every other respect than that which a community of condition imposed, they differed *toto coelo* from each other. The Algonquin languages are radically distinct from those of the Iroquois, both in grammatical and in verbal forms. The flatter face, inferior stature, and more delicately formed extremities of the Algonquin are in contrast with the prominent features, the larger proportions and muscular development of the Iroquois. The Iroquois is preeminently a landsman, a warrior and a lover of manly sports, while the Algonquin loves the water, is unaggressive, and spends his spare time in idleness. Taciturnity, with all that it implies, such as the absence of humor, is characteristic of the Algonquin, but not of the Iroquois. The Iroquois was originally a sun-worshipper, but such the Algonquin never was. In fact these two families have nothing in common beyond the mere accidents of condition and certain minor features of life resulting from mutual intercourse. The Algonquin and the Iroquois, who have jointly contributed to the portraiture of the ideal red-man, are the representatives of two families as distinct as any that can be found outside of the Aryan and Semitic areas of the Old World.

In seeking the origin of the Iroquois and Algonquin families, language must be our chief guide, and first in language stand grammatical forms. There are three important differences in structure which separate Algonquin from Iroquois grammar. The former frequently makes use of prepositions like the Aryan and Semitic languages; the latter invariably employs postpositions, like the Turanian tongues. Thus in Cree, one of the most widely distributed Algonquin dialects, *tchik-iskutek* means "near the fire," *tchik* being the preposition "near"; but in Iroquois the same expression is translated by *ontchicht-akta*, in which *akta*, "near," is a postposition. The place of the temporal index in the order of the verb is a second distinguishing feature of the two grammatical systems. In the Iroquois the mark of time is final, although it is sometimes implemented by a prefix to the initial personal-pronoun; thus in *ke-nonwe-s* I love, *ke-nonwe-skwe* I loved, *wake-nonwe-hon* I have loved, and *enke-nonwe-ne* I shall love, *s*, *skwe*, *hon* and *ne* are the indices of present, imperfect, perfect and future time, *nonwe* being the verbal root and *ke* the pronoun. But in Algonquin the temporal index is, in the more important tenses at least, prefixed to the verbal root; so that in *nin gi-sakiha* I have loved, and *nin-ga sakiha* I shall love, *gi* and *ga* are the indices of the perfect and future respectively, *sakiha* the verbal root, and *nin* the personal pronoun. A third peculiarity of Algonquin grammar is that the accusative or direct regimen follows the verb. It is true that the same order appears frequently in Iroquois, but the principle of the latter group of languages, as exemplified in the case of pronominal accusatives, is, like that of neighbouring and allied American tongues, to place the verb after its regimen. As regards phonology, the difference between the Algonquin dialects and those of the Iroquois is well marked. The soft vocalic forms of the Ojibbeway, the Nipissing, the Cree, the Delaware, present a remarkable contrast to the more manly but harsh and guttural utterances of all the members of the Iroquois family. The first clause of the 35th verse, chap. 5. St. Matthew's Gospel, reads in Ojibbeway: "Kagoohween kiya ewh ahkeh; mesah ween ewh ootahkookahjegun"; but in Mohawk it is: "Nokhare ne oghwhentsyate, ne wahoene raouhha naah ne thoraghsidageaseraghkouh." It is true that within the Aryan area similar contrasts appear, as in a comparison of the Italian with the German, but in such cases the influence of climate is recognized, a factor which cannot enter into any comparison of the Algonquin with the Iroquois. Moreover the Algonquin dialects are in this respect, large as is the area they cover, completely isolated; for all the surrounding languages, as well as those which interrupt their continuity, bear a closer resemblance phonetically to the Iroquois than to them. Such are the Tinneh or Athabascan tongues that border upon the Algonquins in the north-west, the Dacotah or Sioux west of the Mississippi, and the Choctaw-Cherokee which originally formed their southern boundary. This isolation of language extends beyond the region of phonology into that of grammatical construction, for the three distinguishing peculiarities of Algonquin grammar, the use of prepositions, the preposition of the temporal index in the verb, and the postposition of the accusative, are neither Tinneh, Dacotah nor Choctaw. That these peculiarities are found west of the Rocky Mountains I know, but the extent of my knowledge does not at present justify me in dealing with the languages in which they appear.

In Central America there is an important family of languages known as the Maya-Quiché. It embraces the Maya of Yucatan, the Quiché and Poconchi of Guatimala, and the Huastec and Totonac of Vera Cruz. Of the Maya, Dr. Daniel Wilson, in his address before the American Association for the Advancement of Science, says, "It strikingly contrasts in its soft vocalic forms with the languages of the nations immediately to the north of its native area." Here then is the same phenomenon that is presented by the Algonquin languages. I do not propose to make the Mayas Algonquin, or the Algonquins Maya-Quiché, but simply to indicate their common relation to a parent stock. All the Maya-Quiché dialects use prepositions, and prepositions exclusively, while the surrounding languages, Aztec, Mixtec, Pima, Tarahumara, &c., employ postpositions. The Quiché verb again is the precise analogue of the Algonquin, the only difference being that the pronoun, instead of occupying an initial position, intervenes between the temporal index and the root. Thus in *ca-nu-logoh* I love, *xi-nu-logoh* I have loved, and *ch-in-logoh* I shall love, *ca*, *xi* and *ch* are the indices of present, past, and future time, *xi* and *ch* being the equivalents of the Algonquin *gi* and *ga*, or better still of the Cree *ki* and *ka*. In Maya also the accusative seems to follow the governing verb as in Algonquin. There is, however, in these languages an important syntactical peculiarity which does not appear in Algonquin so far as is known to me; it is the postposition of the genitive. Thus in Maya, *upoc Pedro* "the hat of Peter" reverses the order of the Iroquois, Dacotah and Choctaw, which is that of the English "Peter's hat." The Algonquin dialects follow the latter order, and it may fairly be asked whether this be not a result of surrounding influences rather than one of the original forms of Algonquin speech. Apart from this, however, there are, in the use of prepositions, the preposition of the temporal index and the postposition of the accusative, together with phonetic coincidence, links sufficient to ally the Algonquin with the Maya-Quiché languages.

The next great family of languages which employs prepositions is found in La Plata and Paraguay on the Gran Chaco, and is known as the Mbaya-Abipone, including the Mocobi, Toba, Lengua and other dialects. Here again we meet with "soft vocalic forms," contrasting more or less with the manlier utterances of the Peruvian and Chileno tribes, who almost invariably employ postpositions. The verb again is essentially the same as that of the Quiché, the pronoun intervening between the temporal index and the root; thus in *ne-ya-enagui* I came, *de-ya-enagui* I shall come, *ne* is the index of past and *de* of future time. But in the neighbouring Peruvian and Chileno languages the temporal index follows the verbal root as in Iroquois, Dacotah, &c. Of the positions of the accusative and genitive in this family I am not able to speak. It is worthy of note, however, that in Mbaya the adjective follows the noun it qualifies, while in the Maya-Quiché and Algonquin languages it precedes, as in the majority of American tongues. The identity in form of the Mbaya and the Quiché verb, a form in itself so peculiar and differing so widely from those of nearly all other American languages, is the main link uniting the earlier fortunes of the Mbaya-Abipone family with the Maya-Quiché and the Algonquin.

Turning now from America, where can the philologist discover a language or group of languages that will satisfy the grammatical conditions of the prepositional American family in comparison? Such language or languages must be soft, abounding in vowel sounds, must employ prepositions, must set the temporal index before the verbal root, and, if we take the Quiché and Mbaya as typical, must also make it precede the pronoun before the root, must postpone the accusative to the verb, and probably the genitive to its governing word and the adjective to its noun. These conditions are numerous enough to satisfy the most exacting critic. I do not profess an exhaustive acquaintance with the grammatical systems of the Old World; but, after a survey of the most important of these, I find one that does fulfil all the conditions, and only one. It is that of the Malay-Polynesian languages, which cover the vast area from Malacca to New Zealand, and from Malagascar to the Sandwich and Easter Islands. Every one who has ever heard of these languages knows that they carry the palm for soft, liquid sounds over all other tongues. They use prepositions, and prepositions exclusively. Their verb is identical in structure with that of the Quiché and Mbaya. Take, for instance the verb "to make" in the language of the Tonga or Friendly Islands, which is *gnahi*, and compare it with the corresponding Mbaya verb *yoeni*: the Tongan *ne-oo-gnahi*, I made, and *te-oo-gnahi*, I shall make, are not simply analogous to, but identical with the Mbaya *ne-ya-yoeni*, *de-ya-yoeni*. In the case of the accusative, *na-ia-gnahi he togi*, "he made axes," is a Tongan sentence exhibiting its position after the verb in the Malay-Polynesian languages, thus furnishing a fourth point of agreement between these languages and the prepositional American forms of speech. The nominative was found to precede the genitive in the Maya-Quiché, and this is its position in the Tongan, as in *tama he matabool*e, "the child of the chief." Finally, in Mbaya the adjective follows the noun, and the Tongan *he tangata lille*, "a man good," shows that it is thus in accordance with Malay-Polynesian order. There are many other resemblances uniting the two groups thus compared, such as the absence of gender and the substitution for it of a distinction between nouns as animate and inanimate, the employment of the first person plural in an exclusive and in an inclusive form, the formation of derivative nouns, etc.; but, as these are common also to many Turanian languages of Asia, they do not aid in determining the origin of Algonquin, Maya and Mbaya speech.

The grammatical forms of the three American families under consideration being proved Malay-Polynesian, and no other languages in any kind of geographical relation to America, whether in Eastern Asia, Western Europe and Africa or the Papuan and Australian areas, presenting anything analogous to them, it is to be expected that they should be confirmed by equally close lexical resemblances. The limits of this paper will not permit me to set them forth at length, and I must, therefore, refer the reader to my vocabularies published in the *Canadian Journal*. But a few may serve to indicate how close these resemblances are :

	Algonquin.	Malay-Polynesian.
man........	linnou *Delaware*, ilenni *Shawno*,	lanan *Java*, ulun *Malagasy*,
	renoes *Sankikani*, nemarough *Virginia*,	remau *Amblaw*, maroka *Gilolo*,
	ethini, eyinew *Cree*,	tane *Tahiti*, ohana *Tonga*,
	menapema *Miami*.	mondemapin *Gani*.
woman......	weewan *Ojibbeway*, wewimow *Cree*,	wewina *Teor*, wahine *Sandwich*,
child........	enese *Narraganset*,	anak *Malay*, &c.
	pappoos *Piankashaw*,	bibigi *Tonga*,
boy.........	necovis *Micmac*,	ngofa *Tidore*,
	bawtoos "	budak, *Malay*,
	unquece "	anak "
girl.........	epidek "	opideka *Galela*,
head........	wile *Delaware*,	ulu, *Malay* &c.
	wilan *Shawno*,	ilon *Malagasy*,
	uppa *Algonquin*	oupoko *New Zealand*.
mouth......	madoon *Penobscot*, mitoon *Cree*,	moudoo *Tonga*, motoo *Mariannes*,
	namadthun *Bethuck*,	numatea *Amblaw*.
tongue......	weelauloo *Penobscot*,	ileeloo *Tonga*,
	otaineni, *Ojibbeway*.	tumoma *Matabello*,
tooth........	nibit *Algonquin*, wipit *Delaware*,	niffi *Malagasy*, afod *Gani*.
nose........	yoch *Ojibbeway*,	iuka *Morella*,

	Algonquin.	Malay-Polynesian.
eye	miskichi *Cree.*	massou *Malagasy.*
ear	touwango *Penobscot.*	tayinga *Tagala.*
hand	niligee *Shawno.*	ngalan "
	nachk *Delaware.*	ingoa *New Zealand.*
foot	kussie *Shawno.*	kakee *Malay.*
black	kusketa *Cree.*	kokotu *Tidore.*
	mokkum *Algonquin.*	moitomo *Bolanghitam.*
white	wabi *Algonquin*, wompi *Natick.*	babut *Ahtiago*, umpoti *Cajeli.*
red	mik *Cree.*	mia Sula.
bad	mattik *Nanticoke.*	maduki *Bouton.*
good	wulillisiwi *Delaware.*	weel *Pelew.*
	meyoo, mithoo *Cree.*	mai *Lariki*, maitai *Tagala.*
butterfly	kwakwapisew "	kupukupu *Malay.*
axe	togkunk *Algonquin.*	togi *Tonga.*
canoe	wuskiwoose, oot *Cree.*	wog *Gani*, oti *Tidore.*
bow	uchape, *Cree.*	jobi-jobi *Tidore*, djub *Sula.*
bread, food	meechim "	macunnan *Malay.*
grass	muskoose "	moochie *Tonga.*
sky, heaven	heyring *Shawno.*	harani *Sandwich.*
nut	pukan *Cree.*	pooe *Pelew*, beequee *Malay.*
sleep	nebat *Micmac.*	moopat *Pelew.*

	Maya-Quiche.	Malay-Polynesian.
axe	baat *Maya.*	peda *Sula*, &c.
bad	ilil *Maya*, tsiri *Poconchi.*	ollo *Java*, atoro *Galela.*
belly	pam *Quiche.*	pompon *Salayer.*
break	pax "	fachi *Tonga.*
body	cucut *Maya.*	gete "
fight	tock "	tow "
bow	pimp "	panna *Malay.*
come	pet *Quiche.*	paituco *Baju.*
ear	leexicen *Maya*	likan *Ahtiago.*
good	alhua *Huastec.*	alla *Baju.*
head	hol *Maya.*	ulu *Malay.*
heaven	taxah *Poconchi.*	tahua *Marquesas.*
leaf	lu *Maya.*	lo *Tonga.*
man	illauh *Huastec.*	lelah *Baju.*
neck	kay *Maya.*	gia *Tonga.*
night	agab *Quiche.*	gubie *Bolanghitam.*
rain	chuluhaa *Maya.*	kull *Pelew.*
skin	keuel "	koli *Sula.*
small	mehen "	mahe "
star	ghumil *Poconchi.*	umali *Camarinn.*
flower	lol *Maya.*	lelum *Sanguir.*
ant	zinic "	singa *Teor.*
frog	xtutz "	codae *Malay.*
fly	xlem *Quiche.*	kelang *Mysol.*
bone	bak "	buko *Sanguir.*
saliva	tub *Maya*, chub *Quiche.*	tefoo *Mysol*, kivi *Gilolo.*
shoe	xahab *Quiche*, chanal *Maya.*	guiapoo, quenella *Malay.*
pot	cucul *Maya.*	quell *Pelew.*

	Mbaya-Abipone.	Malay-Polynesian.
boy	yonigi *Mbaya.*	anak *Malay* &c.
child	niganigi "	inianak *Ceram.*
earth	alobo *Mocobi.*	lupa *Tagala.*
	iigodi *Mbaya.*	tougoutoo *Tonga.*
eye	natocle *Abipone*	matacolo *Ceram.*
face	natobi *Mbaya.*	nangabio *Gilolo.*

Mbaya-Abipone.	Malay-Polynesian.
fish ....noay *Mocobi.*	nau *Gilolo.*
moon.........epenai *Mbaya.*	bouan *Tagala.*
tongue ....noqueligi "	nangaladi *Gilolo.*
white.........yalaga *Mocobi.*	kuloh *Celebes.*
name ....oonagadi *Mbaya.*	hingoa *Tonga.*
come.........enagui *Mbaya*, anac *Toba.*	inokere *Tidore*, maika *Celebes.*
food.........gecenique "	genanga *Tonga.*
make ....yoeni "	gnahi "
bad ....beagi "	behei *Amblaw.*
day ....nagata *Mocobi.*	hangat *Bouru.*

The poverty of my collection of Mbaya-Abipone words places the comparison of these dialects at a great disadvantage as contrasted with the Algonquin and the Maya-Quiché, although I must confess that even in my short vocabulary many terms appear which have no corresponding forms among the Malay-Polynesian languages known to me, but exhibit decided evidence of a Turanian origin. Similar words occur in the Maya-Quiché and Algonquin vocabularies, and may be the result of admixture on the part of the peoples employing them with other American tribes of Turanian derivation. Thus *naccuta*, the Mocobi word for "hair," is Aymara Peruvian, Kadiak and Asiatic Tchuktchi, languages whose grammatical structure is totally different from that of the Mbaya-Abipone.

Language naturally leads to mythology and religion in such an enquiry as this. According to Sir John Lubbock and Mr. Tylor, the Polynesians do not worship the heavenly bodies. I do not know whether this is the case with the Mbaya-Abipone family or not, but solar worship had at least no prominence among the Maya-Quichés, and was unknown among the Algonquins before the adoption of the Delawares into the Iroquois confederacy. On the other hand, the Dacotahs. Iroquois, Choctaws, Natchez, Mexicans. Peruvians, Muyscas and Chilenos were sun-worshippers. The heaven of the latter peoples was supposed to be continental, happy hunting grounds in some distant region, or it was celestial above the clouds: but the Algonquin heaven was. like that of the Polynesians. an island in the ocean. The Abbé Maurault, in his Histoire des Abénaquis. says: "Ce Grand-Esprit résidait sur une île du grand lac (l'Océan Atlantique)." In this we find an evidence of insular derivation. The same appears in the story of the creation of the world. Maui of New Zealand, with whom Mr. Tylor compares the Algonquin Manitou or Monedo, fished up the earth with a hook from the universal ocean, as did Tangaloa of the Friendly Islands. The Quiché Tohil, Tzakoll or

Tockill, who is undoubtedly the Malay-Polynesian Tangaloa or Tagala, according to the Popol Vuh or sacred book of the Quichés, called the earth into being in a similar waste of waters. The Ojibbeways and Delawares tell an identical story of Manitou; while other Algonquin tribes make the rat his agent in the work of creation. The notion of the Ojibbeways of Lake Superior that they inhabited an island, and their habit of alluding to the American continent as such, seemed surprising to Kohl, the traveller, who imagined it to be the result of knowledge acquired by exploration, instead of a necessary result of their system of cosmology. In their un-Darwinian account of the origin of man the Malay-Polynesians, Algonquins and Maya-Quichés agree. The Tagalas of the Philippines believed that "mankind sprang out of a large cane with two joints, and the man came out of one joint and the woman out of the other." In Samoa the tradition is that the first land brought forth wild vines, and from the worms which developed when they rotted men and women were produced. According to the Delawares, Manitou, having brought up the first land from the ocean, made man and woman out of a tree; and, in one of the Ojibbeway legends in Kitchi-Gami, the first man appears among the reeds which Manitou had planted upon the shore. Compare these with the Quiché legend, in which "man was made of a tree called *tzite*, woman, of the marrow of a reed called *sibac*," and there appears an agreement in tradition to which I know of no parallel. I have already stated that the Quiché or Maya-Quiché Tockill is the Polynesian Tangaloa and the eponym of the Tagalas in the Philippines This is confirmed not only by the identity of the Tagalan and Quiché accounts of the creation of man, but also by the appearance of the Quiché deity Bitol in the Tagalan Bathala, just as the Algonquin Waubuno reappears in the Polynesian Ofanu. The Algonquins, Quichés and Abipones agree with some Polynesian peoples in identifying the soul with the shadow; and Mr. Tylor, in his Primitive Culture, draws special attention to "the conception of the spirit voice as being a low murmur, chirp or whistle, as it were the ghost of a voice," a conception common to the Polynesians and the Algonquins.

Space or rather the lack of it precludes my saying anything of the physical and moral characteristics of the Algonquins, Maya-Quichés and Mbaya-Abipones, as compared with those of the Malay-Polynesians. I may simply refer the reader who has any acquaintance with these features in the American tribes under consideration to the sketch of Malay physique and morale in Mr. Wallace's Malay Archipelago, which I have transcribed in part in my article on the Affiliation of the Algonquin Languages in the *Canadian Journal.* It will, I think, be found equally applicable to the American tribes of Malay-Polynesian origin. Before quitting the field of language, however, I should mention that the name of the Delawares, the most prominent originally of all the Algonquin tribes, finds not indeed its counterpart, but its parallel, in the Malay area. It consists in the prefix of the word meaning man, Lenni, to the tribal designation Lenape. So we find Malay tribes calling themselves Oran-Benua, Oran Malaya. Let the Javanese Lanan take the place of the Malay Oran, and the analogy is complete. Of manners and customs I may select one, the Couvade, which Butler, in his Hudibras, thus describes :

"Chineses go to bed
And lie-in in their ladies' stead."

This singular practice prevails among the Abipones, but is so far from being peculiar to them that it is found also in Bearn, Congo and Southern India. It is not, therefore, a distinctive mark of ethnic relationship; but, on the other hand, it can interpose no obstacle to the origin which has been claimed for the Abipones, inasmuch as the practice obtains largely among the Malay inhabitants of Borneo, from whose stock the Abipones may have received it. If it be asked whence the Maya-Quichés derived their architectural knowledge and skill, the massive stone structures of the Malay Archipelago, of the Marquesas, Navigators, Easter and Sandwich Islands may give reply. But if the question be, Whence came the snowshoes, the skin dress, the quill ornamentation, the birch canoe, the calumet and the scalping art of the Algonquins? the answer must be, From Northern Asia, where all of these now are or once were found. The Malay immigrant became perforce a borrower and a learner by his change of condition from the circumstances of a tropical and insular to those of a cold or temperate continental home. Athabascans, Dacotahs and Iroquois from Northern Asia taught him their arts of peace and war; but his character, his physical features, his language and his religion he had no need to change, even where he had the power, for they can flourish as well amid the snows of Labrador as under the burning skies of the Indian ocean.

How came the Malay to America? Dr. Pickering, in his Races of Man, replies: "In attempting from any part of Polynesia to reach America a canoe would naturally and almost necessarily be conveyed to the northern extreme of California; and this is the precise limit where the second physical race of men makes its appearance." The same writer holds that "if any actual remnant of the Malay race exists in the eastern part of North America, it is probably to be looked for among the Chippewas (Ojibbeways) and the Cherokees." The judgment of Dr. Pickering, founded upon observation of physical features, led him to sound conclusions in the case of the Algonquin Ojibbeway, but was misleading in the extreme in that of the Cherokee, who is a Turanian of the Turanians. Where the Maya-Quichés and the Mbaya-Abipones landed it is hard to say, but in the case of the former there seems to be historical evidence from their own traditions that they once dwelt considerably to the north of their Central American home. The Quiché mythology appears to link the Malays of Yucatan and Guatimala with the Tagalas of the Philippine Islands; and if, as Dr. Pickering says, "San Francisco is commonly regarded in Mexico as being on the route to Manilla," we should find the landing place of the Maya-Quiché colonists at some point on the Northern Californian Coast. There or farther north, probably in Oregon, where Dr. Pickering finds his "second physical race of men," we should place the beginnings of Algonquin life in America. What part of the Malay-Polynesian area they originally came from I am not yet in a position to say; but that it was a Malay rather than a Polynesian region seems evident from the forms *lenni*, *linnon*, *ilenni*, *alnew*, *renoes*, *etc*, denoting man, forms which refer the ethnologist to Java, Borneo and the Moluccas group. In the Illinoans, a tribe of Borneo, we may even find the parent stock of the Algonquin Illinois, who have given their name to one of the United States. From Borneo or some neighbouring region where Papuan influences have more or less corrupted the verbal forms of Malay speech, the Mbaya Abipones must have started for the Western, but to them Eastern World.

I have already stated that my knowledge of the tribes west of the Rocky Mountains hardly justifies me in taking them into account in this discussion of origins. There is one Oregon family, however, that helps to carry the line of Malay migration across the continent, to which I must briefly refer. With the Sahaptin or Nez Percé grammar I have not yet had opportunity to become acquainted. Dr. Latham regards them as the first of the Oregon tribes in point of culture, as in physical appearance more like the Indians east of the Rocky Mountains than any others in the same area, and mentions the fact that the more eastern of them have crossed that great natural barrier into the buffalo region, where they have become hunters, like the neighbouring Algonquin Blackfeet and Shiennes. In the Sahaptins I believe that the link is found uniting the Algonquin stock with the Pacific. Language, however, must be the first test. The number 2 in Cayuse, a Sahaptin dialect, is *leplin*, a form so peculiar that in a collection of over six hundred vocabularies the only one with which I can compare it is *leplu* of the Gani, a language of the Moluccas group. The same formation in *lep* appears in the number 7, *noilip* in Cayuse, but *lepfit* in Gani. Otherwise the Sahaptin numerals have miscellaneous Malay-Polynesian affinities: the Sahaptin *mitat*, 3, connecting with the Paumotuan *neti*, and *reti* of the Isle of Pines, which latter language gives *tahue* as the equivalent of the Cayuse *tawit*, 5, and *noibeti* as that of the Cayuse *noimat*, 8, while the Cayuse *piping*, 4, and *noina*, 6, are represented by the Javanese *pappat* and *nannam*. In the ordinary vocabulary most of the Sahaptin words are found to relate to those of the dialects of Celebes, Ceram, Gilolo, Bouru and other islands of the Moluccas. Thus, dog, which is *mantal* in Williamet, and *naapang* in Cayuse, is *muntou* in Celebes, and *nawang* in Ceram; man, which is *iniaw* in Wailatpu, and *keewas* in Sahaptin, is *anow* in Gilolo, and *gebba* in Bouru. Knife is *tekek* Sahaptin, and *shekt* Cayuse, and in Ceram the same forms appear as *tuka* and *seite*, while *wals*, another Sahaptin term for the same object, meets us in *oyless* of the Pelew Islands, which would naturally be one of the earlier stages in the north-eastward progress of the Malay emi-grants. Mouth is *mandi* in Williamet, *him* in Sahaptin, and *shumkakoh* in Cayuse, forms which appear in the Tongan *moudoo*, the Teor *huin* and the Javanese *saukum*. The Williamet *hammeih*, house, is the Bouru *huma*; the Klikitat *wassas*, canoe, the Gilolo *wog*; the Williamet *umpium*, day, the Celebes *unuceno*, and *umhok*, flesh, in the same dialect, the Celebes *untok*; while *tshal*, another Williamet word denoting the colour red, is the Gilolo *desoella*. Peculiarly Malay-Algonquin forms are the Sahaptin *bipi*, white, and the Williamet and Cayuse *puti* and *tenif*, tooth, which find their analogues in the Ceram *babut*, the Gilolo *afod* and the Ceram *nifan*. Two peculiar cases of inversion are presented in the Williamet *tshita-pinna*, girl, and *man-tsal*, river, which in Wahai, one of the Ceram dialects, are *pina-hieti* and *tolo-maina*. For further examples I refer to my comparative vocabularies in the *Canadian Journal*, as those stated are amply sufficient to establish a connection of the Sahaptin family with the Malays of the Moluccas group.

In this sketch I have not been able to fulfil all the conditions of perfect induction, but sufficient evidence. has, I think, been adduced to make a case worthy of fuller investigation. The theory of a Polynesian migration to America is one that has been long and generally held, but held in so loose and indefinite a way that it has been barren of ethnological results. The Rev. Richard Garnett has indicated the presence of Polynesian grammatical forms in South America, but has vitiated his comparison by dragging into it the Dravidian languages, which are Turanian as distinguished from Malay. Now, if an American language can be proved Malay in origin, it is thereby cut off from all Turanian connection, for the two systems are radically different. Dr. Edkins, of Pekin, recognizes the distinction, and finds that "on the American continent Turanian and Polynesian linguistic principles meet in the various Indian languages; but so far is he from allowing the relationship of Turanian with Polynesian that he maintains "a Polynesian immigration from the Ocean and a Turanian immigration by the Aleutian Islands and by Iceland and Greenland, which united to form the population of the American continent." Still, like Mr. Garnett, we find Dr. Edkins looking for his Polynesians in South America and in Mexico. If the Mexicans and Peruvians be Polynesians, they are Polynesians with Turanian grammar, vocabulary, religion and arts, and consequently ethnology as a science, on American ground at least, is impossible. Again Dr. Edkins seems to say that in individual American languages Turanian and Polynesian principles meet. This is true to a certain extent, as we have seen in the case of the languages of Malay-Polynesian origin, which, intruding into a Turanian region, could not fail to be partially, but very partially, influenced by their surroundings. Some Polynesian principles may perhaps be detected in the Iroquois dialects, though of this I am not sure. I can find none in the Tinneh, the Dacotah, the Choctaw or the Peruvian; they are essentially and exclusively Turanian.

Let it be granted that the Malay origin of Algonquins, Maya-Quichés and Mbaya Abipones, with Sahaptins, is established, and a foundation is laid for a history of aboriginal America. Javanese, Moluccan and Tagala traditions may be found to check and supplement those of the Algonquins, Sahaptins and Maya-Quichés; and, as the geologist settles the relative ages of his formations by their fossil remains, so words may enable us, in similar grammatical strata, to fix the various periods of Malay migration to this continent. I reserve the consideration of the Turanian American languages for another occasion.

ON SOME POINTS IN LITHOLOGY.*

By Prof. James D. Dana.

(*From the American Journal of Science.*)

4. *Containing Quartz or not.*—Since quartz is the most universal of the materials of rocks, its presence is least entitled to be made a basis for distinctions among them. In sedimentary deposits, the original of many of the crystalline kinds, it is a very common ingredient owing to their mode of origin, and its more or less abundance is a matter of no great geological importance. Sufficient reasons exist, therefore, for the course pursued by recent writers on lithology in making the presence or not of quartz even in crystalline rocks a basis only for a subdivision under a *kind* of rock. Thus there is under dioryte, *quartz-dioryte*; under trachyte, *quartz-trachyte*; under felsyte, *quartz-felsyte*; and so in other cases.

Syenyte is defined by such authors as consisting chiefly of orthoclase and hornblende. Now a rock made prominently of these minerals often contains also quartz; and the name for the quartz-bearing kind, which a system of lithology using the above-cited terms would seem to require, would be *quartz-syenyte*. To call it "hornblende-granite," as is often done, is at variance with the system which uses the word *quartz* as an affix in other cases.

This term "hornblende-granite," is at variance also with the fundamental idea and nature of granite. Granite is eminently

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* Continued from page 48.

a potash-bearing rock. The feldspar is a potash-bearing species; and the mica, whether muscovite or biotite, yields on analysis little less potash than the feldspar, the amount being eight to twelve per cent. These two micas are both present in most granite, gneiss and mica schist: and they are so near akin that they sometimes occur combined in a single crystal—the presence of a little iron in the original material having apparently determined the formation of the latter where it occurs. On the contrary the hornblende of such rocks contains usually less than one per cent of alkalies, and rarely in any kinds over five per cent. Looking to chemical and mineralogical constitution—the true criterion as to identity among rocks—the strongly drawn line is between the mica-bearing series and the hornblende-bearing series. Granite belongs to a *mica* and *potash-feldspar series*; and syenyte, whether quartzless or quartz-bearing, to a *hornblende* and *potash-feldspar series.*

Moreover, the original syenyte, from Syene, Egypt (to which the name "syenites" was applied by Pliny and other ancient writers) is a quartz-bearing "syenites." The larger part of the syenyte of all Archæan regions is quartz-bearing. The quartzless kind is seldom met with in Eastern North America, or, as far as explored, in the Rocky Mountain region. There are hornblende granites; but these are granites which contain hornblende *in addition to* the mica and other ingredients.

Transitions are common between granite, hornblende-granite and quartz-bearing syenyte; but they are so also between these and quartzless syenyte, between syenyte-gneiss and ordinary gneiss, between hornblende schist and mica schist, and between these and other rocks. They are throughout lithology a source of difficulty in characterizing kinds of rocks, as already stated. But they do not set aside the fact that the division between the mica and potash-feldspar series and the hornblende and potash-feldspar series is the most reasonable on mineralogical and chemical grounds.

5. *Containing "Plagioclase."*—The fact that the composition of the triclinic feldspars between the extreme species albite, a sodium-aluminum tersilicate, and anorthite, a calcium-aluminum bisilicate, may be explained by supposing them combinations of these species through isomorphous substitutions of the tersilicate and bisilicate (the amount of sodium present determining the amount of tersilicate in the combination, and the

amount of calcium that of bisilicate) was immediately followed by the assumption that these two silicates combined *indefinitely*, and, therefore that all the triclinic feldspars were essentially one species, and for this reputed species the name *plagioclase* has been used. Some ground for the assumption was found in the analyses of the feldspars; but how much was uncertain, because, in several cases, *mechanical* mixtures of one species with another had been ascertained to exist in crystals. Now that Des Cloizeaux has proved, by optical investigations, that several of the species of triclinic feldspars are really species, that is, that the combinations of the two silicates, the tersilicate and bisilcate, are based on *definite* ratios, as in combinations in other departments of chemistry, and that there are not indefinite blendings, the term "plagioclase" has become merely a synonym for "triclinic feldspar."

The consequences to lithology of this introduction of the term "plagioclase" were unfortunately great. It was made a sufficient definition of a rock to say that it consisted of "*plagioclase* and hornblende," "*plagioclase* and augite," and so on; and this is now common in recent memoirs on rocks. It was a convenient idea; for an examination with the microscope is made in a hundredth part of the time required for a chemical analysis.

Now this word "plagioclase" covers compounds varying in the silica afforded by analyses from 43 to 69 per cent.; and in the alkali from all lime (20 per cent.) to all soda (12 per cent.) Anorthite, the lime feldspar, is not oligoclase, even if to the two a common name be applied; they still differ 20 per cent. in silica (which is one-fifth the mass), and also in the alkali present. Expressions like "consisting of plagioclase and hornblende," as in the definition of dioryte, have consequently an immensely wide signification; for the word dioryte is made to cover oligioclase-dioryte, labradorite-dioryte, and anorthite-dioryte.

This confounding of things thus unlike may be called simplifying the science of lithology; but it is a confounding of important distinctions in the view of those who are interested in a definite knowledge of rocks, and in the important geological questions connected with their constitution. Some lithologists recognize the bearings of such questions, and use the qualified terms for the kinds of dioryte above cited. But the most recent turn is in the other direction. Rosenbusch's learned work, the latest, says that the rocks of the "family" of diabase consist of "plagioclase and augite," and that the feldspars, oligoclase, labradorite and anorthite have been observed in them. Dioryte is defined as a "family" of older rocks consisting essentially of "plagioclase and hornblende." Had the different *kinds* of rocks embraced in these families been separately stated and described, the account might have been satisfactory. But, under both diabase and dioryte, the term "plagioclase" is used as if sufficiently defined in itself, and under dioryte it is given with its aggregate signification alone, no mention being made of the particular feldspar the dioryte of different localities contains. *

If a dioryte happens to be porphyritic, it is at once put into the grand division of dioryte porphyry, when the only distinction may be that the feldspar is in defined crystals, the chemical and mineralogical constitution being identical. But if the feldspar of one dioryte contains twenty per cent. of silica more than another and no soda at all, it is still all dioryte.

In geology, it is essential to a thorough study of the questions it has before it that the kinds of feldspars should not be massed under a common name, and that in every case the investigation should be considered unfinished until not merely the amount of silica in the rock is accurately ascertained, but also the particular species of feldspar is correctly and fully determined, however great the labor required to reach a conclusion. The use of the term *plagioclase* in such a case is an acknowledgment of incomplete work, and should be so treated.

But the objection to the use of the term "plagioclase" is still stronger than has been stated. It now includes not only the soda-lime feldspars from anorthite to albite inclusive, but also part of *potash*-feldspar. The establishment on an unquestionable basis, of Breithaupt's *microcline* by Des Cloizeaux, and his further observations that this triclinic potash-feldspar is a very common mineral, much of what was supposed to be orthoclase belonging to it, has extended the range of "plagioclase," until it is now almost an equivalent of the general term feldspar, so that "*plagioclase* and hornblende" has, as to chemical constitution, the same signification now with *feldspar* and hornblende.

* It should be here acknowledged that Rosenbusch's very valuable work bears the title "Mikroskopische Physiographie der massigen Gesteine," so that it does not claim to cover the subject of the chemical or mineralogical constitution of rocks.

6. *Rocks consisting of a triclinic feldspar and mica.*—The term dioryte, formerly defined as a rock consisting of oligoclase or albite and hornblende, has been introduced into the the name of a series of rocks containing no hornblende, but mica instead. Thus: "*mica dioryte*" is defined as a "plagioclase-mica rock" in which mica is substituted partly or wholly for hornblende, and it is called mica-dioryte whichever of the triclinic feldspars be present, even if anorthite. This change in the use of the name dioryte so as to include a rock containing no hornblende. makes "plagioclase" the essential constituent, and places mica and hornblende in a subordinate position, as the heads only of subdivisions.

The remarks made respecting syenyte apply equally here; and also those respecting "plagioclase." A mica-dioryte is like granite, eminently an alkali-yielding rock, the mica (biotite) affording usually ten per cent of potash; and as granites often contain oligoclase as well as orthoclase, the amount of potash and soda in a "mica-dioryte" and a granite may not be very widely different. Dioryte, on the contrary, is prominently a hornblende rock.

Looking to the mineralogical and chemical constitution of the rocks, we are naturally led to recognize alongside of a mica and *potash-feldspar* series, which is headed by granite, also a mica and *soda-lime feldspar* series, and to include in the latter the so-called mica-diorytes.

7. *Hornblendic or Augitic.*—Hornblendic and augitic rocks stand apart as a general thing in all systems of lithology. Yet the minerals are essentially identical in chemical composition, and related in crystallization, though different in their occurring crystalline forms and in the angle of the cleavage prism. The identity in composition is so close that chemical analysis is not able to distinguish them. Hence the related eruptive rocks of the hornblendic and augitic series (or those containing the same species of feldspar in like proportions) must have originated in material of essentially the same chemical composition. The relation between the two minerals is thus far closer than between the triclinic species of feldspars.

Nevertheless, too much importance is not given them when each is made distinctive of an independent series of rocks; for the very wide extent to which augitic rocks retain unvaryingly their augitic characters—such rocks constituting full two-thirds of the earth's eruptive masses—shows that the special conditions producing augite, instead of hornblende, whatever they are, have often acted on a vast scale in the earth's history. And so, also, the very wide distribution of hornblendic rocks, especially among the metamorphic kinds, is evidence of a like comprehensive influence of the conditions needed to make hornblende in place of augite. The geological importance of the distinction is reason enough for recognizing it in lithological systems.

8. *Massive or Schistose.*—Massive structure is often made *prima facie* evidence of igneous origin. Granite, with hardly a questioning thought, has usually been placed solely among eruptive rocks. The igneous origin of dioryte even now is hardly left open to investigation by some litholigsts. Serpentine has been in the same category, though at present there are advocates of its metamorphic origin. And so other massive rocks are too likely to be set down as eruptive without a fair investigation. No two rocks are put farther apart in some lithological systems than granite and gneiss; and yet, none are more closely related in constitution and all essential characteristics.

The following are reasons for disregarding this distinction of massive or schistose in classifying rocks, and for allowing a massive structure little weight in deciding the question as to eruptive or metamorphic origin.

(1.) *Massive rocks may be both metamorphic and eruptive.*—Granite, syenyte, with dioryte and other hornblendic rocks, are examples of massive rocks that are of both modes of origin. Many localities where kinds of these rocks occur metamorphic have been described. I will mention two or three from the many I have observed in New England. (*a*) Ten miles east of New Haven, Connecticut, in a railroad cut at Stoney Creek, a bed of granite, having a small northward dip, changes gradually to gneiss, and then to gneiss with some very micaceous mica schist, so that within thirty yards from east to west these three rocks are found constituting the same bed; and the granite is a part of the general gneissic formation of the region. (*b*) The labradorite-dioryte two miles west of New Haven graduates rather abruptly above and below, and also laterally, from a massive rock into a slaty chloritic mica schist, and does this so often and variously, that there is no reason for questioning its metamorphic origin. (*c*) A hornblende (or actinolite) rock, just north-east of Bernardston, of a massive kind, occurs among thin schistose beds of mica schist and hornblendic schist and is part of a series of metamorphic strata. From a hand specimen either of these rocks would be pronounced eruptive; but observation in the field proves that they are not so.

(2) *Certain kinds of mineral constituents are almost sure to make a massive metamorphic rock when the process of metamorphism is one attended with much heat.*—Hornblende and augite are minerals of this kind. Both are rather fusible. and crystallize readily, so that heat easily obliterates all traces of bedding. This principle alone will account for the fact that the rocks northeast of Bernardston, alluded to above, are massive wherever hornblende is the chief ingredient. It explains also the existence of the massive labradorite-dioryte among the schists west of New Haven. Feldspar also, when alone, or accompanied by quartz without any associated mica (as in felsyte, quartz-felsyte, granulyte), is almost sure, under the circumstances mentioned, to make a rock, with the bedding obliterated, in other words, a massive rock; and only with a low degree of heat in the metamorphism, would any original bedding be retained. And even if hornblende is present, there is the same tendency to massive forms. Serpentine is another species that makes almost necessarily a massive rock, whatever the method of origin, because the mineral has nothing in its structure that favors any other condition.

(3.) *Pressure may be a source of schistosity or foliation, and it may also obliterate bedding.*—On the first of these points illustration is not necessary. As to the second, there are many examples in the crystalline limestone region of Western New England, both in Vermont, Massachusetts and Connecticut. At West Rutland, Vermont, as first observed by Prof. Edward Hitchcock, many limestone beds have been cemented by the pressure which gave them their high dip into a bed of great thickness, so that masses as large as a moderate-sized house could be cut out if needed. The component beds are easily distinguished in the southernmost of the three quarries. Moreover, in the middle of the same valley the metamorphism of the limestone stratum was not complete enough to obliterate the fossils—shells, corals and crinoids being distinguishable; so that there could have been no fusion to produce the coalescence. As this welding of beds is so perfect in the limestone, it is reasonable to believe that a similar cause may have acted in the case of feldspathic, hornblendic and augitic rocks, without even the aid of incipient fusion.

(4.) *The sedimentary beds which have been converted into crystalline rocks were often originally massive.*—This is the condition of most conglomerates, and often of coarse sandstones. In such cases there would be no bedding to obliterate; and the production of a massive rock would be a natural result of the metamorphism, whether the heat attending it were great or small. Part of the metamorphic granite of the world may therefore never have been in a pasty state; and so also part of the metamorphic hornblende rocks; some metamorphic felsyte beds, certainly those that are of conglomerate origin, were originally massive.

There is hence reason enough for neglecting the distinction of massive and schistose in drawing out a system or classification of rocks, and for making the question of origin in the case of either kind, the massive no less than the schistose, a subject for careful investigation.

9. *Metamorphic or Eruptive.*—The question whether a crystalline rock is metamorphic and *in place*, or eruptive, is of the highest geological interest; for it is a question as to origin. At the same time, no subject, if we exclude the part of metamorphism relating to the obviously schistose rocks, is in so unsatisfactory a state. With some authors, as above intimated, the question so far as it relates to *massive* crystalline rock is not an open one. On the other hand, when investigation has taken place, opposite opinions have generally been reached. The remedy of this is to be found in more thorough study from a wider basis of facts.

Were the question in all cases rightly decided, lithology would be able to study and compare the two series, and give greater completeness and higher geological value to the descriptions of rocks. Applying different names to the like rocks in the two series is not necessary, unless there is some strong geological reason in favor of it; for when a rock occurs both metamorphic and eruptive the fact is best exhibited if that rock has but one name.

The writer has proposed to distinguish the metamorphic under any *kind* of rock by adding to the name the prefix *meta*; for example, *dioryte* for the eruptive and *metadioryte* for the metamorphic part. But *meta* is here used simply as an abbreviation of the word *metamorphic*, not to indicate a difference of *kind* in the rock.

Conclusion.

The principal points with regard to rocks which have been brought out in this paper, are the following.

1. The necessities of the science of Geology constitute the most prominent motive for distinguishing *kinds* of rocks; and they should determine to a large extent upon what characters distinctions should be based.

2. In determining the rocks to be grouped as one in *kind* under a common name, near identity in the chemical and mineral composition of the chief constitutents is the main point to be considered; not near identity in their crystalline forms, for isomorphism presupposes diversity of composition.

3. Distinction of *kind* should be based on difference in chemical and mineral constitution as regards the chief constituents. When such difference exists, rocks are different in *kind*, and need, for the purposes of geology, distinct names. If it does not exist, the distinction is only that of *variety;* unless (as in the case of trachyte and felsyte), the very wide extension of the rock under persistent characters makes a distinction of name important to geology.

4. It follows from the preceding, that differences in texture: as coarse, or fine, or aphanitic; porphyritic, or non-porphyritic; stoney throughout, or having unindividualized portions among the stoney grains, and differences in microscopic inclusions; are no basis for distinctions of *kind* among rocks, but only of *variety;* and that *porphyritic structure* is of hardly more consequence than coarse or fine granular.

5. No marked change in the constituents of the earth's erupted material occurred after the close of the Cretaceous period, or just before the commencement of the Tertiary era; and hence, no ground exists for the distinction of "older" and "younger" among eruptive rocks. The "younger" eruptive rocks are essentially like the "older" in chemical composition and their chief mineral constituents; and they differ when at all only in texture and some other points of as little importance—qualities that distinguish merely varieties, and which have proceeded from greater prevalence in these later times of subaerial eruptions.

6. Since "plagioclase" is not the name of a mineral species,—several minerals, of widely different compositions being embraced under it—it is a confounding of differences and resemblances to speak of it as a constituent of a rock. And since it now includes, through the defining of the feldspar microcline, a large part of potash feldspar, which had been supposed to be orthoclase, it has become almost synonymous with the term feldspar. The

"simplicity" its adoption has been supposed to give to lithological system would be greater if "feldspar" were substituted, and with its present range of constitution, the evil would be hardly less.

7. Rocks differing mineralogically, and not chemically, like related hornblendic and augitic rocks (the minerals hornblende and augite being dimorphous), are rightly made distinct rocks, since the difference has depended, to a large extent, on wide-reaching geological operations or conditions, and is, therefore, of great geological significance.

8. Since quartz is the most widely distributed and therefore the least distinctive of the minerals of rocks, it may rightly be regarded as of subordinate importance in the distinguishing of rocks, and hence not only such names as *dioryte* and *quartz-dioryte*, *trachyte* and *quartz-trachyte*, etc., are acceptable, but also *syenyte* and *quartz-syenyte*.

9. Biotite being closely like muscovite in composition, and not less common than it in granites, gneisses and mica schists, and being, moreover, unlike the mineral hornblende in chemical constitution and formula, the rocks in which biotite is a chief constituent cannot rightly be put in the same group with hornblende rocks; or those in which hornblende is a chief constituent in a group of mica-bearing rocks. Consequently the name "mica-dioryte," for a rock containing no hornblende, and the name "hornblende-granite" for a rock containing no mica but hornblende instead, imply alike false relations.

The discussion suggests the following additional remark:

The incapabilities of the microscope and polariscope have favored the use of the term "plagioclase," and have led some investigators to overlook or slight distinctions in chemical constitution. Lithology is to receive hereafter its greatest advances through chemical analyses; for chemistry alone can clear away the doubts the microscope leaves, and so give that completeness to the Science of Rocks which geology requires for right and comprehensive conclusions.

Moreover the researches made in the laboratory to be of real geological value should be, if possible, supplemented by investigations in the field as to transitions among the rocks, and as to other kinds of relations. This field work has often been well done, but not so by all lithological investigators.

The principles presented lead to the following subdivisions in an arrangement of crystalline rocks, exclusive of the Calcareous and Quartzose kinds. Since leucite is a potash-alumina silicate, like orthoclase and microcline (it affording twenty per cent. or more of potash), it is here referred to the same group with the potash feldspars; nephelite, sodalite and the saussurites being eminently soda-bearing species, they are included with the soda-lime feldspars (anorthite to albite). This reference for lithological purposes of these minerals is sustained by their resemblance to the feldspars in constituents, and also in the quantivalent ratios between the alkalies alumina and silica, this ratio being in leucite 1 : 3 : 8, as in andesite, and in sodalite and nephelite 1 : 3 : 4, as in anorthite. The term *potash feldspar*, as used in the headings below, is hence to be understood as covering orthoclase, microcline and leucite; and *soda-lime feldspar*, as including the triclinic feldspars from anorthite to albite, and also nephelite, sodalite and the saussurites.

The arrangement is as follows. In the first series, the rocks graduate into kinds which are all feldspar, and into others that are all mica; and yet the amount of potash present is approximately the same.

I. The Mica and Potash Feldspar Series: including Granite, Granulite, Gneiss, Protogine, Mica schist, etc., Felsyte, Trachyte, etc., and the Leucite rock of Wyoming.

II. The Mica and Soda-Lime Feldspar Series: including Kersantite, Kinzigite; and the nephelitic kinds Miascyte, Ditroyte, Phonolyte, etc. (These nephelitic kinds belong almost as well in the preceding series.

III. The Hornblende and Potash Feldspar Series: inciuding syenyte (with Quartz-syenyte), Syenyte-gneiss, Hornblende schist, Amphibolyte, Unakyte (this last containing epidote in place of hornblende); and the nephelitic species Zircon-Syenyte, Foyayte.

IV. The Hornblende and Soda-Lime Feldspar Series: including Dioryte (with Propylyte), Andesyte, Labradioryte (or Labrador-dioryte), etc., and the saussurite rock, Euphotide.

V. The Pyroxene and Potash Feldspar Series: including Amphigenyte.

VI. The Pyroxene and Soda-Lime Feldspar Series: including Augite-Andesyte, Noryte (Hypersthenyte and Gabbro in part), Hypersthenyte (containing true hypersthene), Doleryte (comprising Basalt and Diabase), Nephelinyte, etc.

VII. Pyroxene, Garnet, Epidote and Chrysolite Rocks, containing little or no Feldspar: including Pyroxenyte, Lherzolyte, Garnetyte (Garnet rock), Eclogyte, Epidosyte, Chrysolyte or Dunyte (Chrysolite rock), etc.

VIII. Hydrous Magnesian and Aluminous Rocks, containing little or no Feldspar: including Chlorite schist, Talcose schist, Serpentine, Ophiolyte, Pyrophyllite schist, etc.

REMARKS ON CANADIAN STRATIGRAPHY.

By Thomas Macfarlane, Esq.

Mr. Selwyn's recent paper "On the Stratigraphy of the "Quebec Group and the older crystalline rocks of Canada" marks an important event in the history of the Geological Survey. To those who, like myself, have not heretofore accepted unhesitatingly the theories of the Survey authorities, the publication of this paper is of great interest. At the same time, many will, I think, regret that it is unaccompanied by any geological map or sections of the territory whose stratigraphy is discussed. Without this it is quite impossible for the general public, and quite difficult for the student of Canadian geology, to follow Mr. Selwyn, to obtain a clear idea of the reasons which have caused him to differ so profoundly from his predecessor Sir W. E. Logan, or to form a judgment as to the relative merits of their respective conclusions. Mr. Selwyn indeed informs us that "a considerable amount of careful inves- "tigation and laborious work in the field is yet required before "the indicated divisions can be correctly delineated on the map," but, although this may be an excellent reason for not as yet publishing any map illustrative of Mr. Selwyn's views, still it cannot be regarded as affecting the map of south-eastern Quebec by Sir W. E. Logan, so long promised by him, and upon which he laboured so earnestly. Indeed, I trust that the members of the Natural History Society and the public generally will join with me in urging upon Mr. Selwyn the advisability of publishing this map, for I think that we have all been under the impression that the views of the former Director of the Survey derived their strongest support from stratigraphical considerations.

My object in making these remarks on Canadian Stratigraphy is to eliminate, as far as possible, from Mr. Selwyn's paper, the facts upon which he bases his conclusions, and to examine how far the latter are new, or acceptable. Mr. Selwyn in referring to the opinions of those who have gone before him in the study of Quebec rocks, asserts that "most of these opinions have been ad- " vanced on palæontological, mineralogical or theoretical grounds, " without any study of the actual stratigraphy of the field." Indeed, he has expressed himself to the effect that his views are the result of a careful examination and mapping of the stratigraphy, while those of myself and others are the results of either mineralogical or palæontological comparisons, the former of which especially he supposes to be very misleading. From theses utterances, and from the very excellent opportunities which we know Mr. Selwyn possesses for making observations in the field, we are entitled to expect to find in his memoir a careful description of the new facts and data which have influenced his opinions, and these I shall endeavour to point out. We must, however, distinguish betwixt these and Mr. Selwyn's general geological descriptions, and also try to ascertain whether they involve negligence or inaccuracy on the part of previous observers.

I. Among these newly observed phenomena is that having reference to the Champlain and St. Lawrence fault. "The line of " this dislocation," says Mr. Selwyn, "or unconformity—which- " ever it may be—has been supposed to pass in rear of the Quebec " citadel. This I hold to be a mistake, and I think it can be dis- " tinctly shewn that it passes from the southwest end of the Island " of Orleans, under the river, and between Point Lévis and Quebec." To an ordinary observer the rocks underneath the city and citadel of Quebec bear a much greater resemblance to the contorted strata of Point Lévis than to the even-bedded shales and limestones which generally occur on the northwest side of the fault. But, after all, even if the fact be as Mr. Selwyn states, he will probably admit that this is not of the slightest importance so far as regards the correctness of his theoretical views.

II. Mr. Selwyn places on record the results of an actual examination of certain supposed Potsdam rocks, described in the Survey Report for 1866-9, and has not observed anything in their architecture or fossils to justify their separation from the Lévis formation. This is quite an important fact, of which I shall take notice when discussing the theory which Mr. Selwyn builds upon it.

III. Mr. Selwyn states that, on the River Etchemin, the rocks of his second division crop out apparently unconformably from beneath the fossiliferous belt or Lévis formation. But he is uncertain whether this "apparent unconformity" may not be a fault, and therefore it would seem hazardous to base much theorizing upon it. I cannot detect, elsewhere in Mr. Selwyn's paper, any unequivocal example of discordance such as would prove that the Lévis formation is quite distinct from the underlying "Volcanic Group."

IV. Mr. Selwyn notes the occurrence in his second division of "altered volcanic products," both intrusive and inter-stratified, and speaks of a great development of those *Volcanic* rocks. The term "volcanic" is very seldom used by modern lithologists as indictaing a particular texture or composition in a rock. Among older authors, Sartorius von Waltershausen writes of the volcanic rocks of Sicily and Iceland, all of which occur in the neighbourhood of active volcanoes. Von Richthofen, in his Natural System of volcanic rocks, written in 1868, refers exclusively to tertiary and post-tertiary eruptive rocks ranging from rhyolite to basalt. Mr. Selwyn in applying the term to intrusive rocks of Cambrian or Silurian age probably uses it in the sense of eruptive, for it would be very difficult to shew any connection between them and volcanic vents. In this case he does not put on record a new fact, but merely an old opinion expressed by previous observers. But Mr. Selwyn claims further in reference to these rocks "that "neither their true stratigraphical position nor their geological "characters have been correctly defined, and they have, regardless "of these, been confounded and incorporated with the true Sillery "sandstones, which are only a local development of thick sand-"stones at several horizons in the Quebec group or fossiliferous "Lévis formation." The geological characters mentioned have probably reference to their lithological features, and we are left to infer that certain eruptive crystalline or sub-crystalline rocks have been described as sandstones by Mr. Selwyn's predecessors, and that he has been the first to determine them correctly. But when Sir William and his assistants classed a certain diorite, for instance, in the Sillery formation they did not therefore determine it as a sandstone. When I speak of the Primitive Gneiss formation I do not necessarily mean that every rock in it is a true gneiss. And, similarly, if previous observers have placed certain "volcanic" rocks in the same formation with the Sillery sandstones, we may be certain that they did so intelligently, and that Sir William Logan and his staff were fully aware of the differences between a crystalline and a fragmentary rock.

V. Mr. Selwyn calls attention to two characters not pointed out by Sir W. E. Logan which distinguish the "Volcanic" from the Lévis area on the Rivière du Sud. One of these is the occurrence of fossils in the district north of the river ; but this does not seem to be a new discovery. The other distinction is a peculiar schistose structure in the sandstones of the "Volcanic" group, which is not to be observed among those of the Lévis formation. It is worthy of note that here we have Mr. Selwyn himself making use of a lithological peculiarity for separating two different groups of rocks. The absence of fossils from his second or "Volcanic" division is emphasised by Mr. Selwyn ; and no doubt this difference, as compared with the Lévis formation, is a most important one. Still we know that Sir W. E. Logan was aware of this distinction ; so that here again we have, not the announcement of a new fact by Mr. Selwyn, but simply a new explanation of a certain peculiarity. Sir William accounted for the absence of fossils by metamorphic action ; Mr. Selwyn would probably attribute it to volcanic interference : the difference is, after all, only in theory.

Although I have searched very carefully, I have failed to find in Mr. Selwyn's paper any other traces of original observation than those I have enumerated. The first of these items has no bearing upon the mutual relations of Mr. Selwyn's second division and the Lévis formation ; the fourth cannot be said to be a new observation at all, and thus we have, as the actual basis of fact for Mr. Selwyn's new conclusions, the absence of Potsdam strata from the neighbourhood of the Lévis formation, the supposed unconformity on the River Etchemin and a trifling lithological peculiarity among the sandstones of the Rivière du Sud. The supposed unconformity is by far the most important part of this basis ; but we must recollect that Mr. Selwyn is far from being positive about it, and, further, that the same difficulty occurred to him as regards the contact of the rocks on the northwest edge of the fossiliferous belt. There too, he does not distinguish between an unconformity and a fault, and I believe were this latter point decided it would go far to settling this vexed question of the age of the Quebec group.

After this examination I think it can reasonably be submitted that these new data are altogether insufficient to destroy the confidence which many have heretofore placed in the conclusions of Sir W. E. Logan and in the labours of those who worked under him during the last thirty years of his life. If laborious and painstaking "study of the actual stratigraphy in the field" is to count for anything, it is no discredit to Mr. Selwyn to say that his work in this respect is far outweighed by that performed by Sir William. Further, we all know that the closing years of his life, even after his official connection with the Survey ceased, were devoted to a re-examination of the Eastern Townships rocks and to the completion of his map. Surely all this ought not to be thrown aside as useless work. Surely Sir William, had he lived, would have had something to say in these days in defence of his opinions. Although he is gone from us, it is surely our duty to take care that justice is done him, and I contend that it would be only an act of simple justice to his memory to give to the world the results of his labours, just in the shape which they attained at his death. Apart altogether from his theoretical conclusions, the correctness of which Mr. Selwyn disputes, the observations of Sir William and his assistants, as to the actual phenomena exhibited by the rocks of south-eastern Quebec, have a practical value to the country, and to all future observers, which I conceive it to be the duty of the Survey to put on record.

When we consider the very slender foundation of new material upon which Mr. Selwyn's views regarding the Quebec group are built, it would seem that the conclusions he has arrived at are, to a very large extent, theoretical, and therefore just as little entitled to immediate acceptance as those of others who have written upon the subject. In reviewing Mr. Selwyn's conclusions, I shall attempt to state them as briefly and honestly as possible, and I shall first refer to those which from my own point of view appear to be well founded.

1. The principal feature of Mr. Selwyn's essay is of course the new view he takes as to the stratigraphy of the Quebec group. The order, in age, of its different members he maintains is just the reverse of that indicated by Sir W. E. Logan; the fossiliferous belt or Lévis formation is newer than the more crystalline rocks to the south-east, and the latter are probably of Cambrian age. Now although I cannot see that Mr. Selwyn has brought forward any new and adequate proof of the correct

ness of this view, still I feel bound to advocate it, because of my experience among similar rocks in Scandinavia and Germany, and stratigraphical and lithological comparisons which I have made between these and Canadian rocks. Indeed in the first paper which I had the honour of presenting to the Natural History Society of Montreal, dated 8th April, 1862, in speaking of the so-called metamorphic rocks of the Eastern Townships, I maintained that "so soon as the true limits and effects "of metamorphism are recognized, it will probably be acknow-"ledged that, whatever view may be entertained as to their "origin, the schistose rocks above referred to underlie the Silu-"rian and all unaltered or metamorphosed strata." Further, in a pamphlet published by me in 1871, entitled "Observations on Canadian Geology," I made the following remarks: "Indeed "in the attempts which have been made at determining the age "of the Eastern Townships rocks it has always been the rule to "begin with the Potsdam sandstone as the oldest rock, and to "assume that those to the eastward (regardless of their litholo-"gical characters) follow each other in ascending order. Any "one who has studied the structure of similar regions in Europe, "such as those above mentioned, can scarcely fail to come to the "conclusion that the opposite of this assumption is the truth; "that the oldest rocks are those of New England, and that as we "come north-westward, we pass over more and more recent "strata." (p. 13.) In mentioning the Silurian rocks in the same pamphlet, I made a still more distinct statement of my view of the matter, which I give here in full. "We have seen "that in comparing the great mass of the New England and "Eastern Townships rocks with strata of similar lithological "characters in Europe, such as those of Saxony above alluded "to, there is no difficulty in recognising them as Azoic and pre-"Silurian. This applies to the gneiss, mica schist, chlorite "schist, and to much of the clay slate of the region referred to. "As in Saxony, there exists a passage (perhaps only apparent) "from these crystalline and semi-crystalline rocks into others of "a distinctly detrital and fossiliferous character, so in the Eastern "Townships we have a similar passage from roofing slate into "softer grey slates, grauwacke (Sillery sandstone), graptolitic "shales and fossiliferous limestones. This peculiar structure "was indeed the reason why these oldest fossiliferous strata were "formerly called the Transition (*Uebergangs*) formation. The "same series of rocks in the Province of Quebec occupies a belt "along the west side of the Quebec group, having a breadth of "about twenty miles, and including all undoubted sedimentary "and fossiliferous strata. It is the same band of rocks which "continuing southward into Vermont has there been called the "Taconic, and which Dr. Hunt wishes to classify as Upper Cambrian. We have already seen that the term Cambrian is much "more applicable to the Green Mountain series, and there would "appear to be no good reason for ceasing to regard these rocks "as belonging to the Silurian system. As has already been explained, however, it would be proper to exclude from that "series any non-fossiliferous rocks whose aspect is semi-crystalline, and which have been so frequently classed as metamorphic "Lower Silurian. These, as we have seen, it is much more "reasonable to class with the Cambrian rocks." (pp. 15 and 16.) From these quotations it will be perfectly evident that Mr. Selwyn's views as to the age and structure of the Quebec group are the same as those I have held for the last seventeen years and repeatedly brought before the public. It may seem a matter of little consequence as to where the merit of priority lies, but I confess I think differently, and maintain that Mr. Selwyn's recent paper ought to have contained some allusion to the passages above quoted.

But, in spite of all this, I feel bound to say that the matter is not ended here; that the independent student of our geology will neither accept Mr. Selwyn's views nor any others, unless they satisfactorily dispose of the difficulties which have all along beset this subject. Mr. Selwyn banishes Potsdam strata from the proximity of the Lévis rocks, and claims that his new divisions have "at least the advantage of simplicity." This may readily be admitted for what it is worth, but they do not in the slightest degree meet the question with which Sir W. E. Logan found himself face to face during the latter part of his lifetime, and which may thus be stated: How can this Lévis formation be really Lower Silurian in age when it underlies, unconformably, the lowest of Lower Silurian rocks, namely, the typical Potsdam sandstone of the St. Lawrence valley? Mr. Selwyn says, that the Lévis formation is Lower Silurian, and the horizontal Potsdam sandstone is Lower Silurian too, and thinks that he has effectually disposed of the question "without invoking any of "the numerous almost impossibilities in physical and dynamical "geology which are required to explain the previous theory of "the structure." But we must not imagine that such a simple explanation could not possibly have occurred to Sir W. E. Logan, and that his introduction of those "almost impossibilities" was unnecessary. I am inclined to think that the phenomena which Sir William worked so indefatigably and so loyally to explain, remain to this day as tangible as ever, and that Mr. Selwyn's new theories afford no solution of the problem.

2. Mr. Selwyn maintains the igneous origin of many of the crystalline rocks of his second division, and especially of the "diorites, dolerites and amygdaloids" which occur in connection with certain copper ores. This is another view I have often maintained. and I might readily quote passages from my papers giving the authority of Naumann and others in support of it.

3. Mr. Selwyn particularly insists upon this point, "that the "fact of crystalline rocks (greenstones, diorites, dolerites, felsites, "norites, &c.) appearing as stratified masses and passing into "schistose rocks, is no proof of their not being of eruptive or "volcanic origin." This is a principle of very wide application, and cannot in my opinion be controverted. In my paper on the Acton mine, dated 28th October, 1862, I described a striking instance in support of this very point. I said, "Between the "cupriferous limestone and the underlying shale, there is often "intruded a fine grained greenstone, which sometimes forms "very considerable and irregular masses; sometimes intersects "the limestone strata, and often presents a peculiar banded "structure, resembling more that produced by igneous flow than "that due to deposition from water." Further, when discussing the origin of eruptive and primary rocks in January, 1864, I insisted upon the view now brought forward by Mr. Selwyn, and gave an explanation of it in the following words: "The instances "of a similar modification of structure among the greenstones are "very numerous, and they are even more important as shewing "more clearly the cause of this structure among igneous rocks. "The diorites usually occur in the form of veins, irregular masses "and layers. The veins sometimes exhibit the following re-"markable phenomena: In the middle they consist of granular "diorite, and at the sides of slaty diorite or hornblende schist, a "gradual transition being generally observable from the granular "to the schistose rock. The cause of these phenomena may "most reasonably be sought for in the circumstances attending

" the cooling of the rock, and they are most likely the same as " those which occasioned a similar structure among the porphy- " ries. The fluid rock of the diorite vein was probably in motion " in the centre, while the parts adjoining the side walls were " solidified. The current in the centre would have a distending " and arranging action at the junction of the fluid with the soli- " dified parts, and an elongation and parallel grouping of the " minerals there being formed would be the consequence. Not " only has this slaty texture been observed in connection with " veins, but it has also been remarked that the more irregular " masses of diorite assume a slaty structure towards their junc- " tion with the older rocks, the stratification being as in the case " of the veins parallel with the line of such junction."

I have thus brought into prominence three of Mr. Selwyn's conclusions with which I feel bound to agree, but I have yet to notice those of whose correctness I have very grave doubts.

1. In discussing the distribution of copper ores in the Quebec group, Mr. Selwyn asserts that the copper ores of his third division occur both in beds and lenticular layers parallel with the stratification, " but in no case accompanied by intrusive crys- " talline rocks." This position cannot be maintained with regard to the mines of Capelton. In the Capel mine intrusive dykes are met with, and in the Hartford there is one about twenty feet thick, almost vertical, with separation joints exactly resembling, on its sides, the mortar seams in a stone wall. This dyke appeared to influence the copper deposit quite favorably. It was of a basaltic nature, but intrusions of diabase are also to be found at this mine both underground and on the surface. Mr. Selwyn's reference to the Acton mine is equally unfortunate. The " diorite " there occurring is not itself cupriferous, and as for the limestone which carries the ore, although I had opportunities for observing it daily, it never occurred to me to regard the whole mass as " vein-like," nor did it seem to behave otherwise than as a bed " belonging to the stratification."

2. Mr. Selwyn is unwilling to assign " either an age or an " origin to the cupriferous diorites, dolerites and amygdaloids of " the Eastern townships different from that of the almost iden- " tical rocks of Lake Superior." Leaving age and origin aside, I shall mention a few particulars in which the two groups are scarcely " identical." In Quebec the eruptive rocks are mostly fine grained, frequently schistose, never sufficiently cupriferous to

furnish a paying mine; their small percentage of copper is combined with sulphur; amygdaloids are comparatively rare, and seldom contain anything else than calcspar; these beds are intruded amongst or interstratified with slates, shales and limestones; contorted strata are often observable, and a belt of fossiliferous rocks adjoins them to the north west. On Lake Superior the supposed identical rocks are distinctly granular, seldom schistose, frequently support remunerative mines on their native copper; amygdaloids are abundant, and filled with native copper, calcspar, quartz, zeolitic and other minerals in profusion; they have the form mostly of overflows, not intrusions, and they are associated with sandstones and the coarsest of conglomerates, shewing porphyritic, Laurentian and Huronian boulders; the strata are not contorted, have a regular dip in one direction, are innocent of fossils themselves, and are far distant from any formations containing them.

3. Mr. Selwyn disputes Dr. Hunt's contention that the Keweenian series overlies the Huronian unconformably, and cites U. S. authorities against this view. Preferable to these would have have been Mr. Selwyn's own testimony as regards this question, and it is to be regretted that he has not yet devoted much time to the Lake Superior region. When any one wanders along a sea-beach, with overhanging cliffs on one hand, and observes on the other the water-worn boulders, pebbles and sand derived from it, he feels pretty certain that the shingle is unconformable to the cliffs. So, on Lake Superior, along its eastern shore, between Sault Ste. Marie and Michipicoten, there are frequently found, betwixt the water and the Huronian or Laurentian hills, narrow strips or patches of the rocks of the Upper group, which often jut out as small islands into the lake, and doubtless extend out great distances beneath its waters. Such limited strips of these rocks are found, for instance, skirting the base of Gros Cap, along the south shore of Bachewahnung Bay and at Cape Gargantua. Among these rocks the conglomerates are full of Huronian débris, and in those of Bachewahnung Bay boulders may be observed of red jasper conglomerate, the characteristic rock of the typical Huronian. If this, and the position of the Maimanse series, unconnected with any Huronian background, be not sufficient, I would mention the attitude of the rocks of Michipicoten Island. Here the strata, igneous as well as sedimentary, have an average strike of N. 68° E. and a dip of 25° southeastward. The nearest Huro

nian rocks on the north shore run nearly east and west, dipping 34° to 55° northward. To these, the island rocks are consequently as unconformable as are the walls of a house to its roof.

It is further to be remembered that the discordant relation of the Nipigon group to the Huronian system is admitted by Mr. Selwyn to be an "apparent great unconformity," and as the Nipigon group is held by Mr. Selwyn to be part of the "Upper Copper bearing rocks," this is almost conceding Dr. Hunt's position. This admission is not at all weakened by Mr. Selwyn's supposition that they are the products of an ancient volcanic crateriform vent, and that Lake Nipigon is an extinct volcano, a gigantic *Maare*, or water-filled ancient crater, like the Lake of Laach. This invention almost justifies the opinion that Mr. Selwyn is himself sometimes ready to invoke "almost impossibilities in physical and dynamical geology."

4. Writing of Dr. Hunt's Norian system, Mr. Selwyn pens the following remarkable passage: "If it is admitted—which, "in view of the usual associations of Labrador feldspar, is the "most probable supposition—that these anorthosite rocks represent the volcanic and intrusive rocks of the Laurentian period, "then also their often massive and irregular and sometimes "bedded character, and their occasionally interrupting and cutting off some of the limestone bands, as described by Sir W. E. "Logan, is readily understood by any one who has studied the "stratigraphical relations of contemporaneous and sedimentary "strata of volcanic, palæozoic, mesozoic, tertiary and recent "periods. Chemical and microscopical investigation both seem "to point very closely to this as the true explanation of their "origin. That they are eruptive rocks is held by nearly all geologists who have carefully examined their stratigraphical relations. But I am not aware of any one having suggested that "they are the products of volcanic action in the Laurentian or "perhaps lower Huronian epoch." It is unnecessary here to combat the doctrine that norites are not merely eruptive, but volcanic rocks. I must content myself with remarking that on Mr. Selwyn rests the burden of proving any new theories he may choose to bring forward, and consequently of shewing that volcanoes were active in the Azoic age.

5. Mr. Selwyn underrates the very praiseworthy efforts which Dr. Hunt has made towards bringing order out of the chaos of our primary geology, and can see no utility in the names he

employs for distinguishing certain non-fossiliferous formations. He not only condemns such "mineralogical stratigraphy," but adverts, in a manner which must grate very harshly on the feelings of many, to the "palæontological stratigraphy" of his revered predecessor. Yet on the next page Mr. Selwyn proceeds to class together groups of rocks of almost every conceivable origin, and very questionable age, as belonging to the Huronian system. I need not detail the extraordinary differences which distinguish the various members of this heterogeneous combination, both in mineralogical, lithological and stratigraphical respects. Mr. Selwyn himself points out one of these differences when he maintains that the copper ores of the Huronian and "Upper Copper bearing" rocks occur under conditions quite as distinct as those of his first and second divisions in the Quebec group. Mr. Selwyn's own recapitulation of what is to be classed as Huronian is a proof that his plan of applying stratigraphy pure and simple is not likely to be a great improvement on the methods of those who have preceded him. It may, like his views on the Quebec group, have the merit of simplicity, but we must not allow ourselves to be influenced overmuch by the advantages of this peculiarity. Instead of disparagement, such efforts as those of Dr. Hunt merit our warmest thanks, and we must wish him every success in his efforts to determine the value of mineral fossils in crystalline rocks. As he himself very fitly remarks, "In no other way did William Smith prove, in Great "Britain, the value of organic fossils, and thus lay the foundations "of palæontological geology."

(Read before the Natural History Society of Montreal, 28th April, 1879.)

A CANADIAN PTERYGOTUS.

(*Pterygotus Canadensis.*)

Among some specimens kindly presented to the museum of the University in the winter of 1877–8, by Lieut.-Col. Grant of Hamilton, was a slab of Niagara limestone holding a well-preserved ectognath or mandible of a large *Pterygotus*. (Fig. 1.)

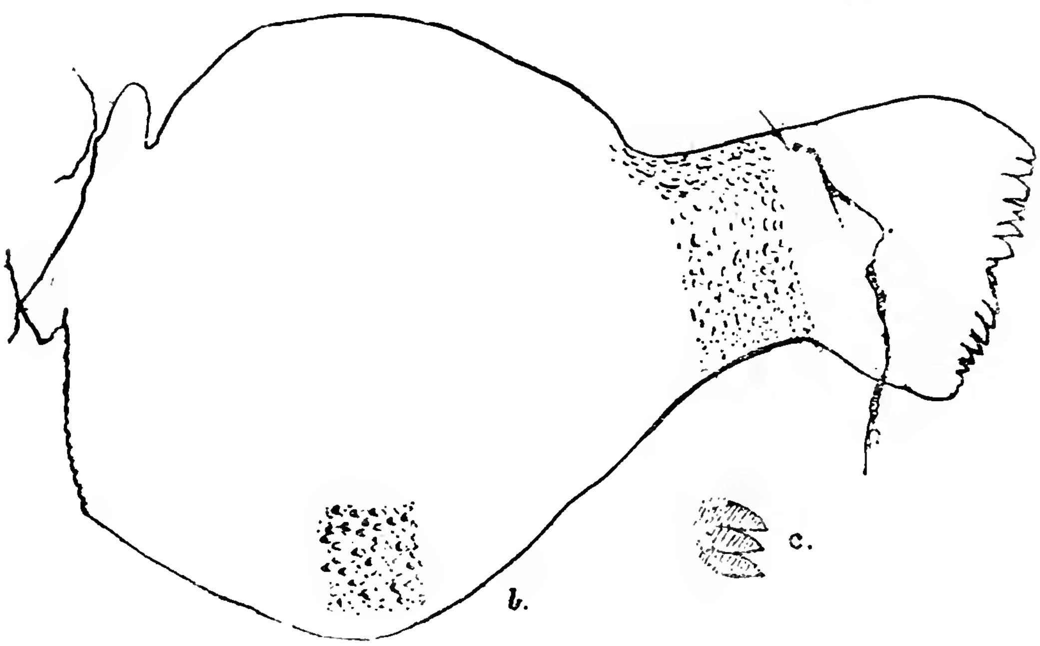

Fig. 1. Ectognath of *Pterygotus Canadensis*, natural size. (The shaded portions represent the slaty character of the surface.) *c.* teeth enlarged.

As the species seemed to be new, and I could not learn that anything similar had been found in rocks of this age in Canada, a notice of it was communicated to the Natural History Society of Montreal at its meeting of April 28, 1879, and was reported as follows in the *Daily Witness* of the 30th :

" A very remarkable discovery recently made in the Niagara limestone is that of some fragments of a gigantic Crustacean of the genus *Pterygotus*, comparable in size with the great *Pterygotus Anglicus* of the Devonian of Scotland, though of much greater geological age. Some small species of *Pterygotus* have been described by Hall from the Waterlime formation of New York, and a fragment of an undescribed species has been found by the same palæontologist in the Clinton ; but the present is, so far as known, the first example of a large and well-developed species of this genus from so old a formation. Col. Grant hopes to obtain additional remains. In the meantime the well-preserved maxilliped or ectognath before us, with rounded scaly basal part and narrow maxillary process with about 12 denticles and $3\frac{1}{2}$ inches in length, is sufficient to indicate the existence of a new and large species, which may for the present be named *P. Canadensis*, and which was a Canadian predecessor of *P. Anglicus*."

Since the above was written the removal of a part of the stone has exposed a little more of the mandibular edge, so as to show a few more teeth, making about fifteen in all, which are of the form represented in Fig. 1, *c*, except the posterior one, which is broad and slightly notched in front.

Lieut.-Col. Grant has more recently obtained another fragment of an animal apparently of the same species. It seems to be a segment of the thorax, somewhat crushed at the ends, but showing the characteristic markings very distinctly at the anterior edge. The portion preserved is barely six inches in length, and an inch and a half wide. Fig. 2 represents the middle portion of it.

Fig. 2. Body ring of the same, central portion, natural size.

The first-mentioned specimen was found by its discoverer in the corporation quarry at Hamilton, in the lower cherty beds of the Niagara limestone, which at this place contains also a large *Conularia* and species of Graptolites. The second specimen was found at some distance from the first, but apparently in beds of the same age. The specimens are sufficient to indicate the existence of a very large crustacean of this genus, apparently the first found in the Niagara limestone formation of Canada.

According to the Rev. Mr. Symonds, in Woodward's Monograph of the British Merostomata,* the oldest known *Pterygotus* in

* Publications of Palæontographical Society, Vol. XXV.

Britain, is represented by a jaw-foot found in the Upper Llandovery sandstone, which is somewhat older than the Niagara limestone. It has been named *P. problematicus*, and fragments referred to the same species have been found in the Wenlock limestone, the English representative of the Niagara.

This note is published merely to secure to the discoverer, who has laboured with much diligence and success in the palæontology of the Niagara formation, the credit which belongs to him, and to direct attention to this interesting fossil, which it is hoped may some day be represented in our collection by perfect specimens.

J. W. Dawson.

March 20th, 1879.

MÖBIUS ON EOZOON CANADENSE.*

By J. W. Dawson, LL.D., F.R.S.

Eozoon Canadense has, since the first announcement of its discovery by Logan in 1859, attracted much attention, and has been very thoroughly investigated and discussed, and at present its organic character is generally admitted. Still its claims are ever and anon disputed, and as fast as one opponent is disposed of, another appears. This is in great part due to the fact that so few scientific men are in a position fully to appreciate the evidence respecting it. Geologists and mineralogists look upon it with suspicion, partly on account of the great age and crystalline structure of the rocks in which it occurs, partly because it is associated with the protean and disputed mineral Serpentine, which some regard as eruptive, some as metamorphic, some as pseudomorphic, while few have had enough experience to enable them to understand the difference between those serpentines which occur in limestones, and in such relations as to prove their contemporaneous deposition, and those which may have resulted from the hydration of olivine or similar changes. Only a few also have learned that *Eozoon* is only sometimes associated with

* Der Bau des Eozoon Canadense, von Karl Möbius, Professor der Zoologie in Kiel. Palæontographica, Band xxv.

serpentine, but that it occurs also mineralized with loganite, pyroxene, dolomite, or even earthy limestone, though the serpentinous specimens have attracted the most attention, owing to their beauty and abundance in certain localities. The biologists on the other hand, even those who are somewhat familiar with foraminiferal organisms, are little acquainted with the appearance of these when mineralized with silicates, traversed with minute mineral veins, faulted, crushed and partly defaced, as is the case with most specimens of *Eozoon*. Nor are they willing to admit the possibility that these ancient organisms may have presented a much more generalized and less definite structure than their modern successors. Worse, perhaps, than all these, is the circumstances that dealers and injudicious amateurs have intervened, and have circulated specimens of *Eozoon*, in which the structure is too imperfectly preserved to admit of its recognition, or even mere fragments of serpentinous limestone, without any structure whatever. I have seen in the collections of dealers and even in public museums, specimens labelled "*Eozoon Canadense*" which have as little claim to that designation as a chip of limestone has to be called a coral or a crinoid.

The memoir of Professor Möbius affords illustrations of some of these difficulties in the study of *Eozoon*. Professor Möbius is a zoologist, a good microscopist, fairly acquainted with modern foraminifera, and a conscientious observer; but he has had no means of knowing the geological relations and mode of occurrence of *Eozoon*, and he has had access merely to a limited number of specimens mineralized with serpentine. These he has elaborately studied, and has made careful drawings of portions of their structures, and has described these with some degree of accuracy; and his memoir has been profusely illustrated with figures on a large scale. This, and the fact of the memoir appearing where it does, convey the impression of an exhaustive study of the object, and since the conclusion is adverse to the organic character of *Eozoon*, this paper may be expected, in the opinion of many not fully acquainted with the evidence, to be regarded as a final decision against its animal nature. Yet, however commendable the researches of Möbius may be, when viewed as the studies of a naturalist desirous of satisfying himself on the evidence of the material he may have at command, they furnish only another illustration of partial and imperfect investigation, quite unreliable as a verdict on the questions in hand. The following considerations will serve to indicate the weak points of the memoir.

1. A number of errors and omissions arise from want of study of the fossil *in situ*, and from want of acquaintance with its various states of preservation. Trivial errors of this kind are his referring to my photograph in Plate III, of the "Dawn of Life," as if it were natural size, and his stating that the larger specimens have fifty laminæ, whereas they often have more than an hundred. More important is his failing to appreciate aright the occurrence of *Eozoon* in certain layers of regularly bedded limestones, the rounded or club-shaped forms of the more perfect specimens, the manner in which the layers become confluent at the edges of the forms, as described by Sir W. E. Logan and myself, or the amount of crushing and fracture which most of the specimens exhibit. Thus he fails to convey any adequate idea of the Stromatoporoid forms and mode of occurrence of the organism, or indeed of its general character and probable mode of growth. Farther he treats it from the first as a mere laminated aggregate of calcite and serpentine, without reference to its occurrence in any other state, and also without reference to the fragmental limestones in part made up of its remains. He objects strongly to the want of definiteness of form and distribution in the chambers and connecting passages, without making allowance for defects of preservation, or mentioning the similar want of defined form in some *Stromatoporæ*. He admits, however, that the modern *Carpenteria* and its allies are in some respects equally indefinite. He farther objects to the impossibility of detecting regular primary chambers like those in modern foraminifera, but seems not to be aware that, as I have recently shown, some *Stromatoporæ* originate in a vesicular, irregular mass of cells, and that in *Loftusia*, both the Eocene *L. Persica*, and the Carboniferous *L. Columbiana*, the primary chamber is represented by a merely cancellated nucleus.*

2. With reference to the finely tubulated proper wall of Eozoon, he has fallen into an error scarcely excusable in an observer of his experience, except on the plea of insufficient access to specimens. He confounds the proper wall with the chrysotile veins traversing many of the specimens, and obviously more recent than the bodies whose fissures they fill. That he does so

* See Journal of London Geol. Soc., January, 1878.

is apparent from his stating that the proper-wall structure sometimes crosses the bands of serpentine and calcite, and also that it presents a series of parallel four sided prisms, whereas, when at all perfectly preserved, it shows a series of cylindical threads penetrating a calcite wall. That some of his specimens have contained the proper wall fairly preserved is obvious from his own figures, in which it is possible to recognize both this structure and chrysotile veins, though confounded by him under the same designation. He objects, somewhat naïvely, that many of the chambers fail to exhibit this nummuline wall, and that it sometimes presents a ragged appearance or is altogether opaque. In point of fact it can appear distinctly, either in decalcified specimens or in slices. only when the minute tubes are filled with some substance optically distinguishable from calcite, or not acted on by dilute acid. When the proper wall is merely calcareous (and I have specimens showing that it is often in this state, and without any serpentine in its pores). its structure is ordinarily invisible. and it is the same when the calcareous skeleton has from any cause lost its transparency or has been replaced by some other mineral substance. Even in thickish slices, the tubes, though filled with serpentine, may be so piled on one another as to be indistinct. All this may be seen in Tertiary *Nummulites*. When wholly calcareous their tubulation is often quite invisible, and when imperfectly injected with glauconite or other silicates, they often present a very irregular appearance. If Professor Möbius will study the Nummulites injected with glauconite from Kempten,* Bavaria, in addition to the casts of *Polystomella* from the Ægean to which he refers, he will be better able to appreciate these points. It may be worth repeating here that, in examining the original specimens of Eozoon, I did not recognize the proper wall. I did not doubt that it must have existed in some form, since I could easily detect the canals in the supplemental skeleton; but I did not wonder at its nonappearance, knowing the chances against its preservation in a recognizable form. Its discovery was due to the subsequent investigations of Dr. Carpenter.†

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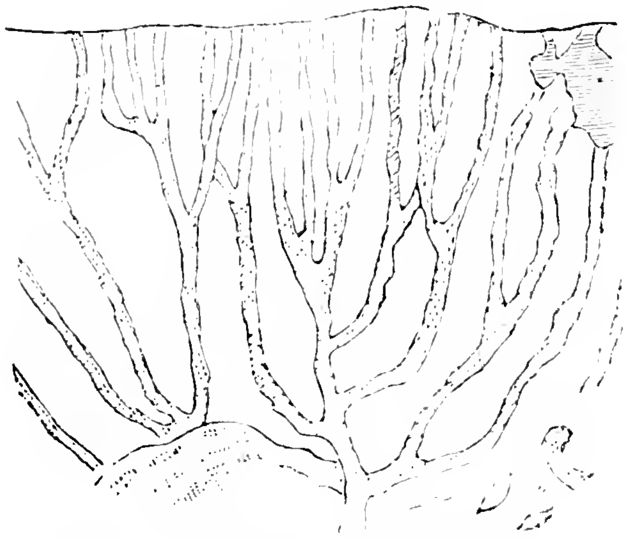
* I am indebted to Dr. Otto Hahn for specimens of these most interesting fossils.

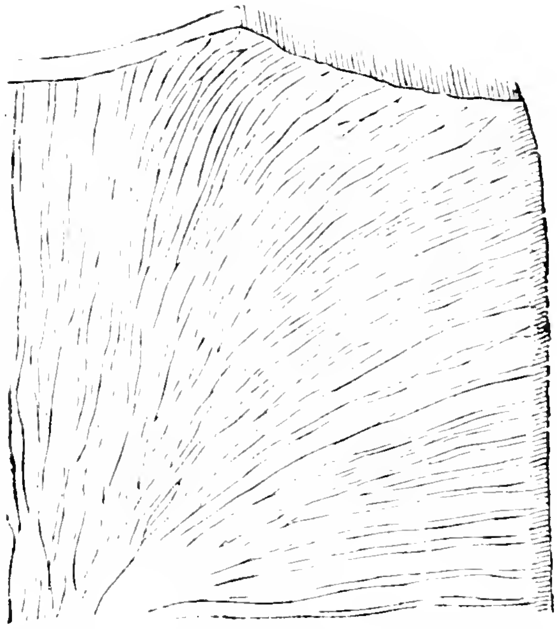
† It may deserve mention here that the Carboniferous *Fusulina* very rarely shows its tubulated wall, and that Dr. Carpenter had maintained its Nummuline affinites before he obtained specimens showing this particular structure. Structures so delicate as these are indeed only preserved exceptionally in fossil specimens.

1



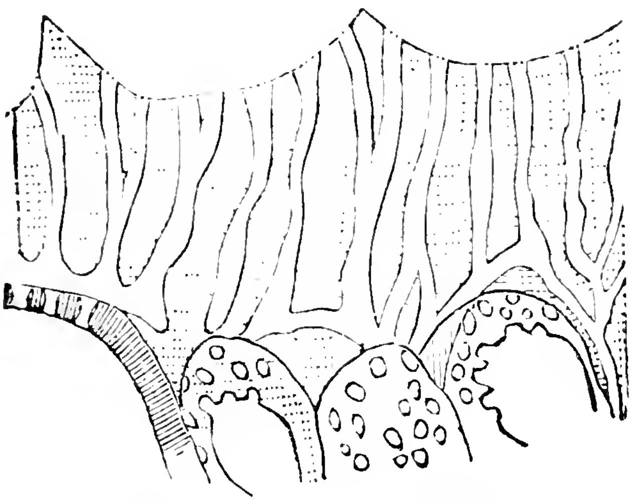
Canals of *Eozoon* (after Möbius).

2.



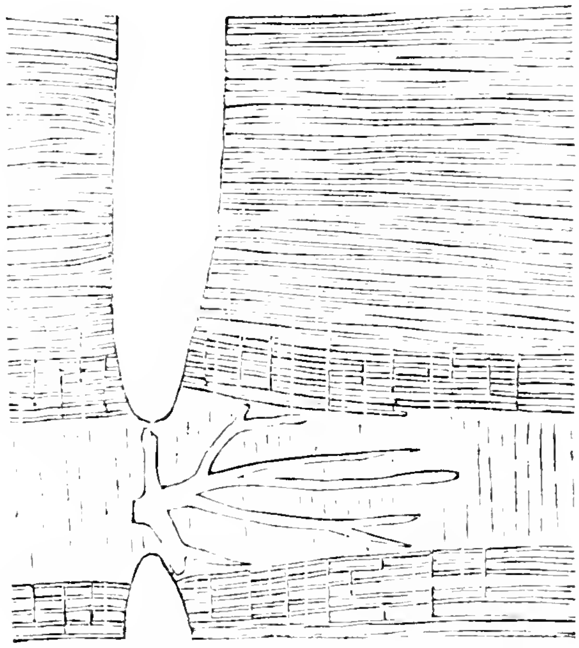
Finer canals of *Eozoon* (after Möbius).

3.



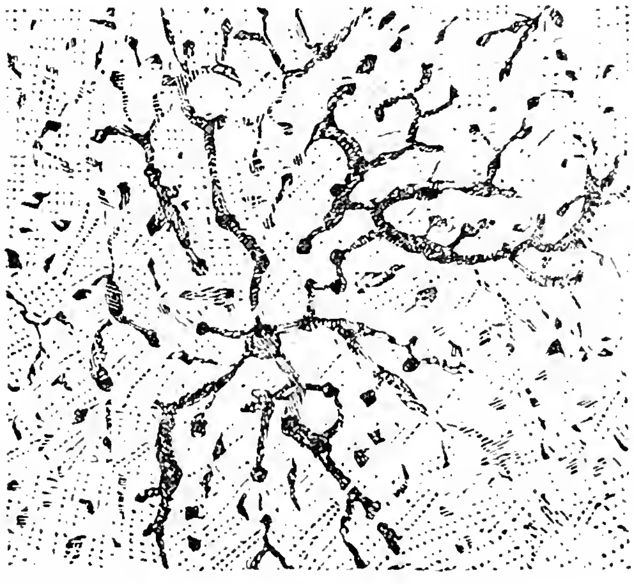
Canals of modern *Calcarina* (after Mobius).

4.



Canals and Tubule of Tertiary *Nummulina* (after Mobius).

5.



Canals of *Cœnostema*—Upper Silurian—(original).

3. To the canal system, Professor Möbius does more justice, and admits its great resemblance to the forms of this structure in modern *Foraminifera*. This indeed appears from his own figures, as will be seen from the fac-simile tracings reproduced here, figs. 1, 2, 3 and 4, which well show how wonderfully this structure has been preserved, and how nearly it resembles the similar parts of modern *Foraminifera*. He thinks, however, that these round and regularly branching forms are rather exceptional, which is a mistake; though it is true that the sections of the larger canals are often somewhat flattened, and that they become flat where they branch. They are also sometimes altered by a vicinity of veinlets or fractures, or by minute mineral segregations in the surrounding calcite, accidents to which all similar structures in fossils are liable. Another objection, not original with him, is derived from their unequal dimensions. It is true that they are very unequal in size, but there is some definiteness about this. They are larger in the thicker and earlier formed layers, smaller or even wanting in the thinner and more superficial. In some slices the thicker trunks only are preserved, the slender branches having been filled with dolomite or calcite. It is difficult, also, to obtain, in any slice or any surface, the whole of a group of canals.* Farther, as I have shown, the thick canals sometimes give off groups of very minute tubes from their sides, so that the coarser and finer canals appear intermixed. These appearances are by no means at variance with what we know in other organic structures. Another objection is taken to the direction of the canals, as not being transverse to the laminæ but oblique. This, however, may be dismissed, since Möbius has of course to admit that it is not unusual in modern *Foraminifera*. It may be added that some of the appearances which puzzled Möbius, and which are represented in his figures, evidently arise from fractures displacing parts of groups of canals, and from the apparently sudden truncation of these at points where the serpentine filling gives place to calcite. It would also have been well if he had studied the canal systems of those *Stromatoporæ* which have a secondary or supplemental skeleton, as *Cœnostroma* and *Caunopora*. In illustration of this I give in fig. 5 a group of these canals from a recent paper of my own.†

* I have succeeded best in this by etching the surface of broken specimens.

† Journal of London Geological Society, January, 1878.

4. A fatal defect in the mode of treatment pursued by Möbius is that he regards each of the structures separately, and does not sufficiently consider their cumulative force when taken together. In this aspect, the case of *Eozoon* may be presented thus: (1.) It occurs in certain layers of widely distributed limestones, evidently of aqueous origin, and on other grounds presumably organic. (2.) Its general form, lamination and chambers, resemble those of the Silurian *Stromatopora* and its allies, and of such modern sessile foraminifera as *Carpenteria* and *Polytrema*. (3.) It shows under the microscope a tubulated proper wall similar to that of the Nummulites, though of even finer texture. (4.) It shows also in the thicker layers a secondary or supplemental skeleton with canals. (5.) These forms appear more or less perfectly in specimens mineralized with very different substances. (6.) The structures of *Eozoon* are of such generalized character as might be expected in a very early Protozoan. (7.) It has been found in various parts of the world under very similar forms, and in beds approximately of the same geological horizon. (8.) It may be added, though perhaps not as an argument, that the discovery of *Eozoon* affords a rational mode of explaining the immense development of limestones in the Laurentian age; and on the other hand that the various attempts which have been made to account for the structures of *Eozoon* on other hypotheses than that of organic origin have not been satisfactory to chemists or mineralogists, as Dr. Hunt has very well shown.

Professor Möbius, in summing up the evidence, hints that Dr. Carpenter and myself have leaned to subjective treatment of *Eozoon*, representing its structure in a somewhat idealized manner. In answer to this it is necessary only to say that we have given photographs, nature-prints, and camera tracings of specimens actually in our possession. We have not thought it desirable to figure the most imperfect or badly preserved specimens, though we have taken pains to explain the nature and causes of such defects. Of course, when attempts at restoration have been made, these must be taken as to some extent conjectural; but so far as these have been attempted, they have consisted merely in the effort to eliminate the accidental conditions of fossilized bodies, and to present the organism in its original perfections. Such restorations are not to be taken as evidence, but only as illustrations to enable the facts to be more easily understood. It is to be observed, however, that in the study of such fossils as *Eozoon*, the observer must expect that only a small proportion of his specimens will show the structures with any approach to perfection, and that comparison of many specimens prepared in different ways may be necessary in order to understand any particular feature. A single figure or a short description may thus represent the results of days spent in the field in collecting, of careful examination and selection of the specimens, of the cutting of many slices in different directions, and of much study of these with different powers and modes of illumination. My own collection contains hundreds of preparations of *Eozoon*, each of which represents perhaps hours of labor and study, and each of which throws some light more or less important on some feature of structure. The results of labor of this kind are unfortunately very liable to be regarded as subjective rather than objective by those who arrive at conclusions in easier ways.

Taken with the above cautions and explanations, the memoir of Professor Möbius may be regarded as an interesting and useful illustration of the structures of Eozoon, though from a point of view somewhat too limited to be wholly satisfactory.—*Amer. Journal of Science and Arts, March*, 1879.

The following notice of the Memoir on Eozoon by Prof. Möbius, referred to in the above paper, is from the "Annals and Magazine of Natural History Society" for April, 1879.

The author first enumerates the published memoirs on *Eoozon*, and states how he was led to look specially into the matter, having met with his *Carpenteria rhaphidodendron*, of Mauritius, which at first sight he thought would present some striking analogy to the presumed Laurentian fossil. The sources whence he obtained Eozoonal preparations and the methods of examination are also mentioned. The form and size of *Eozoon*, as recognized by Dawson and Carpenter, and their comparison of its structure with that of certain Foraminifera, are given in some detail; also the shape, size, and arrangement of the serpentinal bodies ("chamber-casts," "concretions," &c.), their connexion, and the fibrous layer ("acicular crust," "nummuline layer," &c.) between these bodies and the limestone (calcite) are treated of as figured in the accompanying plates. The little Eoozonal stalk-like bodies traversing the associated limestone (calcite), and regarded by Eoozonists as "casts of canals," are next dealt with (p. 185). The structure, as a whole, is compared with that of Foraminifera at pages 186–189. The absence of any primary or central chamber, the apparently capricious distribution of both the "tubuline layer" and the "canals," the impossibility of representing the *Eozoon* as a whole by any drawing of one natural specimen, and the consequent necessity of using diagrammatic figures to illustrate the reconstructed body, are points dwelt upon in this chapter, leading to Prof. Möbius's conclusion that he does not believe *Eozoon* to be a Foraminifer or organic at all.

At pages 189–191 the authors refers to the brief published observations on *Eozoon* emanating from the lamented Max Schultze, who stated that he could not agree in the opinion that the so-called "nummuline layer" was really of Foraminiferal origin; and expressed his intention of giving further study to the other peculiar structure, which had been referred by Dawson and Carpenter to the "canal-system," and with specimens of which his friends were supplying him.

The reason for referring the structure of the Eozoonal marble to a Rhizopodal organism have been given in detail, with illustrations, in many papers and notes by Carpenter and Dawson in this and other periodicals. The objections now again raised by our author have been already dealt with in those papers. Of the structures treated of by Prof. Möbius the branching and lobular infillings of the "canal-system" are particularly valued by Eozoonists as good evidence, on account of their peculiar arrangement, so agreable to the disposition of canals in certain Foraminiferal shells. Such appearances in *Calcarina*, &c. were figured and published without reference to and before the discovery of *Eozoon*. That ancient organisms, though belonging to the same groups as represented in nature to-day, should differ widely in details of structure, is a truism illustrated by many newly discovered fossil (and even recent) forms of life, whose structure is found to be wonderfully different from, and yet wonderfully consonant with, the make-up of the already known types of organic structures; and this invalidates our author's objection to a reliance on the possibilities of Nature. What zoologist or botanist can predicate the structural details of the next discovered plant or animal, however narrow the limits we may suppose to define its alliance to any previous known form?

Although many mineralogists regard the eozoonal rock as having been as inorganic in its origin as it now is in its material, yet Dr. Sterry Hunt, for one, who has long studied it, thinks that its peculiarities are not due to a mineral genesis alone. We know also that not only Foraminiferal shells, but other calcareous tests and skeletons, both recent and fossil, have their tubes and cavities filled by various minerals, with results very similar to what is regarded as having taken place and as being visible in *Eozoon*.

It is not that here and there, and, indeed, in very many parts of a true Eozoonal rock there are lines and patches, fibrous and concretionary, of purely mineral origin, as well as their mineral matrix,—the point to be kept in view is that the structure of certain portions is best explained by reference to mineral infiltration of tubular and cavernous shells, which grow and spread after the manner of Foraminifera, though not identical with any known form in particular. Also it has to be remembered that not only has the enclosing rock been itself subjected to mineral changes, but has been crushed, broken and twisted, and that the scarcity of large areas of perfect and undisturbed structure, in such a relatively large *Rhizopod*, has to be supplemented, in the study of its whole, by such diagrammatic constructions of what the experienced observer recognizes and wishes to explain, as our author condemns at p. 188, because, he thinks, the Eozoonists in their diagrams have overstepped the line of probability. Without such illustrations, showing (like models) both the elevation and perspective of internal arrangements, we may remark, external appearance and microscopic sections would very imperfectly elucidate the descriptions of large Foraminifera. The correlation of the mineral representatives of, at least, the "canal-tubes" and "chambers" in *Eozoon*, both of which are cut at many different angles in sections, and can rarely be seen in elevation, and then only to a small extent, are best shown by this method—especially, too, as the student has, in this case, to make a mental translation of threads into tubes, and nodules into chambers.

At page 198 Prof. Möbius consoles the Eozoonists with his opinion that the doctrine of evolution need not be despaired of because he removes the primordial *Eozoon* from the category of

Beings. We do not see the value of this commonplace and wordy little chapter, except to illustrate what (at pp. 178, 179) he warns Eozoonal and other naturalists to avoid, namely, time-wasting and immature talk, in which words take the place of ideas.

Plates xxiii. to xxxiv. inclusive contain carefully drawn figures (coloured) of preparations of the Eozoonal ophitic marble, as thin slices, as etched surfaces, and as separated particles, communicated by Drs. Carpenter and Dawson.

Plates xxxv. to xl. inclusive (excepting one figure) contain enlarged sections of the shell-structure of *Polytrema miniaceum*, *Cycloclypeus*, *Nummulina*, *Calcarina Spengleri*, *Tinoporus baculatus*, *Orbitoides papyracea*, *Polystomella*, and *Carpenteria rhaphidodendron*. All (except one) of these drawings have been made by the Author himself.

In none of the preparations of known recent and fossil Foraminifera here figured does Prof. Möbius see any thing more than a distant resemblance to Eozoonal structure, which latter, as before said, he regards as inorganic.

This memoir is a handy *résumé* of the objections made by anti-eozoonists to the presumed organic origin of the object under notice; and the plates brought together by Prof. Möbius, with no little labour and skill, are useful as a compendious set of sectional figures of *Eozoon* and many of its more modern relations; and, though he fails to see their alliance, close as the analogies may be, yet his work is highly useful and praiseworthy; it is disinterested, straightforward, and consciencíously offered for the advancement of knowledge.—*Annals Nat. Hist., April*, 1879.

ON THE WATER SUPPLY OF MONTREAL AND ITS SUBURBS.

By J. Baker Edwards, Ph.D., D.C.L., F.C.S., Professor of Chemistry, University of Bishop's College, and Public Analyst.

(Read before the Natural History Society of Montreal, April 28th, 1879.)

In order to render this review as complete as possible, I will commence by quoting the analyses of Dr. T. Sterry Hunt, in his report to the Water Committee of this city in 1854.

The samples were collected in the months of March and April, and gave the following amount of mineral matter per imperial gallon after destruction of the organic matter by heating to redness. These results are interesting for comparison with more recent analyses:

	R. Ottawa Ste. Anne's.	St. Lawrence Cascades.	Lachine.	Old City Water Works.
Mineral matter per gallon.	3.73	10.76	8.41	9.62

Dr. Hunt, in his report, states that the amount of chlorides found in the city water taken from the old works on Commissioners street always contained an excess of chlorides over the water of the St. Lawrence, showing local sources of impurity, probably due to the drainage of the city.

The nature of the organic matter does not appear to have been very closely investigated; but it is suggested that it was of a vegetable and harmless character.

In the very valuable and elaborate reports of the Geological Survey, published in 1863, Dr. Hunt furnishes us with fuller analyses, and makes the following "comparison" of the waters of the Ottawa and the St. Lawrence:

"The comparison of the waters of the two rivers shows the following differences: the water of the Ottawa, containing but little more than one-third of the solid matter of the St. Lawrence, is impregnated with a much larger quantity of *organic matters*, and contains a large proportion of *alkalies* uncombined with *sulphuric acid* or *chlorine*."

The organic matter determined by loss after ignition was estimated as follows:

	Ottawa R.	St. Lawrence.	Lachine.	River front of City.
Grains of organic matter per gallon.	1.11	.98	1.49	1.29

We have, therefore, on the best authority, the condition of the old water supply and of the river waters in question before the present works were completed.

My own analyses date from 1870; but the first series of results which I now submit were made in 1872, from samples of water which I collected myself during a trip from Niagara, in the month of June of that year.

The quantity of water at my disposal was too small to determine the organic nitrogen; but as a record of the solid contents of the waters of the St. Lawrence it may possess some interest.

	Organic Carbon.	Mineral Salts.	Total.	Hardness, by Clark.
River Niagara,	1.10	6.60	7.70	3.5°
Lake Ontario,	1.01	6.50	7.51	3.3°
Toronto Bay,	* 2.50	8.50	11.00	4.5°
St. Lawrence, Long Sault,	1.20	6.60	7.80	3.3°
Do Pointe Cascades,	1.20	6.60	7.80	3.5°
Do S. Shore Aqueduct,	1.20	7.60	8.90	3.5°

* Containing nitrogen.

With the exception of the water of Toronto Bay, these waters are all clear and pellucid, and run sufficiently near in mineral contents to justify us in accepting the mean as a fair estimate of the quality of the St. Lawrence water. This gives us an average of about 1 grain per gallon of organic carbon, and 7 grains of mineral matter for St. Lawrence water above Lake St. Louis, in the month of June, 1872. In water taken from near the south shore, in May, 1873, I found:

Organic Matter.................	1.1
Mineral Salts.....................	7.8
Hardness, 3.5°	8.9

In December, 1879, water from the inlet of the Longueuil water works gave me:

Organic Matter...............	1.5
Mineral Salts........	10.0
Hardness, 6°	11.5

In May, 1879, water from the same point, as supplied from the Longueuil water works, contains:

Organic Matter................	2.03
Mineral Salts...................	9.72
Grs. per imperial gallon,	11.75
Hardness, 6.25°, Clarke.	

(At this time the river was pretty full and brimming the wharves at Montreal.)

From the above it will be seen that the water gains 3 degrees in hardness on the south shore between the Lachine rapids and Longueuil, while there is no great increase in mineral lime solids.

The alkaline silicates disappear in the dried residue, and saline chlorides and sulphates are increased in quantity.

These are indications, therefore, that the water at Longueuil is somewhat affected by passing the city, but not to such an extent as to render the water unwholesome, although it would be much safer if sand filtered.

On the other hand, the water at Hochelaga gives considerable indications of nitrogenized impurity, the result of animal decay, and it is doubtful whether simple filtration would render it fit for human consumption. It is evidently affected by the sewage of the city both near the shore and in mid-stream. Any attempt to utilize it for a water supply would be attended with great expense, and still involve some risk of typhoid impurities.

WATERS OF THE NORTH DISTRICT.—1872 and 1873.

In contrast to the table of the waters of the St. Lawrence and the south shore, the following analyses of the waters of the north district will be found of interest, showing that, whilst the lake waters are of remarkable purity being taken at a great elevation and above the ordinary sources of impurity, the river waters of the north district which drain from the Laurentides, all contain alkaline silicates, and are slightly coloured with organic spores giving a yellow marsh-like tinge, to the waters. These waters, when conveyed for some distance in iron pipes, become of an ochreous tinge, from the precipitation of the vegetable matter in solution, which is unpleasing to the eye and somewhat difficult of filtration. A water of similar character has been introduced into Liverpool, England, and was for some time disliked on account of its peculiar color; but it has proved a wholesome and useful water, and the color is no longer deepened by the iron pipes which convey it from Rivington, a distance of twenty-five miles.

The waters of the north district gave the following results per imperial gallon :

	Organic Carbon.	Mineral Salts.	Total.	Hardness, by Clark.
Lake Kilkenny,	1.10	2.15	3.25	0.5
Lake Masson,	1.05	2.05	3.10	0.5
Rivière du Nord,	1.80	2.70	4.50	1.2
River Ouareau,	2.05	3.95	6.15	1.1
River Ottawa,	1.90	2.30	4.20	1.3
Do at Ste. Anne,	1.80	4.40	6.20	2.5

The Lake waters were perfectly colourless, while the River waters were more or less tinged.

The waters which supply the city of Montreal and the municipality of St. Cunegonde are taken from the aqueduct on the north shore of the river, just below Lachine, and are the mingled waters of the St. Lawrence and of the Ottawa Rivers in varying proportions at different periods of the year.

During the winter months the waters of the St. Lawrence are higher and more uniformly fed than those of the Ottawa: being confined under the ice, they therefore displace the Ottawa water, and, pressing over the rapids at Ste. Anne, they drive the northern waters chiefly over the "Back River" to the north of the Island of Montreal. The extent of this diversion depends partly upon the grounding of the ice about the western shore of the Isle Perrot and the ice block at Lachine rapids, circumstances which differ in extent and duration at every season, and contribute to the frequent variation of the character of the water supply at Montreal. This difference is more apparent in the color, flavor and comparative clearness of the water than in the results which appear by analysis of the salts which they contain,—the chief difference being in the organic constituents and in the aëration by carbonic acid, and in the presence of alkaline silicates or their neutralization by calcium salts.

The present system of supply on the rising main exaggerates the evil of a mixture of incompatible waters by carrying into all the houses below the level of St. Catherine street the suspended matter or dirt, with its accompanying disgusting lower organism, which fill the pipes and accumulate in the closet cisterns, especially in the spring, when the ice breaks up and renders the water muddy, and again during the heavy rains of the fall.

Of this suspended matter, my friend Dr. G. P. Girdwood has published a record in the *Canada Medical Journal*, Vol. vii, page 102, showing that in three months' ordinary summer supply the average daily deposit of *insoluble mud* varies from 2 grains to 4.8 grains per gallon, while under the exceptional circumstances of disturbance, the amount rises as high as 14 grains per gallon. As inhabitants of this mud, he enumerates fifteen forms of animal life, which he found in addition to those which I had previously described in the *Canadian Illustrated News* (Dec. 7, 1870).

The following table gives the result of analyses of the Montreal water supply in recent years, and during different seasons of the year:

Table of Analyses of Montreal Water Supply.

Date of Collection.	Locality.	Total Solids per Impl. Gallon.	Organic Carbon.	Mineral Salts.	Hardness by Clark.	Albuminoid Nitrogen, per million by Nessler.	Appearance.
May, 1872	Water Workshops - -	14.01	4.01	10.00	2.7	.001	Turbid, discolored —river high.
Sept., 1872	Wheelhouse - - -	9.25	2.00	7.25	2.3	.001	do.
Feby, 1873	Laboratory, Beaver Hall	8.50	1.00	7.50	3.6	.001	Turbid.
June, 1873	do.	9.10	2.90	7.10	3.8	.010	Clear.
Sept., 1873	do.	7.25	1.00	6.25	3.0	.010	Clear.
Feby, 1874	do.	9.10	1.50	7.60	3.8	.001	Turbid.
Dec., 1874	High Level Reservoir -	6.50	.50	6.00	2.0	none.	Very clear.
Dec., 1877	Laboratory, Beaver Hall	8.60	1.00	7.60	2.5	trace.	Clear.
Jany, 1878	do.	9.10	1.00	8.10	3.0	trace.	Clear.
March, 1878	do.	9.50	1.00	8.50	2.0	.010	Turbid.
July, 1878	do.	8.00	1.50	6.50	2.5	trace.	Clear brown.
Nov., 1878	do.	7.50	1.50	6.00	2.0	trace.	Clear.
Jany, 1879	do.	5.95	2.15	5.80	0.6	trace.	Clear.
April 7, 1879	do.	11.20	4.90	6.30	1.75	1.00	Turbid and very impure.
April 24, 1879	Service at I. R. Office -	8.05	1.40	6.65	2.50	.03	Nitrogen in excess.
May 9, 1879	Hydrant at St. Cunegonde	6.80	2.10	4.70	3.25	.02	Not clear. Nitrogen in excess.

It will seen from this table of analyses that the Montreal water supply is a most valuable product, and that it often contains excess of mineral matter in suspension, and sometimes organic debris from local or temporary causes. A far more wholesome water supply would be secured from the same source by the addition of settling beds of masonry and filter beds of gravel and sand after the Liverpool model, which I am informed should not cost more than 10 cts. per 1000 gallons, and would certainly contribute largely to the health of the inhabitants and to the hygienic reputation of the city. Moreover, upon other economic grounds, this is a wise and prudent improvement, which has been too long denied to the well-taxed public of Montreal. This I have urged to the successive Mayors, Chairmen of Boards of Health, and of the Water Committees, and I wish once more to urge these considerations on the municipal and sanitary authorities.

The waters of the Ottawa and of the north district generally which flow past Montreal island are remarkable for the sandy or flinty character of their minute animal and vegetable organisms, and for the presence of alkaline silicates, which when co-mingled with the waters of the St. Lawrence become precipitated into gelatinous hydrate of silica. As the result of frequent microscopic examinations of the deposits formed by subsidence of the water supplied to my laboratory, and also the deposits separated by the process of filtration in my house filter, I find that the deposits consist of

1. *Angular fragments of sand and flint.*
2. *Gelatinous silicious magma.*
3. *Organic silicious filaments of Diatoms*, also *spicules and gemmules of fresh-water Sponges* and *skeletons of Algæ*. This deposit resembles in general character the well-known "Tripoli powder" used for the burnishing of metals, the keenness and polishing power of which, is due to the presence of similar vegetable sandy fragments, which are scarcely less hard than "Emery powder" and will cut fine scores in the brass work of taps and valves, which, followed by hard particles of sand, give rise to continual leakage.

Therefore, I submit that the filtration of the water, *before it is pumped into the mains of the city*, would, by removal of this *gritty flinty* matter accomplish a *saving of waste* alike in water, taps, valves and working machinery, which would *more than repay* the cost of filtration, and prove at the same time a great sani-ary benefit. With regard to the *cost of filtration* I ascertained when last in Liverpool, that the cost of filtering 11 millions of gallons per diem, including cleansing and change of filters and interest of Capital, involved a comparatively small outlay and was maintained at a rate of £1250 sterling per annum, say $575 per annum for each million gallons per diem. The balance of the Liverpool supply is drawn from well water naturally filtered through the red sandstone rock.

Under the intermittent system the consumption in Liverpool was on the whole average 33½ gallons per head, per day; in certain districts 58 to 69 gallons per head per day. Under the constant service system this fell to 19½ gallons per head per day. Under the system of district meters and inspection this is now reduced to 12 gallons per head per day, with a constant, more uniform and ample supply. Now a consumption of 33½ gallons per head per day indicates a waste of 21 gallons per head per day and this saving is effected at a cost of one farthing per 1000 gallons, whilst an additional supply must be reckoned to cost from 5d to 6d per 1000 gallons.

I venture to think that the adoption of the Liverpool district plan in Montreal, of which filtration is the first element, would

1stly. *Double the available supply.*

2ndly. Afford also, a *spare head of water for flushing sewers and cleansing streets.*

3rdly. *Improve the sanitary condition* of the city by the supply of *filtered water* and thus guard against prevailing endemic and threatened epidemic disease, reduce the rate of infant mortality, and promote the general health and sobriety of the citizens at large.

Next to a really satisfactory supply of water to the city, the important and increasing necessities of the suburban districts demand consideration and timely relief. Either by extension of the city limits or by developments of the water supply to the suburbs, it is obvious that some better provisions for water supply ought to be made for those who very wisely forsake the crowded streets and lanes of the city and resort to the beautiful and healthful suburbs of Montreal Mountain. Why should not a head of purified water be here maintained sufficient to supply the whole island of Montreal? A liberal and enlightened municipal policy would not rest content with the present area of distribution, but would seek powers by which this water should be accessible in every direction, in which enterprize may seize upon a good locality, in which to plant real estate.

In the district of Hochelaga, the future Leith of our city, we have, as shown in an earlier portion of this paper, cut off the inhabitants from a reasonable enjoyment of our common river, by impregnating the same with sewage at the new outlet of Colborne avenue.

We also stand in great danger of permanently contaminating the water of Longueuil, and therefore the extension of the city southward; and the projection of the sewage at a more northern point much beyond the present will be an absolute necessity in the near future. For the provision of an ample supply of good water the municipality of Hochelaga have made diligent search, but no available source has been discovered nearer than the Back river. Hochelaga must therefore depend on Montreal for a water supply.

The district of St. Cunegonde at the west also requires water, and a large water supply. The farm of Prof. Macgregor at Braeside furnishes a remarkable spring, which would afford a wholesome and large supply of water from the Laurentian hills on the north.

My analysis of this spring, made in April last, gave the following result:

Total solid contents per imperial gallon	31.30
Hardness by Clark, 19°	
Albumenoid nitrogen	no trace.
Carbonate of lime and magnesia	22.00
Organic carbon	1.75
Silicious carbon	2.30
Silica wh. iron and alumina	.10
Chlorine (combined)	1.72
Sulphuric acid do.	.73
Alkaline bases	2.70
	31.30

This is a very excellent water, but rather hard for domestic and industrial purposes. I am informed that the flow of the spring is equal to about 4000 gals. per diem.

At Cote St. Antoine, outside the city limits, the residents are supplied by water carts, which are sometimes replenished from the flushets of melting snows in neighbouring fields, sometimes from the canal direct. These carted waters are usually very impure. The water flowing from Montreal mountain is however of good quality. At the Mile End also, water carters purvey water from the quarry ponds, full of animalculæ and vegetable matter, which is unfit for domestic use.

At Mount Royal Vale surface water is collected which is well mingled with clay, and when clear this water appears to be of good quality but rather hard. An analysis of this water in April last, gave the following result:

Organic carbon - -	4.20
Carbonate of lime - -	14.40
Silica and alkaline salts -	2.40
Hardness by Clark 14°	21.00

At Lachine also, better waters, although somewhat harder, are obtained from local wells than from the river water. I found that in the month of March, 1878, the river water gave

Organic carbon - -	3.1
Mineral salts - - -	9.6
	12.7 grains,

and that it also contained excess of albuminoid nitrogen.

It would therefore appear highly desirable for the hygienic welfare of our suburban residents and our summer visitors, that the Montreal water works should be considerably extended, and the filtered water distributed from our mountain reservoirs to the whole outlying districts. This *great improvement*, which I have consistently and persistently advocated for some years, I hope to live to see an *accomplished fact*.

PROCEEDINGS OF THE NATURAL HISTORY SOCIETY OF MONTREAL.

The fifth meeting of this Society for the present session was held on the evening of Monday, April 7th.

Principal Dawson occupied the chair.

The minutes of last ordinary meeting and also of last meeting of Council were read and approved.

Five new members were elected, and two proposed.

A fine specimen of fresh-water black-bass, *Centrarchus fasciatus*, was presented to the Museum by Mr. Alex. Fowler.

Mr. J. T. Donald then read a paper on "Elephant remains from Washington Territory."

This paper was a statement of the result of an effort to determine the species to which Elephant remains, represented by a molar forwarded to the Society, belonged. The remains were referred to *Elephas primigenius*, var. *Jacksoni*.

The chairman next addressed the meeting "On the origin and history of successive floras of America." He showed that these floras had all originated in the north and then moved southward.

The various theories as to the causes by which these polar regions had been rendered fit habitations for plants of our temperate climes were presented and discussed, after which the meeting adjourned.

The sixth regular meeting took place on Monday Evening, April 28th. The President occupied the chair. After routine business, Kenneth Campbell, Esq., presented the Society with a specimen of coca, *Erythroxylon coca*, from Mexico.

Mr. Thomas Macfarlane, of Acton, Que., read a paper entitled "Remarks on Canadian Stratigraphy." This was a reply to, and criticism of Mr. Selwyn's paper "On the Stratigraphy of the Quebec Group and the older crystalline rocks of Canada," read before the Society in February last.

Mr. Macfarlane's paper appears in the present number of the *Naturalist*.

Mr. Selwyn replied to Mr. Macfarlane, explaining some of the statements he had made in the article referred to, and maintaining the correctness of the position assumed by him in these statements.

Dr. T. Sterry Hunt also spoke in reference to Mr. Selwyn's late paper. He contended that the Norian rocks are not eruptive, and objected to Mr. Selwyn calling his "systems" of rocks such as Norian and Montalban *theoretical*, when thirty years labor had been spent upon them.

Dr. J. Baker Edwards then presented the meeting with "Notes on the Water Supply of Montreal and its Suburbs," which we publish in full.

MISCELLANEOUS.

Some remarks on Inter-Glacial Epochs, in reference to Fauna and Flora existing at the present day in the Northern Hemisphere, between the parallels of 81° and 83° N., by H. W. Feilden, F.G.S.—In the brief paper that I have the honour of submitting to your notice, it is my desire to draw your attention to the theory of intercalation of series of warmer climates during what is called the Glacial Epoch.

In accordance with the opinions of Professor Oswald Heer and the late Sir Charles Lyell, the existence of Inter-Glacial Periods has been indisputably evidenced by the Dürnten beds of Switzerland, and the Forest bed of our Norfolk coast; and while Professor Heer considers that the Dürnten lignite beds represent the existence of a climate similar to that now existing in Switzerland, Lyell remarks that the Forest bed of Cromer presents a singular analogy to that of Dürnten, and that "both of them alike demonstrate that there were oscillations of temperature in the course of that long period of cold."*

Mr. James Geikie in his valuable work "The Great Ice Age," has likewise adopted the theory of the intercalation of warmer climates to account for the inter-glacial beds of Scotland. In fact, so many of our greatest modern authorities have given their adhesion to this theory, that it may almost be regarded as an accepted fact amongst modern geologists. That the so-called inter-glacial beds of Scotland and England were deposited between the commencement of the Glacial Epoch and its final withdrawal from Great Britain, is a well-established fact; but the question I am desirous of presenting to your consideration is, whether the so-called inter-glacial beds represent what Lyell terms "oscillations of temperature," or merely modifications of temperature due to alteration in the levels of land-masses, and the consequent change in their character as condensers of moisture, with probably a change also in the direction of the oceanic currents.

My suggestion, that it may not be necessary to connect the so-called inter-glacial beds with sudden changes or oscillations of temperature, is based upon the results of observations in Grinnell Land during 1875-76.

* Lyell, Principles of Geology, vol. i. p. 196, eleventh edition.

Having been fortunate enough to pass twelve months in the most northern portion of the earth that civilized man has yet visited, a region subjected to as rigorous extremes of cold as any yet recorded, where the sun remains below the horizon at mid-day for five months, where the mean annual temperature is—3°·473, where a minimum of—73°·75 was registered during the month of March, and where for only three months of the year the mean temperature rises up to and above the freezing point of fresh water, viz. +32°·455 in June; +38°·356 in July; +31°·913 in August. I was impressed with the fact that this region is undergoing less glaciation than Greenland, lying twenty degrees of latitude to the southward in the parallel of Shetland, and differing remarkably from the northern part of Greenland, lying between the same parallels, and separated by a narrow water-way not twenty miles across.

In Grinnell Land, from lat. 81°·40′ N. to lat. 83°·6′ N., no glaciers descend to the sea, no ice-cap buries the land; valleys from which the snow is in a great measure thawed during July and part of August stretch inland for many miles, and the peaked mountains, snow-clad during the greater portion of the year, in July and August have great portions of their flanks which rise to an altitude of 2,000 feet bared of snow.

The opposite coast of Greenland presents a very different aspect, a *mer-de-glace* stretches over nearly its entire surface, its fiords are the outlets by which its great glaciers protrude into the sea. In Petermann Fiord the ice cap with its blue jagged edge lying flush with the face of the lofty cliffs was estimated to be forty feet thick.

When we turn to the Flora and Fauna of Grinell Land the difference is equally astonishing; some fifty or sixty flowering plants are found in its valleys, and between latitudes 82° and 83° N., I have seen tracts of land so profusely decked with the blossoms of Saxifraga oppositifolia that the purple glow of our heath clad moors was brought to my recollection.

Musk oxen in considerable numbers frequent its shores; the Arctic fox, the wolf, and ermine, with thousands of lemmings live and die there. The bones of these mammals, along with those of the ringed seal (*Phoca hispida*), are now being deposited in considerable quantities in the fluvio-marine beds now forming in the bays and at the outlets of all the streams, or rather summer torrents of Grinnell Land. With these bones will be associated those of birds, such as geese and sea-gulls. Numerous mollusca and crustacea, many species of rhizopods, with the remains of land and sea plants, will there find a resting place.

Supposing that these beds were examined at some future period under conditions, when the glacial epoch had disappeared from the sourrounding area, it would be difficult to realise that they were contemporaneous with the beds formed under the Greenland ice cape in the same parallel of latitude and on the opposite shore of a channel not twenty miles across.

In the one case, enormous thicknesses of till with ice-scratched stones have in all probability been deposited; in the other, fluvio-marine beds containing a comparatively rich assemblage of marine and land forms, with river rolled pebbles, would be brought to light.

In the face of these facts is it incredible to suppose that the inter-glacial periods of Great Britain are due not so much to "oscillations of temperature" as to alterations in the amount of moisture in the atmosphere, and the position of the land-mass regarded as a condenser?

It is evident that the glaciation of Greenland and the west shore of Baffin's Bay and Ellesmere Land is not a result altogether of degrees of heat and cold, or in other words, temperature, but equally the result of geographical position which causes these regions to act as mighty condensers, throwing down in the form of snow the heated vapour of the south, and so effectually eliminating the moisture from the air that a tract of country like Grinnell Land lying still further to the north and subjected to an equally rigorous climate, is comparatively exempt from glaciation.—*From the Scientific Proceedings of the Royal Dublin Society.*

THE ROCKY MOUNTAIN LOCUST.—At its last session Congress appropriated $10,000 for the completion of the investigation of the Rocky Mountain locust by the United States Entomological Commission. The work during the coming season will be carried on in Colorado and the Western Territories, particularly Utah and Eastern Idaho, where the locust abounds each summer, doing more or less damage. Parties will also be sent into Montana, the main breeding place of the destructive swarms periodically visiting the Western Mississippi States.—*American Naturalist, May*, 1879.

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SKETCHES OF THE PAST AND PRESENT CONDITION OF THE INDIANS OF CANADA.

By George M. Dawson, D.S., Assoc. R.S.M., F.G.S.

It is computed that the Indian population of the Dominion at the present day numbers nearly 100,000, distributed as follows—the figures being those of the last report of the Department of the Interior :—Ontario, 15,666 ; Quebec, 10,917 ; Nova Scotia, 2,116 ; New Brunswick, 1,425 ; Manitoba and N. W. Territories, 27,308 ; Athabasca District, 2,398 ; Rupert's Land, 4,370 ; British Columbia, 35,154 ; Prince Edward Island, 296.

Constituting thus nearly a fortieth part of the entire population of Canada, the Indians would even numerically be a not unimportant factor in questions of interior policy. As the original possessors of the land, however, though possessing it in a manner incompatible with the requirements of modern civilization, and as having been at times ready to assert that ownership, even in a forcible manner, they acquire quite a special interest ; even without that afterglow of romance which follows the memory of the red man in those regions from which he has already passed away.

Though in the ante-Columbian period of American history nearly all the Indian tribes and nations appear to have been either drifting or gradually extending, by force of arms, in one direction or another, as indicated by their history or traditions, their movements were neither so rapid nor erratic as those which have occurred since the old organization and balance of power began to crumble before the advance of irresistible force from without. We may therefore trace, with some degree of definiteness, the extension of the greater Indian families as they existed when first discovered, grouping together, for this purpose, many tribes which, though speaking the same or cognate languages, and with a general similarity in habits and modes of life, were not unfrequently at bitter enmity among themselves, and in some cases had almost forgotten their original organic connection.

In North-eastern America, the great Algonkin family was numerically the most important, occupying a vast extent of country, from beyond the western end of Lake Superior, along its northern shores, to the region of the Ottawa—which appears to have been the original focus of this group of Indians—filling the great wilderness between the St. Lawrence River and Gulf and the southern part of Hudson's Bay, occupying New Brunswick, Nova Scotia and the present New England States, and stretching even further southward, to the confines of Florida.

There appear to have been seven main tribal divisions, which are said to have numbered each from 3,000 to 6,000 warriors, and are those referred to collectively by the Jesuits, who had comparatively little knowledge of the tribal intricacies of this part of the continent, as *ces grands bourgs des Naragenses.* Many of the names of these tribes and of their smaller subdivisions are still perpetuated in a more or less travestied form in the names of places; and in the history of the early days of the English colonies some of them appear continually. In addition to these, inhabiting Maine and New Hampshire, was the great Abenakis tribe, afterwards of some importance in Canadian history, when pressed northward by the disturbances incident to the establishment of the English Colonies. Closely allied to these, were the Malecetes and Micmacs of New Brunswick and Nova Scotia. To the north of the Gulf and lower part of the River St. Lawrence were a number of roving tribes, afterwards known collectively as the Montagnards; in the Ottawa region, the Algonkins proper, and further to the north-west the Chippewas or Ojibways centred, when first discovered, near the Sault Ste. Marie, whence the name *Sauteux* applied to them by the French. These last were pressing westward, waging incessant warfare with the Sioux, and gradually dispossessing them of their hunting grounds about the sources of the Mississippi.

South of the Algonkin territory was the great Iroquois nation, extending from the southern part of Lake Champlain to

Lake Erie, and including the Senecas, Cayugas, Onondagas, Oneidas and Mohawks, a fierce, intelligent, unscrupulous confederacy or league of tribes, estimated afterwards by La Hontan at 70,000 in number, warring with neighbours and extending their boundaries in every direction, their very name a terror over half the northern part of the American continent. Allied to these by blood and language, although at the dawn of history at bitter enmity with them, were the Hurons, estimated at 30,000 to 40,000 in number, inhabiting the eastern border of the great lake which now bears their name. The Neutral Nation also inhabiting the peninsula of Upper Canada, and of the Iroquois stock, were, with the Eries, destroyed by the confederated Iroquois almost before their contact with the whites, and scarcely figure in history.

Following the more fertile country of the valley of the St. Lawrence, there appears to have been an outlying member of the great Iroquois-Huron family, holding the banks of the River and present sites of Montreal and Quebec, while the Algonkins, as we have already seen, peopled all the neighbouring regions.

Such were the main features in the distribution of the Indian nations of the north-east portion of the Continent at the time when they were about to be brought into contact with a stronger external power. In regard te their internal condition and progress in the arts, notwithstanding the gloss with which time may to some extent cover these aborigines, we cannot disguise from ourselves that they were for the most part the veriest savages. The northern Algonkins were found rarely, if ever, cultivating the soil, even on the most limited scale; hunters, fishermen adding to their dietary such wild roots and berries as the country happened to afford; living from hand to mouth, with little providence even for the annually recurring season of cold; probably then, as now among the more remote tribes, not infrequently forced even to cannibalism during seasons of scarcity; wanderers, not as some of them afterwards became in the service of the great fur companies, over immense areas of the Continent, but each little tribe migrating, with the seasons, in its accustomed district, from the lake abounding in trout or white fish, to the region frequented by deer, or the rocky hills and islands where berries ripened most abundantly; battling, with scanty means, against the heat of summer and the winter's cold, and not usually living with any sense either of security in life or in the possession of their meagre belongings; often at war, even among themselves, and their very slumbers haunted with an ever present shadow of dread; yet, withal, knowing no better state to envy, dimly looking forward to some distant future perfection, rudely imagined, in the "Happy hunting grounds"; regarding their own exploits in defence or retaliation—which had not yet paled before the greater "medicine" of the whites—as the highest expression of *good*.

The Iroquois, the Hurons and their congeners had raised themselves a little higher in the scale, adding to the uncertain pursuit of the chase the surer product of the field: they sometimes cultivated the ground, it would appear, on a pretty extensive scale, preserved their corn in granaries, and lived in permanent walled villages, situated with reference to the fertility of the soil. The Hurons alone, inhabiting, in this way the shores of Georgian Bay and Lake Simcoe, were, as we have already seen, estimated by Father Sagard at between 30,000 and 40,000 souls. Pictures of the same mode of life are found in the account of the Canadian expedition of the winter of 1666 against the Mohawks, to the south of Lake Champlain, and in Cartier's quaint and simple narrative of his first visit to Hochelaga (now the city of Montreal), which he says was surrounded with "goodly and large cultivated fields, full of such corn as the country yieldeth. It is even as the millet of Brazil, as great and somewhat bigger than small peason, wherewith they live even as we do with our wheat." The Iroquois, though thus more advanced, were in customs and modes of thought essentially one with the other Indians, and used their greater resources as a means of waging more savage and effectual war. They were a scourge to the surrounding nations, and more especially hostile to their relatives the Hurons, the Iroquets—as the Indians found by Cartier inhabiting the banks of the St. Lawrence were afterwards called—and the whole race of the Algonkins. These peoples found themselves, at the time of the arrival of the Europeans, cruelly oppressed by the wars of the Iroquois, scarcely able to hold their own, and would, in the natural course of events, have been absorbed or destroyed by them, or gradually forced to retreat into the hyperborean region. The French, with whom we have more particularly to deal, like the Spaniards, constantly used the christianization and civilization of the natives as a powerful argument in favour of their exploring enterprises, and really attempted to carry out their professions. In the early history of Canada we continually find the priest in advance of the explorer and the trader; and, though it is hinted that in some cases the traffic in peltries occupied part of the attention of the missionary, we seldom find them lending the Divine sanction to unprovoked violence or robbery.

The intercourse of the Europeans and Indians of the north-eastern portion of America can scarcely be said to have been begun by Cabot in his voyages of 1497–98–99, when he first discovered this part of the coast. With Cartier, in 1534 and 1535, in his memorable voyages up the St. Lawrence, the first real contact occurred. The natives appear to have received him often timidly, but were found ready enough to trade when friendship had been cautiously established. At the villages of Stadacona (Quebec) and Hochelaga he was received even with rejoicing, the natives bringing gifts of fish, corn and "great gourds," which they threw into his boat in token of welcome. It is evident, however, that they well understood and wished to maintain their territorial rights, for we find that when Cartier, in his first voyage, set up in the vicinity of the Baie des Chaleurs his "cross thirty feet high," the aged chief of the region objected to the proceeding, telling the French—as well as his language could be understood—that the country all belonged to him, and that only with his permission could they rightly erect the cross there. It was too, when, in 1541, Cartier attempted his abortive colony at Quebec, that the natives first manifested jealousy and a hostile spirit.

Much later, in 1607, when the permanent occupation of the country was begun by Champlain at Quebec, the erection of a fort sufficiently strong first received the attention of the colonists: showing that they did not place a too implicit confidence in the continued friendliness of the Indians toward their enterprise. The French would indeed have found the foundation of their colony a difficult matter, but for the state of the Indian tribes at the time of their arrival. The Iroquets of the St. Lawrence valley had, since the date of Cartier's second voyage, been exterminated, probably by the Hurons, and the Algonkin nations were in a state of chronic war with the too powerful Iroquois. Champlain, adopting the only policy open to him, the traditional one of intruders, allied himself, offensively and defensively, with his neighbours the Algonkins, thereby perpetuating the warfare between these peoples, and initiating the long series of conflicts detailed in the early history of the colony, which were only stopped for a time by the peace of Montreal, in 1701, when representatives of tribes, from the Gulf of St. Lawrence to the Mississippi, to the number of 1,300 chiefs and deputies are said to have been present.

Time will not permit us, however, to trace the fortunes of the aborigines through the long period of colonial history, during which the Iroquois, allied to the English, and the Algonkins, supported and encouraged in war by the French, occupied together a position, as it were, between the blades of the scissors, in which their number and importance were continually diminishing. The history of the Indians in this period, is besides., so much that of Canada and New England that, though capable of treatment from our standpoint, it is too well known to need recapitulation here.

It has at times been affirmed that the English government did not extinguish the Indian title in Canada proper, when it took possession of the country. This is not however, strictly speaking, the case; for in the proclamation of George III, in 1763, consequent on the treaty of that date, by which Canada became finally British, the following passage, relating to the Indians, occurs:

"And we do further declare it to be our royal will and pleasure, for the present, as aforesaid, to reserve under our sovereignty, protection and dominion, for the use of the said Indians, all the lands and territories not included within the limits granted to the Hudson's Bay Company; as also the lands and territories lying westward of the sources of the rivers which fall into the sea, from the west and north-west, as afore said. And we do hereby strictly forbid, on pain of our displeasure, all our loving subjects from making any purchases or settlements whatever, or taking possession of the lands above reserved, without our special leave and licence, for that purpose."

Different commissions of enquiry into the condition of the Canadian Indians have since been issued from time to time, and of which those of 1847 and 1856 were probably the most important. In reference to the Indian title, the commissioners of 1847 thus state their views: * "Although the Crown claims the territorial estate and eminent dominion in Canada, as in other of the older colonies, it has. ever since its possession of the

* Quoted by Hind, Canadian Exploring Expedition.

Province, conceded to the Indians the right of occupying their *old hunting grounds*, and their claim to compensation for its surrender, reserving to itself the exclusive privilege of treating with them for the surrender or purchase of any portions of the land. This is distinctly laid down in the proclamation of 1763, and the principle has since been generally acknowledged, and rarely infringed upon by the Government." These statements are interesting in connection with the difficulty—referred to further on—as to Indian title in British Columbia. In carrying out this policy, we find the Government paying sums of money to certain tribes, and providing them with annuities as their lands become desirable for settlement. The payments thus made, though often apparently large, were always small in proportion to the extent of territory ceded. The country, for instance, north of Lakes Superior and Huron remained in possession of the Ojibways till 1850, when the whole of this vast region, at least equal in extent to England, and inhabited by between 2,000 and 3,000 Indians was surrendered to the Canadian Government for $16,640 paid down, and $4,400 in perpetual annuity. On this, the Commissioners remark: "If we considered that it came properly within our province, we should not hesitate to express our decided regret that a treaty, shackled by such stipulations, whereby a vast extent of country has been wrung from the Indians for a comparatively nominal sum, should have received the sanction of the Government." In a table prepared under the same commission is the following summary of areas of land given up, at different times, by the Indians of Canada, with the price paid to them per acre:

Ojibways, $2\frac{1}{2}d.$ per acre......................	7,373,000
" $\frac{7}{8}d.$ "	6,737,750
Ottawas, Pottawatamies, Chippewas and Hurons, $\frac{3}{16}d.$ per acre......................	2,001,078
Delawares, $2s.$	
Saugeen Indians, $3\frac{1}{2}d.$ per acre............	1,500,000
Ojibways of Lake Superior, as already given. Acreage not known.	

Average rate per acre about $1\frac{1}{2}d.$

In view of such facts, we may well ask upon what principle they have been remunerated for their lands; certainly not by any standard either of their absolute or relative value, rather by that of the relative ignorance of the various tribes at the time they were treated with, and the urgency of their then present wants. Looked at from this point of view, the transaction loses altogether the aspect of an equitable purchase. It must be evident that the Government, in such arrangements, does *not* fully acknowledge the Indian title, the "territorial estate and eminent dominion" being vested in the crown, and the claim of the Indians restricted practically—though not patently in the transactions as effected with the Indians—to right of compensation for the occupancy of their hunting grounds.

It is very difficult to arrive at any certain conclusion regarding the original number of the Indian population of this part of the Continent. The New England tribes are, as we have seen, said by some authorities to have each possessed several thousand warriors. The Iroquois were estimated by La Hontan at 70,000, and the Hurons, at an earlier date, at from 30 to 40,000. Garneau, on the contrary, gives, as the result of careful calculation, numbers very much smaller, and supports them by remarks on the exaggerated estimates of the notions formed by some travellers. He allows, for instance, to the whole Algonquin race 90,000 only, and to the Hurons and Iroquois together 17,000. Though the first estimates may be too great, these almost certainly err on the other side.

In the four eastern provinces of the Dominion, Ontario, Quebec, Nova Scotia, New Brunswick and Prince Edward Island, there are at the present day about 30,000 Indians, the remnant of the former numerous population. A considerable number of Indians in Quebec, and north of the settled districts, in the northern and north-western part of Ontario, still remain in a condition little, if at all, superior to that of their ante-Columbian ancestors. Their lands, unsuited for agriculture, are not coveted by the whites. They have only the advantage of a certain immunity from pillage and war, and of being able to procure from the Hudson Bay Company and other traders such articles of European manufacture as they may be able to afford. After describing the condition of these wild western tribes, Dr. Wilson, in the last edition of his "Prehistoric Man," writes of them: "It is not a little strange to find such pagan rites perpetuated among nomads still wandering around the outskirts of settlements occupied by descendants of colonists, who, upwards of three centuries ago, transplanted to the shores of the St. Lawrence the arts and laws of the most civilized nation of Europe. The regions thus occupied by savage tribes are annually coasted by richly laden merchant fleets of Britain; and the ocean steamers have now brought within a few day's sail of Europe the outcast descendants of the aboriginal owners of the soil. But they experience no benefit from the change. The Mistassins and Naskapees exhibit all the characteristics and some of the most forbidding traits of the Indian savage. They are clothed in furs and deerskins; their only weapons are the bow and arrow, and they depend wholly on the bow and drill for procuring fire."

With by far the greater part of the Indian population, however, this state has long been of the past. In all the provinces, save Prince Edward Island, the Indians hold reserves from the Crown. On the Island, the lands they inhabit were obtained for them by the Aborigines Protection Society and the liberality of private individuals. The Indians are considered wards of the Crown, and are in a state of pupilage, not possessing the right to dispose of or in any way alienate their lands, which are administered for them by a department of the Government. The funds available for Indian purposes, schools, missions, annuities, etc., are partly tribal, being derived from the sale or lease of Indian lands, partly general, by direct grant, or interest on the Indian fund held in trust by the Government. This fund, in the provinces of Ontario and Quebec, in 1877, amounted to over $2,900,000; tho total revenue available for distribution being over $240,000. The sources of tribal funds are more fully specified as follows: Collections on account of lands sold, timber dues, stone dues; bonuses paid for the privilege of working timber limits on Indian reserves; rents collected from occupiers of Indian lands under lease; and smaller sums from licence fees, trespass dues, and a moiety of fines collected from persons convicted of having sold liquor to Indians.

In these older provinces, most of the Indians have made considerable material progress, and in some cases show a satisfactory desire to accumulate property and cultivate the land. By the last report of the Superintendent of Indian Affairs, we learn that the total number of Indians settled on reserves is 22,809. The total number of acres under cultivation is 60,501; houses owned, 4,347, besides barns and stables; horses, 2,741; cows, 2,360, besides other animals, ploughs, harrows, waggons, fanning mills and many other agricultural implements. It is, however, un-pleasant to note the complaints of the superintendent that the schools are very generally poorly appreciated, but a small proportion of the children attending with any regularity.

The remnants of some of the Indian tribes of this part of the Dominion have now drifted far from their original localities. Of the Iroquois, a portion converted by the French—who established missions among them in 1657—separated themselves from their native cantons to the south of Lake Ontario, and settled on lands provided for them on the banks of the St. Lawrence, at Caughnawaga, St. Régis, and the Lake of Two Mountains. Their number at the present time (including some Algonkins living with the Iroquois at the last named place) is 2,964. The greater part of the Iroquois nation—allies, as we have seen, of the English against the French in early colonial days—were loyal to the Crown during the revolutionary war, and on the establishment of the United States many of them migrated to Ontario, under their great chief Joseph Brandt, 1785. They were accorded a reserve of about 1200 square miles, of which they now possess only a small part. These refugees number, at the present day 4,495, and are living on the Grand River, Bay of Quinté, and River Thames. Another considerable band of the Iroquois, chiefly composed of Indians of the Seneca tribe, still inhabit a portion of their original territory in the State of New York, possess a reserve of 66,000 acres, and are good and prosperous farmers. Another party, early in this century settled in Ohio, but were afterward removed to the Indian Territory to the south, and are now stated to number 240. One more small detachment, travelling westward in the service of the fur companies, now frequent, or lately did so, the eastern base of the Rocky Mountains, near the head-waters of the Saskatchewan.

The once powerful nation of Hurons or Wyandots, are now reduced to a mere handful. In 1648, the Iroquois recommenced their war against these people with unwonted fury, and during 1649 and 50, they were finally beaten and as a nation destroyed. After the attack of 1648 the remnants of the tribes found refuge for a time among the neighbouring nations, but were shortly afterwards again gathered together, to perish, for the most part, some by renewed attacks of their enemies, others by famine, during the winter of 1649–50. The survivors, about 300 in number, under the guidance of the missionaries who had been labouring among them, migrated eastward, but were apparently pursued by misfortune. Many perished in attempting to cross from their place of refuge on Isle Joseph to the mainland, others were cut off by prowling Iroquois. The miserable remnant crept through the wilderness of the upper Ottawa to Montreal, and then to Quebec, where for years they inhabited the Isle of Orleans; but still, from time to time harassed by their enemies, moved into the city of Quebec itself, and on the conclusion of peace, removed to Ste. Foye, and afterwards to Lorette, where they now are, to the number of 295. A second small fraction of the Hurons, centering for a time about Detroit, were accorded a reserve at Anderdon in Ontario, but during the present century, have declined from 200 to 76 in number. Still another colony became possessed of lands in Ohio, ceded these lands to the United States, in 1832, and were removed to Kansas, where, in 1855, many became citizens, and the land being divided among these, the remainder were again removed to the Indian Territory, where they now number 258 souls. Such has been the fate of these cultivators of corn and tobacco, the natives, of all others of the northern part of the Continent, most nearly attaining a civilized state.

The vicissitudes to which the Algonkins have been subjected are not so great. Those who have come within the influence of civilisation occupy a great number of small reserves and villages scattered through Ontario and Quebec. The Abenakis, the constant allies of the French, leaving the northern part of New England, now reside at St. Francis and Becancour, and have decreased from 1000, the number remaining in 1760, to 335.

If we had any satisfactory means of estimating the real amount of Indian blood represented by the peoples classed as Indians, we would find the recognized remnant of the native race a much smaller fraction than it appears in the census. In many of the bands scarcely a pure-blooded Indian can be found, and in all great admixture has occurred. Of the Abenaquis Father Marquette writes: "Our Indians are, with but very few exceptions, métis, or half-breeds. Here I do not know one Abenaquis of pure blood: they are nearly all Canadian, German, English, or Scotch half-breeds. The greater portion of them are as white as Canadians, and the dark complexions we see with many are owing in most cases to long voyages." The Hurons of Lorette can scarcely be distinguished as Indians. They have almost entirely exchanged their native tongue for the French patois, and would probably long since have ceased to be known as such, but for their claim to share in the distribution of certain tribal funds administered by the Government, which have now ceased to be of real benefit, and act instead as a deterrent to the complete independence and self-reliance of the members of the community. Similar statements might be made with regard to other tribes, and many of the more advanced Indians begin to show a wish to emancipate themselves from their state of pupilage. This they are now enabled to do on easy terms by the Act of 1876.

The discovery of the great North-west and contact of its Indian tribes with the whites did not occur till long after that of the older provinces of Canada; and our knowledge of the west coast and British Columbia is almost an event of yesterday. The famous journey of Joliet and Marquette to the Mississppi was made in 1672, followed, ten years later, by that of La Salle. In 1727, a Canadian fur company had advanced trading posts to Lake Pepin on the Mississippi; but we find Charlevoix writing from Montreal, in 1721, with nothing more definite than the vague rumours of the existence of the "Lac des Assiniboils" and surrounding region now forming part of Manitoba. Not till 1731 was this country and the valley of the Red River of the north, discovered by Varennes de la Verandrye, accompanied in his expedition by his sons, and a missionary Jesuit. By 1748, the French, with the wonderful energy in discovery characteristic of them at this time, had pushed their explorations far up the valley of the Saskatchewan; and they had already crossed the water-shed separating this valley from the Arctic basin, when Sir Alexander Mackenzie, an officer of the North-west Fur Company of Canada, in 1789, began his voyages of discovery in that region. This intrepid traveller, in that year, traversed the entire length of the river now bearing his name, reaching the Frozen ocean, and, in 1793, only 85 years ago, was the first European to set foot in the great interior of British Columbia.

The wide-stretching Algonkin family of Indians already described as filling so large a part of North America, extended far into the western country. The Sioux, touching, in the early historical years, the west end of Lake Superior, were then being dispossessed of these regions, and their hunting grounds about the sources of the Mississippi by the Algonkin Chippeways, who before settlement began in the Red River valley appear to have usurped a part of that region, and the Lake of the Woods country, and made of them their western stronghold. With fish and berries in abundance, and lake strung to lake, forming an amazingly complicated water communication through all the forest country, the woodland Indian may here be seen to the greatest advantage; and, as in the summer he lazily paddles his bark canoe from island to island, sets his nets in the narrows, or joins in the harvesting of wild rice in the creeks and swamps of the lake margin, one may still almost imagine that his tenure is undisputed, and his life a realization of Hiawatha. But winter is at hand, and many too are the legends still associated with the landscape of fierce conflicts, and massacres by the dreaded Sioux.

West of the Chippeways, but inosculating with them, and spreading far up the valley of the Saskatchewan, were the Cristeneaux or Crees, who speak a language only dialectically different from that of the Chippeways, but exhibit some different traits, being in great part *Plain Indians*. South of the Crees, and inhabiting the river of the same name, where the Assineboines, a tribe which separated from the Dakotas or Sioux, almost within the limit of authentic history, and, like the parent stock, differed much in physical characteristics, and altogether in language from the Crees. Though thus the offspring of the Dakotas, they were bitterly hostile to them, much as occurred further east with the Iroquois. South and west of these, but scarcely stretching far north of the forty-ninth parallel in early times, were the various bands of the Sioux, or Nadouessioux of the early travellers, the first name, by which they are now most commonly known, being an abbreviation of the second, which is a Chippewa word, meaning enemies, and was sometimes also applied by these people to the Iroquois; the Sioux calling themselves Dakotas. Still farther west were the different tribes of the Blackfoot confederacy, roaming between the head-waters of the Missouri, the Rocky Mountains and upper Saskatchewan.

The Indians thus classified according to race, were, however, naturally divided, from the earliest times, by the character of their environment, into two great groups,—those of the plains and those of the forests. The former, typically exhibited in the Sioux. Assineboines, and Blackfeet, were and are physically and mentally better developed than the latter. Their lives were more active, and, with abundance of food in the innumerable herds of buffalo which then covered the plains from the Red River to the foot of the Rocky Mountains, while fierce, treacherous and turbulent, they had leisure to develop some of the better qualities often attributed to the American savage, and to invent those curious mystic ceremonies appropriate to the seasons, which among the Mandans of the upper Missouri, according to Catlin, had assumed great complexity and an elaborate symbolism. The *plain* Crees, or those inhabiting the northern margin of the prairies, were not so warlike nor physically so well formed as their southern neighbours, though, coming first in contact with the whites, and supplying themselves with fire-arms, then unknown to the wilder tribes, they were for a time able completely to turn the tables on their ancient enemies, and carried their conquests far and wide. At the present day matters are again reversed, for the Crees, still supplied by the Hudson Bay Company with the venerable flint lock musket, meet the southern tribes who trade on the Missouri, and are frequently able to afford to arm themselves with the best breech-loaders. In this region, one may see in a single tribe every stage in perfection of arms exemplified, from the bow with arrows tipped with hoop iron to the Winchester-Henry repeating rifle. It is worthy of note, in this connection, that while the Indians may be much more formidable with improved rifles, I have heard them complain that they are really more at the mercy of the whites, for, on the outbreak of hostilities, measures are taken to prevent them from obtaining suitable cartridges, which they are, of course, utterly unable to make for themselves. The woodland or *thick-wood* Crees much resemble in habits and appearance the other western tribes of the Algonkins.

North of all these, is still another entirely distinct family of Indians, the Tinneh, Athabascans, or Chipewyans. These inhabitants of the true "Wild North Land," are divided into many tribes and sets, speaking dialects more or less diverse. From Churchill and the western shores of Hudson Bay they stretch northward to the Esquimaux of the Arctic coast, people the valley of the Mackenzie, the great almost unknown interior of Alaska, and southward in the interior region of British Columbia as far as the Chilcotin River. Remnants of the same people are found scattered among other tribes far to the south, giving rise to interesting questions as to their pre-historic distribution; but the region still entirely occupied by them in the north is truly vast, being not less than 4,000 miles in extent from south-east to north-west. Within their domain are the Barren Grounds, traversed and described by Sir John Richardson, Franklin and Back, a picture of bleak desolation, yet in their grassy savannahs supporting cariboo and other game enough to maintain the wandering bands of natives. They are as yet the undisputed possessors of the great Peace River valley, in Mackenzie's time abounding in buffalo and elk, and destined, at no very distant date, to form a wealthy province of the Dominion. North of this, in the Athabasca-Mackenzie region they roam over a whole continent of barrens, scrubby forests, wide muskegs, and inosculating systems of lakes; while in the northern interior of British Columbia and Southern Alaska they own a veritable sea of mountains.

Resembling the forest inhabiting tribes of the Algonkins in many respects, they yet differ from them in some important points. The name Tinneh or Dinne means simply *the people,* and in combination with some peculiar affix forms the distinctive name of almost every tribal subdivision of the race. In thus speaking of themselves as pre-eminently *the* people, they are not peculiar, but follow the custom of many of the American tribes of different family relationships. When discovered, the Tinneh were constantly at war with all the surrounding nations, including the Esquimaux, to the north, the Crees and southern Indians of British Columbia, to the south, and were, besides, engaged in intertribal wars within their own territory. They do not appear, however, to be in general distinguished for bravery or success in their warlike expeditions. Though scattered over so great an area of country, they show a close general resemblance in customs and disposition. They do not cultivate oratory to the same extent as the southern Indians, nor have they any regard for the truth, though, curiously enough, remarkably honest, both among themselves and towards strangers. They are, however, accomplished and persistent beggars. They already begin to cultivate the ground to a small extent around some of the forts and missions in the southern part of their country, and though generally lazy, when once embarked in a voyage or other enterprise, as a rule, work well. They seldom indulge in a plurality of wives.

Omitting mention for the present of the remaining Indians of British Columbia, such are the great divisions by race of the nations of the North-west. The Esquimaux, living along the whole Arctic sea-board, are never likely to come in conflict with the whites, and, from the inhospitable nature of their country, will always remain secure in the possession of their lands. Of more practical importance, however, than this family grouping is the division into Indians of the plains and those of the forests and northern country, as already pointed out. The tide of settlement has already begun to flow, which in a few short years will cover the portion of the Great Lone Land inhabited by the prairie tribes, with farmers and stock-raisers; and it is in disposing equitably and amicably of the claims of the plain Indians, and in providing for their honest and peaceful support when the buffalo, their present means of livelihood, shall have passed away, that Canada will find her greatest Indian problem. In contrasting the Indian policy of the United States and Canada, it is unquestionable that the latter has generally shown consideration and friendliness toward these people; while the former, with few exceptions, has *practically* pursued a method harsh and aggressive; but it is often forgotten that the circumstances of the two countries for many years past have been very different. In the Western States the uncompromising edge of the advancing populace of Europe has been creeping across the plains—constant broils, outrages and reprisals characterizing its spread. In Canada we are only about to enter on this phase, and in no way but by great forbearance and tact can similar—though probably not so great—trouble be averted.

In 1812 Lord Selkirk founded his colony on the Red River, having acquired from the Hudson Bay Company in the previous year a grant of land for colonization; but, like the government of the Dominion at a later date, finding that he had afterward to arrange with the Indians for their right of ownership. In 1817, several chiefs agreed to give to the King, for the use of the Earl of Selkirk, a tract of land bordering the Red and Assineboine Rivers, as far back on each side as a horse could be seen under (*i. e.* easily distinguished); but we find that it was afterwards made a subject of complaint by the Indians, that they never received for the land more than a first payment, which they considered as preliminary to a final bargain. The quit-rent was understood to be 100 pounds of tobacco, paid annually to the chiefs.

Selkirk's colonists, entering the country by way of Hudson Bay and the Nelson River, were chiefly men from the northern islands of Scotland, and there mingling with French-Canadians—old voyageurs of the fur Companies—soon, like these people, took to themselves Indian wives, usually from among the Crees. Thus arose the Metis or half-breed population of the Red River, for a long time hunters rather than farmers, and as yet—especially the French half-breeds—in too many cases making but a half-hearted attempt at the cultivation of the soil. Yearly expeditions on a great scale—of which we have all read—were made by these people against the buffalo, in early days abounding in the Red River valley itself. Gradually, however, under the attacks of the people, the increasing demand for robes in all quarters, and the quantity of pemmican required by the Hudson Bay Company for the supply of their posts, the great northern herds of buffalo were thinned, and year by year the Red River hunters had to travel farther in search of their game. At last the connection between the Peace River herds and those to the south was broken along the line of the Saskatchewan, and the former all but annihilated; and at the present day a wide belt of country near and south of the Missouri, separates the buffalo still remaining in the South-Western States from those of the north, which are congregated in a limited area near the foot of the Rocky Mountains in the British possessions, and surrounded by a cordon of hungry savages. With this change, a great alteration in the position of the various Indian tribes has occurred. The Assineboines and plain Crees have followed the retreating herds to the south and west, while the thick-wood Indians, formerly confined to their forests by the pressure of these tribes, have issued on the plains; and natives from the vicinity of the Red River and great lakes of Manitoba may now be found even to the Coteau of the Missouri. The remaining buffalo at the present time inhabit a portion of the territory of the Blackfeet; but those Indians do not, now, in the absence of valuable game, try to maintain their former extensive boundaries, and are hemmed in by their hereditary enemies the Sioux and Assineboines to the east, and Crees to the north. In 1874 I met a large camp of Cree Indians on the Milk River at the 49th parallel, a point farther south than I know them to have attained before. In this year, basing my estimate on the information obtainable in the country itself, I ventured to state that the northern herd of buffalo could scarcely maintain its existence as such for longer than twelve or fourteen years, and that at or before that date the trade in pemmican and robes would cease to be of importance. Unless the regulations adopted by the North-west Council are very strictly enforced, and possibly even in spite of this check, the buffalo must become pratically extinct within a very few years. In view of these facts, measures cannot too soon be taken to render the plain tribes self-supporting, on some other basis than that afforded by the chase of the buffalo. Their wandering habits unsuit them for agricultural pursuits; but some of them already possess considerable numbers of horses, and, by encouraging them in stock-raising, and especially in the introduction among them of cattle, from which, under proper regulations, they might derive a great part of their food, a solution of the problem might be found. This, at least, is the only easy transition from their present condition as hunters to a more civilized state; and if this can not be made to succeed, they will for the most part, and at no distant date, be thrown as paupers on the State.

The Indians of Manitoba and the North-west Territory, in the Report of the Minister of the Interior for 1877, are stated to number about 27,308; to which must be added about 1,500 Sioux, refugees from the south, implicated in the Minnesota massacre of 1862; also, for the Athabasca District and Rupert's Land, 6,768 (probably an under-estimate); and now, it would appear Sitting Bull and his compatriots, who, though Sioux, do not represent any particular tribe of that nation, but the disaffected and outlawed members from many bands. Since the acquisition of this territory by the Dominion, seven treaties have been concluded with the Indians, by which, collectively, nearly all the land likely to be given for permanent settlement has been ceded. The last of these was that with the Blackfeet, covering an area of some 35,000 square miles in the south-western corner of the territory, inhabited now by about 5,000 Indians; this nation having been reduced by about one-half during the last twelve or fifteen years by bad whisky, murders, and small-pox.

The general principles on which these treaties have been framed are:—The entire surrender of the territory, a reserve being provided for the Indians, and it being understood that they may continue to hunt and fish as before, without restriction as long as the lands are unoccupied; the establishment and maintenance of schools; the payment of an annuity of a few dollars to members of the tribe, a census being taken in the first instance; the yearly distribution of ammunition, twine for nets, etc., to a stated amount; and the presentation of agricultural implements, cattle, etc., once for all, to bands settling down to farm; also the payment of a salary to the chiefs and their head-men; and the presentation of medals, flags, and a bonus in money on the conclusion of the treaty. No one who has not had some experience in dealing with Indians can realize how great the difficulty in concluding such arrangements with them is: how much talking and iteration is required, and how long they take to deliberate and discuss among themselves the propositions as they understand them; the most trivial point occasionally appearing, for some incomprehensible reason, to assume the greatest importance.

The half-breeds of the Red River have already been alluded to, and nowhere on the North American Continent is the result of the mingling of the European and native races so clearly seen as in our North-West Territory. In what is now the province of Manitoba, a separate race of Metis has grown up since the date of Lord Selkirk's colonization, and these people, holding themselves to some extent aloof from the whites and Indians, are recognized in the terms of confederation of that province, and granted large tracts of land as reserves for themselves and their children. At the erection of the province, the half-breeds numbered, according to the census, 9,770; but this, according to Prof. Wilson, was afterwards found to be an underestimate. While some of these people are scarcely distinguishable from Europeans, others are to all intents and purposes Indians, and it is curious to find in the report of the payment to Indians under Treaty No. 4, that great difficulty was experienced from the number of half-breeds ordinarily recognized as such, who desired to be included with the Indians and draw annuities. In this connection, Mr. G. W. Dickenson remarks: "The question as to who is, and who is not Indian, is a difficult one to decide: many whose forefathers were whites, follow the customs and habits of the Indians, and have always been recognized as such. The chiefs Côte, George Gordon, and others, and likewise a large proportion of their bands, belong to this class. A second class has little to distinguish it from the former, but has not altogether followed the ways of the Indians. A third class, again, has followed the ways of the whites, and has never been recognized or accounted among themselves as anything but half-breed."

When the buffalo retreated so far in the west that it became inconvenient to carry on the hunt from the Red River, a portion of the half-breeds to a great extent relinquished this mode of subsistence ; while others, among whom those speaking French are in the majority, continued to follow these animals,—selecting wintering places far out on the plains, and returning to the settlements only occasionally, with the products of the chase. These hunting half-breeds form—or formed a very short time ago—a body partaking of the character of a tribe among the Indians. They are generally accompanied by a priest, who, in concert with some of the older men, frames rules for the guidance of the camp, administers those which have already become fixed by use in the community, and decides the camping places and dates of movement of the camp, in conformity with public opinion. In the far west these people seem generally to have allied themselves with the Sioux against the Blackfeet, but gave to their allies only so much material assistance as to ensure the continuance of their useful friendship. In July, 1874, I came upon the "Big Camp" of half-breeds near the Milk River. It consisted of over two hundred tents of dressed skins, or canvas. Every family possessed Red River carts at least in equal number to that of its members. These, with the tents, are arranged in a circular form, on camping, to make a *correl* or enclosed space for the protection of the horses. It was stated that about 2,000 of these animals were owned by the half-breeds of the Camp. The Indians, as a whole, are jealous of the half-breed hunters, understanding well that their business-like manner of pursuing the buffalo for robes, not only drives these animals from their feeding grounds, but aids largely in their extermination. The late ordinance of the North-West Council, above referred to, will probably, by the restrictions it imposes, break up this half-breed tribe and drive its members to other pursuits. It is certain that the Metis, as a whole, will continue to approximate more completely to the whites both in appearance and manners. Physically they are robust, and possess great power of endurance, though not infrequently liable to pulmonary complaints.

In British Columbia, where, in the absence of a trustworthy census, the native races are roughly estimated at 30,000, Canada has her latest, and, what appeared, for a time, likely to be her most vexatious "Indian Problem." Races of the Tinné stock inhabit, as we have already seen, the whole northern interior of that country, extending, southward, to the Chilcotin River in latitude 52°. Bordering these on the south, and occupying part of the province, are Indians belonging to the *Shuswap* or *Selish* connection, divided into many tribes, bearing different names, but all allied in language, the differences between the dialects being generally not so great as to prevent intercommunication. In a region physically isolated, in the extreme south-east, are the Kooteney Indians, who appear to differ from all the rest, and are perhaps more closely allied to the Indians of the interior plains, whither they resort, at certain seasons, for the purpose of hunting the buffalo. Along the coast, and on the outlying islands, are scattered a great number of tribes differing more or less, and in former years frequently hostile one to another. Into the race divisions of these it is not proposed to enter, nor indeed is it possible as yet to speak very certainly on this question. In customs, modes of life and thought, there is complete diversity between the coast Indians and those of the interior, which practically transcends the race divisions, being like to in kind, but even greater in degree, than that existing between the plain Indians and those of the woods, in the interior of the continent.

In the northern interior of British Columbia, the Indians, inhabiting a country for the most part thickly wooded, still remain, as they have always been, hunters and fishers; but in many places they now also cultivate small garden patches, producing potatoes, turnips and such other vegetables as require little attention. For their winter supply of food they generally depend chiefly on fish, which is dried and cured during the summer. On all the tributaries of the Fraser, salmon is taken, in some years abundantly. Those tribes nearer the coast, have generally succeeded in maintaining against the coast Indians, the control of some part of the various shorter rivers on which salmon can be caught. Thither they make an annual migration, which they look upon as a sort of holiday-making, revelling during the season in abundance of fresh fish, and on their return carrying back with them supplies for the cold months. They still trade with the coast tribes to some extent, obtaining fish oil and European goods for furs; and this interchange, continuing since time immemorial, has resulted in the formation of well-beaten trails, of which the Bella Coola trail, and the so-called *Grease Trail* (over which, in the far north, oolican oil is packed up from the sea-board) are best known. In the last century, when direct European trade was carried on only along the coast, these interior

Indians were obliged to satisfy all their needs for manufactured articles through the intermediation of the coast tribes. This intercourse led to the general diffusion of the remarkable Chinook jargon, which can only be referred to here. In the more remote parts of this northern country, the natives have changed very little since its first discovery. In 1793, Sir Alexander Mackenzie accompanied a party of them, as they travelled toward their fishery on the Dean or Salmon River. In June, 1876, I journeyed for a couple of days with a similar party going to the same traditional locality for the same purpose, and, with scarcely a word of alteration, Mackenzie's description might have been applied. Every man, woman and child carried a "pack" of size in proportion to their strength, many of the women being, in addition, encumbered with infants, and even the dogs having strapped to their backs a proportion of the common burden of camp equipage or traps. The larger articles and provisions were usually packed in square boxes made of light wood, skilfully bent round, and pegged together so neatly that, with the addition of grease and dirt rubbed into the corners, they are water-tight, and can be used for boiling fish, hot stones from the fire being thrown in till the water is heated. Smaller loads are carried in net-work bags made of raw hide, and slung, together with a blanket, over the shoulders. All were in good humour, and it was with the greatest difficulty I could persuade one to leave his companions to guide me to the southward, where I wished to go. They travelled at leisure, frequently resting for an hour or so, the women attending to their children, the men sleeping in the shade, or gambling with marked sticks, as Mackenzie describes.

In the southern part of the interior, the Indians have come much more freely in contact with the whites, and though many never saw a white face till the gold excitement of 1859 occurred, they have already advanced very materially. In the early days of gold mining, labour was scarce and in great demand, and, consequently, every Indian who could and would work was employed at high wages. From this, many of them became stock-raisers to a small extent, river boatmen, and packers; while others cultivated the soil, sometimes producing more than they required for their own support. Such is their state at present, and on them most of the white settlers rely for aid in tilling, harvesting, and stock herding. While, however, the younger men take readily to these pursuits, many of the older still prefer to live as they did formerly, chiefly on the products of the fishery and chase; and in districts where settlement has not yet penetrated, whole bands still trust almost entirely to these, their primitive means of support.

Along the coast, the natives are, and always have been, almost exclusively fishermen. They hollow from the great cedar trees graceful and sea-worthy canoes, in which they frequently make long voyages, and formerly, in some cases, ventured far from land in pursuit of the whale. Their villages are along the margin of the sea, on a coast generally rocky and rugged, with little arable land. They engage in the chase to a very limited extent, and seldom even venture far into the dense forests, of which they appear often to entertain a superstitious dread, peopling them in imagination with monstrous and fearful inhabitants. Along many of the estuaries and harbours are long lines of shell-heaps, evidencing the indefinite antiquity of their feasting and camping. At the present day, many of the coast Indians are moderately industrious, working on farms, in the coal mines at Nanaimo, or as sailors in small coasting schooners. In Mr. Duncan's charge, at Metlakatla, in the north, is an example of a self-supporting and comfortable community, the result of genuine missionary labour.

Of all the coast tribes, the Indians of the Queen Charlotte Islands are probably the most intelligent and competent. When the earlier navigators visited this region, they were the sea-dogs of the coast, and carried their piratical expeditions far and wide, often engaging in fierce conflicts with the Ucultas, and other tribes who attempted to bar their passage of the narrows at the north end of Vancouver Island. Though, like most of the sea-board tribes, in features remarkably coarse, they are lighter in complexion than the others, often so much so that a rosy colour is discernible in their cheeks. Their superior attractions in this respect have been unfortunate for them, as many of their women resort to Victoria and other towns for the worst purposes, and, owing to disease, they are rapidly diminishing. Their tribal name is *Haida*, and they are remarkable above all the other Indians of the Coast for the size and excellence of their wooden houses, which are ornamented with huge sculptured posts, rising like obelisks or minarets; and also for their great skill and taste in carving in grotesque and complicated patterns all their implements and utensils. The style of this carving, on the one hand, resembles that of China and Japan, and, on the other, that of Mexico and Central America. The Haidas are dexterous and successful fishermen.

Such is a brief sketch of the Indians of British Columbia; from which, however, it will be evident that, owing to the physically diversified character of the country, and correspondingly diverse habits of the natives, they required at the hands of the whites a quite special treatment. It was probably owing to want of information that the Dominion government at first proposed to apply, unmodified, to the whole area of the new province, the traditional Canadian policy of granting extensive reserves to the natives. This led to a long, and in some instances acrimonious correspondence between the general and local governments; and also to accusations by philanthropic societies, imputing injustice and indifference toward the natives to the old colonial government. It may be interesting to go over, briefly, the chief points raised in this controversy, which will also in some degree serve to explain the anomalous condition of the British Columbia Indians in respect to material progress.

Many interesting facts bearing on the first contact of whites and natives on the West Coast are to be found in the volumes of Meares, Portlock and Dixon, Cook, Vancouver and other early explorers; and various arrangements and treaties were made in these early times, which have long since, however, lost all force, and must be omitted here. Among the official documents relating to more recent times, we first find fourteen treaties concluded with the natives by Mr., afterwards Sir James, Douglas, acting for the Hudson Bay Company. These apply to Vancouver Island, chiefly to its southern and south-eastern part, and are dated in 1850 and 1852, several years before the gold excitement of 1858-59. A lump sum was paid on the conclusion of each treaty, which was looked upon as a sale, under the following conditions, to quote from one of them, viz:—"That our village sites and enclosed fields are to be kept for our own use, for the use of our children, and for those who may follow after us; and the land shall be properly surveyed hereafter. It is understood, however, that the land itself, with these small exceptions, becomes the entire property of the white people for ever; it is also understood that we are at liberty to hunt over the unoccupied lands, and to carry on our fisheries as formerly."

In 1858 attention was prominently called to British Columbia, owing to the discovery of gold, and the rush of miners from all quarters, and, accordingly, we find next among the papers (dated in July of that year) an extract from a despatch of Lord Lytton, as Secretary of State for the Colonies, to Douglas, then appointed Governor of the region, recommending kind treatment of the natives, and ordering that in all cases of cession of land, subsistence, in some form, should be granted to them. In September of the same year, there is a second despatch from Lytton, enclosing a memorial from the Aborigines Protection Society, which gives reasons for fearing that, the miners then flocking to the country, the Indians would be harshly treated, and advising, justly, that the native right to the soil should be recognized. In venturing to point out means of satisfying the natives, however, the Society makes various suggestions, some of which, to any one acquainted with the circumstances of the country, look sufficiently absurd. It is said, for instance:—" To accomplish the difficult but necessary task of civilizing the Indians, and of making them our trusty friends and allies, it would seem to be indispensable to employ in the various departments of government a large proportion of well selected men more or less of Indian blood (many of whom could be found at the Red River) ! who might not only exert a greater moral influence over their race than we could possibly do, but whose recognized position among the whites should be some guarantee that the promised equality of races should be realized." Red River being in actual distance and in manners as remote from Victoria as is St. Petersburg from London, this part of the scheme is, to say the least of it, visionary.

Next follows some additional corresp ndence between Governor Douglas and the Colonial Office in 1858-59, of a similar tenor, in which both parties agree in the advisability of endeavouring to locate the Indians in their villages, and render them self-supporting. Douglas, however, instanced as specially to be avoided, the method originally pursued by the Spanish Catholic missionaries to California, where the Indians, though fed, clothed, and taught to labour, were kept in a state of dependence, not allowed to think, act, or acquire property for themselves, and when freed from control were without self reliance, more helpless and degraded than at first. Also, that since pursued toward the same Indians by the American Congress, of supporting them at great cost by the State, the natives nevertheless rapidly degenerating.

In March 1861, the House of Assembly of Vancouver Island prepared a memorial, recapitulating the means adopted by the Hudson Bay Company to extinguish the Indian title, stating that the Indians of the Island have a strong sense of property in land, and that regions then being settled still belonged to the natives. It was feared that bad feeling would arise between the races; but the Colony, being unable to raise £3,000, which would be necessary to purchase the rights of the Indians, asked the Home Government to advance this sum, which was afterwards to be repaid by the sale of public lands. The Secretary of State for the Colonies, however, though ready enough to offer good advice, as we have seen, promptly answers this communication in a curt note, stating that the affair being purely a colonial matter, Her Majesty's Government could not undertake to supply any money.

In a voluminous correspondence, from different sources, extending from 1861 up to the date of the Confederation, it would seem that the idea of recognizing the Indian title to the whole mainland country never appears to have occurred to the authorities; but that the method adopted was to ask the Indians of any particular locality what plot of land they wished to possess, and to make this reserve for them. It generally appears that all the land asked for was given, and sometimes even more than requested, the Governor indeed expressly directing that when a larger area was requisite to the support of the Indians, it should at once be allotted to them. In most cases the natives seem to have been satisfied with this arrangement, though we discover that certain priests, missionaries among them, were already advising the Indians to make larger claims for land. It is evident, in fact, that at this time—to quote from a report by T. W. Trutch, as Chief Commissionner of Lands and Works in 1867, which, though referring specially to the lower part of the Fraser, may be taken as representing the state of affairs over the whole interior :—" The subject of reserving land for the Indians does not appear to have been dealt with on any established system during Sir James Douglas's administration. The rights of the Indians to hold lands were totally undefined, and the whole matter seems to have been kept in abeyance, although the land proclamations specially withheld from pre-emption all Indian reserves or settlements. No reserves of lands specially for Indian purposes were made by official notice in the *Gazette*, and those Indian reserves which were informally made, seem to have been so reserved in furtherance of verbal instructions only from the Governor," or even in some cases were made over to the Indians on the ground by him personally.

About this time, it was found that many reserves made in this loose way, were seriously impeding settlement by blocking access to valuable lands, and otherwise; and, moreover, that the land locked up in reserves was frequently far in excess of the requirements of the aborigines. The authority by which many of these reserves were made, was then disavowed by the government, and, in a letter from the Colonial Secretary (Nov. 1867), the original intention of the Government is defined as having been in all cases to grant the Indians lands cultivated by them, and so much in addition as to bring the reserves up to about ten acres per adult male: it being further stated "that reserves that have been laid out of excessive extent should be reduced as soon as practicable. The Indians have no right to any land beyond what may be necessary for their actual requirements, and all beyond this should be excluded from the boundaries of their reserves. They can have no claim whatever to any of the land thus excluded, for they really never have possessed it,—although, perhaps, they may have been led to view such land as a portion of their reserve. "The Indians appear in almost all cases to have acquiesced quietly in the reduction, feeling compensated to some extent by the greater definiteness given to their claims by actual survey. They are reported in most instances to have been "well satisfied," "satisfied," or "submissively satisfied."

The whole matter of Indian lands was thus in a very unsatisfactory state to be handed over to the Dominion authorities at the date of the admission of this province (1871), for even where substantial justice had been done to the Indians, the records were indefinite, or altogether wanting. On the appointment by the Dominion of a Superintendent of Indian affairs, the misunderstanding which of late attracted special attention began, and soon resulted in the accumulation of a great number of letters, if to no more substantial issue. In the terms of union it was provided that the General Government should assume control of the Indians, and, to quote, that "a policy as liberal as that hitherto pursued by the British Columbia Government shall be continued by the Dominion Government after the Union;" further, that tracts of lands, "such as it has hitherto been the practice of the

British Columbia Government to appropriate for that purpose," shall be handed over to the Dominion in trust for reserves, etc. These provisions, while apparently guaranteeing justice to the Indians, really proved a bar to the well meant policy of the Dominion. The land grants in British Columbia were by no means on so liberal a scale as usual in the other provinces, and were, further, very unequal, being in some cases only about five acres to a family, while over the whole province the average was not more than 6 to 10 acres. The Dominion Government wished the size of reserves to be fixed at 80 acres per family. The local government proposed 20 acres, which was accepted by the Dominion for the coast, but for the interior—where white settlers are allowed to pre-empt a double quantity of land—it was wished to increase this to 40 acres. The local government would not accede to this, and it eventually appeared that they intended the 20 acre basis to apply only to new reservations, and not to lead to the enlargement of those formerly made. Dissatisfaction and agitation meanwhile arose among the Indians, who soon became aware, to a more or less complete extent, of the state of affairs. Certain missionaries get the credit of partly fomenting and rather exaggerating the difficulty, with a view of bringing about an arrangement suited to their own interests; but to what degree this may be true I do not know.

In the end, after several propositions and counter-propositions, an agreement was arrived at between the two governments, of which the following is the substance :—

A commission of three is appointed, one member by each of the governments, the third jointly. This body shall enquire into all matters connected with each band of Indians, and fix reservations, for which no standard size is given, each nation being dealt with separately, on an equitable and liberal basis. It is also provided that, in accordance with the increase or decrease of the number of Indians, the reserves may from time to time be enlarged or diminished in size.

This body has since been reduced to a single commissioner, who is superintending the allotment of permanent reserves on an equitable basis to the Indians of the province.

While, on comparing the Indian policy of the British Columbia Government with the Canadian, where 80 acres may be taken as the minimum size of reserve, the provision made for the Western Indians appears slender, it will be seen from the sketch already given of the habits of life of the Indians, and nature of the country, that it was by no means without reason that the British Columbia Government objected to the crude application of the rule found to work well in the East, to the very different and variously situated natives of the West Coast; that, while reserves even on the 80 acre basis would be barely sufficient in some parts of the interior, where large areas are required for stock ranges, it would be useless and foolish to reserve great tracts of arable land for the coast tribes, who are by nature fishermen, and could under no circumstances be induced to cultivate the soil on any but a very limited scale. The policy obviously best for the natives of British Columbia, is to aid them in following those paths which they have taken already; to assist the tribes of the interior to become successful stock-raisers and farmers, by granting them suitable reserves and grazing privileges; to encourage those of the coast in fishing and becoming seamen, instructing them in improved modes of preserving their fish, and of preparing it for sale to others. If the sites of their villages and fishing stations are secure to them, they will require little more in the way of reserves. To grant to each family 80 acres of good land, it would be necessary to move many tribes far from their traditional haunts, and to this they would only submit under compulsion. In reviewing the state of the natives of the West Coast, it would appear that, though in many instances the British Columbia government seems to have transgressed the limits of strict justice toward them, and has departed from the precedent elsewhere established, in refusing to acknowledge the right of the Indian to the soil; that he, thrown more on his own resources, mingling among the whites with an equality of rights before the law, and exempt from the interference which has elsewhere distinctly retarded the progress of the savage towards civilization and independence, has worked out in a measure his own temporal salvation, has passed the critical stage of first contact with the whites, and in many cases bids fair, at no distant date, to form an important constituent of the civilized population of the country, and this even before the native has been largely mingled with foreign blood.

It is often said that the ultimate fate of the Red Man of North America is absorption and extinction: just as European animals introduced into Australia and other regions, frequently drive those native of the country from their haunts, and may even exterminate them, and as European wild plants accidentally imported, have become the most sturdy and strong in our North American pastures; so the Indian races seem to diminish and melt away in contact with the civilization of Europe, developed during centuries of conflict in which they have had no part, but during which their history has moved in a smaller circle, ever returning into itself. Even the diseases engendered in the process of civilization, and looked upon in the Eastern hemisphere with comparative indifference, become, when imparted to these primitive peoples, the most deadly plagues. Dr. J. C. Nott (as quoted by Prof. Wilson), writes: "Sixteen millions of aborigines in North America have dwindled down to two millions since the Mayflower discharged on Plymouth Rock; and their congeners the Caribs have long been extinct in the West Indian Islands. The mortal destiny of the whole American group is already perceived to be running out, like the sand in Time's hour-glass." Dr. Wilson has, however, himself shown that though the Indian as such can not very much longer survive, Indian blood in quantity quite inappreciated by casual observers now courses through the veins of white persons of the continent.

The ultimate object of all Indian legislation must be, while affording all necessary protection and encouragement during the dangerous period of first contact with the whites, to raise the native eventually to the position of a citizen, requiring neither special laws of restraint or favour. When it is found that the paternal care of the State begins to act as a drag on the progress of the Indian, and that after reaching a certain stage all further advance ceases, the state of dependence must be done away with. To render this change possible, and to effect it in cases where it would already be advisable, the Dominion Act of 1876 was framed. That this measure has not been adopted too soon appears from the concurrent testimony of many interested in the welfare of the Indian, and acquainted with the working of the present system. In concluding, a few of the opinions expressed on this subject may appropriately be given. The Rev. J. Marault (as quoted by Dr. Wilson), writes:—"Many suppose that our Indians are intellectually weak and disqualified for business. This is a great mistake. Certainly as far as the Abenakis are concerned, they are all keen, subtle, and very intelligent. Let them obtain complete freedom, and this impression will soon disappear. Intercourse with the whites will develop their talent for commerce. No doubt some of them would make an improper use of their liberty, but they would be few in number. Everywhere, and in all countries men may be found weak, purposeless, and unwilling to understand their own interests; but I can certify that the Abenakis generally are superior in intelligence to the Canadians. I have remarked that nearly all those who have left their native village, to go to live elsewhere free, have profited by the change." Dr. Wilson himself remarks (in another place) :—" The system of protection and pupilage under which, from the most generous motives, the Indian has hitherto been placed in the older provinces, has unquestionably been protracted until, in some cases at least, it has become prejudicial in its influence. It has precluded him from acquiring property, marrying on equal terms with the intruding race, and so transferring his offspring to the common ranks." The Honorable Mr. Laird, when Minister of the Interior, as the result of his enquiries in connection with the Indian bill above referred to, speaks in the following terms:—" Our Indian legislation generally rests on the principle that the aborigines are to be kept in a condition of tutelage, and treated as wards or children of the State. The soundness of the principle I cannot admit. On the contrary, I am firmly persuaded that the true interests of the aborigines and of the State alike require that every effort should be made to aid the red man in lifting himself out of his condition of tutelage and dependence, and that it is clearly our wisdom and our duty, through education and every other means, to prepare him for a higher civilization by encouraging him to assume the duties and responsibilities of full citizenship."

It is to be hoped that these enlightened views will be practically carried out in the case of all the tribes throughout the Dominion; and that the Indian, freed from tutelage and raised from dependence, may be induced to enter into such of the callings of civilized life as may be most congenial to him, and may thus become an element of strength and progress in the body politic. He undoubtedly possesses qualities which fit him not unequally to bear his part with the other races which enter into the composition of our people, in building up the future greatness of the Dominion.

SOME OBSERVATIONS ON THE MENOBRANCHUS MACULATUS.

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The *Menobranchus maculatus* is an aquatic animal belonging to the vertebrated class known as Amphibia, is of the order *Urodela*, and the family *Proteidæ*. It occurs in Lakes Champlain, George, and Seneca; also in Onion River and other waters of the northern and eastern United States, as well as in various Canadian lakes and rivers. All the specimens before me are from the Don River, Humber River, and Toronto Bay. It is said occasionally to reach the length of two feet; but the majority of adults seem to be little more than half that length.

This tailed amphibian is provided with two pairs of locomotive appendages, each of which is nearly two inches long, and has four toes, destitute of claws. The head is very much depressed or flattened from above downwards, is somewhat semicircular in outline, and is furnished with a wide mouth, fleshy lips, two minute nostrils opening close to the oral cavity, and a pair of small but well developed eyes; eyelids are absent. The teeth, which consist of one row in the lower and two rows in the upper jaw, are numerous, of medium size, conical, and separated by short intervals. In each side of the lower lip is a deep, horizontal groove or furrow, commencing about one-sixth of an inch from the median line, and passing outwards and backwards to the limit of the gape, and into which groove passes the attenuated margin of the upper overlapping lip. The constriction forming the neck, between the head and trunk, is not very strongly marked, but a tolerably large, horizontal fold of skin, extends backwards under the throat. On the sides of the neck are situated the branchiæ or breathing-organs; they are functional throughout life, and are composed on each side of three bunches of reddish bushy lamellæ, or rather three clusters of filamentous processes springing from three main stems, and in these filaments the blood is submitted to the action of the oxygen gas dissolved in the water supplied them. There are two slits, forming the branchial apertures, placed obliquely on each side of the neck, the anterior aperture being almost double as large as the posterior, the former permitting the current of water to flow out between the first and second gills, and the latter between the second and third gills. During sleep, the gills, so active and red in the waking condition, become sluggish in movement and pale in colour; indeed so marked is the difference in the action and colour of these external respiratory organs when awake and asleep, that one would, at first sight of a sleeping *Menobranchus*, suppose it to be dead.

The trunk is cylindrical and thick, being usually five or six inches in circumference. The tail does not become absorbed and disappear in the full-grown animal as it does in frogs and toads, but remains during its whole life; it is compressed o flattened from side to side, forming a strong, vertical, ancipita swimming organ, similar to the tail of a fish, from which, how ever, it differs in being destitute of spines, and in tapering con siderably so as to become lanceolate.

Neither dermal nor epidermic plates, scales, or warty exerescences are ever developed in this creature; on the contrary, the surface of the body is quite smooth, soft, and more or less moist and slippery, owing to a thick greyish gelatinous secretion of the skin, which probably assists its movements over stones, &c., on the bed of the stream. On removing this coating of light-grey slimy matter, the upper surface and sides of the whole animal are seen to be of a dark brownish-grey colour, beautifully speckled or mottled with distinct large dark purple spots for the most part circular in shape. The inferior surface of the body is much lighter in colour than the superior surface, being of a greyish-white tinged with yellow, and also sometimes dotted with little purplish spots.

On dissection of a *Menobranchus*, the flesh is found to be very white and inviting to the palate. Notwithstanding the intense disgust with which most fishermen and many other persons look upon it, there is no reason for supposing its flesh less savoury than that of its near relative, the *Axolotl*, which forms such a delicacy on the table of the Mexican.

As regards its internal anatomy, it may be observed that the alimentary tract consists principally of a mouth, gullet, stomach, and intestine terminating in a cloaca through which pass the generative products, urinary and fæcal matters. The mouth is furnished with three series of similar teeth, as before stated. A large tongue is present, and is free at its anterior extremity. The gullet is thick and muscular, the stomach elongated, and the intestine comparatively short, as in all carnivorous animals. It has been said that its food consists of crustaceans, molluscs, and fishes; but from my observations of the *Menobranchus* in an aquarium plentifully stocked with Molluscs, such as the Physadæ, Limnæans, Paludinæ, Planorbes, Anodonts, &c., as well as Crustaceans, I am not warranted in asserting that it feeds on anything other than true fishes. The liver is disproportionately large; a well-developed gall-bladder is present, as are also a pancreas and spleen. The kidneys form two greatly elongated organs, each like a cylinder rounded at both ends, and having a well-defined longitudinal depression—the hilum—throughout the whole length of one side.

The heart occupies but a limited portion of the thoracic cavity, consisting of two small auricles and a slightly larger ventricle, which latter possesses, as it were, several minute secondary cavities, thus presenting the appearance more of a sponge-skeleton than of one single chamber. The blood-corpuscles are oval, nucleated, and of very great size, their long diameter being about 62 micro-millimetres. In connection with this it may be mentioned that the blood-corpuscles of man measure 7.5 micro-millimetres, or less than $\frac{1}{3000}$ of an inch in diameter; in the frog they are 22 mmm. in length; and in amphiuma they are largest of all, attaining the extraordinary length of 77 micro-millimetres.

True air-breathing lungs are present in the form of a pair of much-elongated narrow sacs stretching back from the cavity of the mouth, one on each side, and having the heart and œsophagus lying between them. Each pulmonary sac is from two to three inches long, and has a diameter nearly as great as that of an ordinary goose-quill. The nostrils are in communication with the pharynx. The nervous supply is by no means feeble, as is evidenced by the great sensitiveness of the animal.

An examination of the skeleton shows the inferior maxilla to be formed of only two pieces or rami, which are directly articulated with the skull, and the latter in its turn is jointed to the first vertebra of the spine by two distinct and separate surfaces. The vertebræ number thirty-three, are amphicoelous, and have short, slender ribs attached to their transverse processes in the dorsal and lumbar regions. The pectoral arch is in connection with the third, and the pelvic arch with the nineteenth vertebra. The fore-legs are always longer than the hind-legs, but the latter have the advantage in thickness. The radius and ulna of the fore-arm, likewise the tibia and fibula of the shank, remain as separate bones; the carpus and tarsus both consist of small cartilages that never ossify; and all the feet are tetradactyle. Here may be observed striking differences from the condition which obtains in the frog, where coalescence takes place both between the bones of the forearm and between the bones of the shank, so that there comes to be but a single bone in each; the carpus and tarsus are ossified, two of the tarsal bones are greatly lengthened to assist in leaping, and each of the hind feet is five-toed.

Some measurements of a specimen in my possession, recently captured in the Don, may be mentioned here. These measurements may fairly be regarded as those of an average *Menobranchus*:

Entire length	-	$13\frac{5}{8}$	inches.
Head	- -	2	inches long.
"	- -	$1\frac{1}{2}$	" broad.
"	- -	$4\frac{5}{8}$	" in circumference.
Neck	- -	$\frac{7}{8}$	inch long.
Trunk	- -	$6\frac{1}{2}$	inches long.
"	- -	$5\frac{3}{4}$	" in circumference.
Tail	- -	$4\frac{1}{4}$	" long.
Fore-leg	- -	$1\frac{3}{4}$	" long.
"	- -	$1\frac{1}{8}$	" in circumference.
Hind-leg	- -	$1\frac{1}{2}$	" long.
"	- -	$1\frac{1}{4}$	" in circumference.
Gill	- -	$\frac{3}{4}$	" long.
Anterior Gill-slit	-	7	lines in length.
Posterior "	-	4	"

Another specimen lately taken from the same stream, and dissected by me, was of less size, being twelve inches long, but possessed similar proportions throughout.

The generic name *Menobranchus* is derived from two Greek words signifying that the external branchiæ are permanent, and do not disappear during the life of the animal, as in the case of the salamander, newt and frog. The specific name *maculatus* (Latin for spotted) refers to the deep purple spots with which the skin is studded.

The name *Necturus lateralis* is also given to it by some naturalists. In many localities it is known to those unacquainted with scientific classification and nomenclature as the "big water lizard," the "mud-puppy," "water dog," or "dog-fish." Of course the study of its anatomy proves it to be lower in organization than either the reptiles or mammals, and higher than the fishes. The principal characters distinguishing it from the fishes are: 1st. the possession of jointed limbs instead of fins; and 2nd, the absence of a median spiny fin. The less important distinguishing characters are: 1st, the nasal sacs, which are closed posteriorly in fishes (except Myxinidæ and Lepidosiren) here open into the pharynx; 2nd, the heart has two auricles, but in fishes (except Dipnoi) there is only one auricle in the heart; 3rd, the presence of lungs, which organs are wanting in fishes (except Dipnoi, where the swim-bladder performs the functions of lungs.)

On the other hand it is separated from lizards and other true reptiles by: 1st, the articulation of the skull with the vertebral column by *two* condyles or articulating prominences on the occipital bone, the reptiles having but *one* such condyle; 2nd, the absence of a quadrate bone between the jaw and skull; 3rd, the formation of each ramus of the lower jaw of only one piece; whereas in reptiles it consists of several pieces; 4th, the presence of gills, which never appear in reptiles at any period of their existence; and 5th, the complete absence of an external covering of scales or scutes.

NATURAL HISTORY SOCIETY.

ANNUAL MEETING.

The Annual Meeting of the Natural History Society took place on the 19th May 1879.

The chair was occupied by the President, Principal Dawson.

The minutes of the last annual meeting and those of the previous meeting of Council were read and approved.

The President then delivered the following address:

ADDRESS BY PRINCIPAL DAWSON, LL.D., F.R.S.

The scientific business of the Society in the past winter has included the reading at our monthly meetings of ten papers, comprising a considerable range of subjects. In Geology we have had papers by Dr. Harrington and myself on the mineralogy and mode of occurrence of Apatite; by Dr. Hunt on the various new points which engaged his attention in Europe in the summer of 1878; by Mr. Selwyn and Mr. Macfarlane on the disputed Stratigraphy of Eastern Canada; by Mr. Donald on the remains of a Fossil Elephant; by myself on the Extinct Floras of America. In other departments were Notes on Canadian Ferns by Mr. Goode; on an Esquimaux Bow and Arrow by Mr. Taylor; on the results of an Excursion to St. Jerome by Mr. Marler and Mr. Caulfield; on the Water supply of Montreal by Dr. Baker Edwards.

Of all these subjects that which has perhaps excited the greatest amount of attention, and which best deserves notice here, is the much disputed Geology of the Quebec Group and the associated rocks in the Province of Quebec. This is a subject which has long been in controversy, and which is mixed up with some of the most difficult questions in general geology and in the local structure of the eastern slope of the American continent, both in Canada and the United States. It is a subject on which I have up to the present time avoided any public expression of opinion:—not that I have been indifferent to it—no geologist could be so—nor that I have had no opinions of my own. Having travelled over and examined large portions of the territory occupied by these rocks, it was impossible to avoid arriving at some interpretation of them. But the subject was too intricate to be lightly treated, and others were working at it in detail, and with advantages of public aid which I did not possess. Now, however, it comes up before this Society, introduced in the elaborate and able paper of Mr. Selwyn, followed by the criticisms of Mr. Macfarlane; and these supplemented by Dr. Sterry Hunt's exposition of his own well-known views, in the discussion of Mr. Macfarlane's paper. Farther, in connection with all these various and somewhat discordant opinions, the conclusions arrived at by our late lamented colleague, Sir W. E. Logan, have been canvassed and to some extent set aside.

In these circumstances duty requires that some extended notice of this subject should be taken in this address; and that if no absolutely certain conclusions on all the points in dispute can be affirmed, the state of the controversy should be clearly explained to the bystanders, and the ground cleared for further wrestling on the part of the combatants, should this prove to be necessary. In attempting to perform this somewhat difficult task, it will be proper that I should refrain from entering into details, and that I should confine myself to the question as it relates to Canada, without discussing those features of it which belong to the regions farther south.

I would first say a few words as to the position of the late Sir William E. Logan in relation to the older rocks of Eastern Canada. When Sir William commenced the Geological Survey of Canada in 1842, these rocks, in so far as his field was concerned, were almost a terra incognita, and very scanty means existed for unravelling their complexities. The "Silurian System" of Murchison had been completed in 1838, and in the same year Sedgwick had published his classification of the Cambrian rocks. The earlier final reports of the New York Survey were being issued about the time when Logan commenced his work. The great works of Hall on the Palæontology of New York had not appeared, and scarcely anything was known as to the comparative palæontology and geology of Europe and America. Those who can look back on the crude and chaotic condition of our knowledge at that time, can alone appreciate the magnitude and difficulty of the task that lay before Sir William Logan. To make the matter worse, the most discordant views as to the relative ages of some of the formations in New York and New England which are continuous with those of Eastern Canada, had been maintained by the officers of the New York Survey.

Sir William made early acquaintance with some of these difficult formations. His first summer was spent on the coast of Gaspé and the Baie de Chaleur, where he saw four great formations, the Quebec group, the Upper Silurian, the Devonian, and the Lower Carboniferous, succeeding each other, obviously in ascending order, and each characterized by some fossils, most of which, however, were at that time of very uncertain age. I remember his showing me in the autumn of that year the note-books in which he had carefully sketched the stratigraphical arrangements he had observed, and also the forms of characteristic fossils. But both wanted an interpreter. The plants of the Gaspé Devonian were undescribed; many of them of forms till then unheard of. The shells and corals and graptolites of the older formations could be only roughly correlated with some of those in the New York reports. The rock formations were very unlike those of the New York series. Still this work of 1842 and '43 was plain and easy compared with that which arose in the tracing of these formations to the south-west. I may add here that I have since studied some of these Gaspé sections with Sir William's manuscript note-books in my hand, and have been amazed by the extraordinary care and exactitude with which every feature of the rocks had been observed and noted down. Much of the detail in these early note-books of Sir William, still remains unpublished. Those who would detract from the work of Sir William Logan, if there are any such, should remember these early beginnings, and compare them with the massive foundations which have been laid for us to build upon.

And now, after the labour of more than thirty years on the part of Sir William and those he had gathered around him, how do these subjects stand? (1) We have all the comparatively flat and undisturbed formations of the great plains of Upper and Lower Canada, our share of the interior continental plateau of America, worked out and mapped, and their fossils characterized so that a child may read them. (2) The complex hilly districts with their contorted, disturbed and altered beds, which extend from New England to Gaspé, have been traversed in every direction,* the limits of their different formations marked, and a theory as to their age and structure put forth, which, whether we accept it or not, has in it important features of the truth, and rests on facts on which every disputant must take his stand. (3) We have the still older formations of the Laurentide hills traced in their sinuous windings, and arranged in an order of succession which must stand whether the names given by Sir William, and now accepted throughout the world, be objected to or not. After the work of Sir William Logan, no cavilling as to names can ever deprive Canada of the glory of being the home of the scientific exploration of the Laurentian; and much examination of the

* The extent of measured and paced sections in these districts by Sir William and Mr. Richardson is almost incredible; and these have been made the basis not only of the geology but of the excellent topographical maps prepared by Mr. Barlow.

ground which he explored enables me to affirm that no one will ever be able permanently to overset the general leading subdivisions which he established in the Laurentian and Huronian systems.

Let us turn now to the particular points brought before us in the papers to which reference has been made. It may be well however first to notice some general geological facts which must be present to our minds if we would enter intelligently into these discussions. The formations with which we have to deal in the more ancient geological periods all belong to the bed of the sea. Now in the sea bottom there have been in process of deposition, side by side and contemporaneously, four different kinds of material, differing extremely in their mineral character and in the changes of which they are susceptible. The first of these consists of earthy and fragmental matter washed by water from the surface or sea margins of the land and deposited in belts along coast-lines, or on broader areas where ocean currents have been drifting the detritus ground from the land by ice or washed down by great rivers. The second consists of organic remains of shells, corals and foraminifera, accumulated in coral reefs and the debris washed from them, in shell beds and in the chalky ooze of the deep ocean. Some beds of this kind are very widely distributed. The third is composed of material ejected by igneous action from the interior of the earth and either spread in the manner of lava-flows or of beds of fragments and fine volcanic ash. Such rocks naturally occur in the vicinity of volcanic orifices, which are often disposed in long lines along coasts or crossing ocean basins, but fragmental volcanic matter is often very widely spread by ocean currents and is interstratified with other kinds of aqueous deposit. The fourth and last description of bedded matter is that which is deposited in a crystalline form from solution in water. In later geological times at least, such deposits take place in exceptional circumstances, not of frequent occurrence. Such beds are dolomite, greensand, gypsum, and rock salt.

Now it may be affirmed that at each and every period of the earth's geological history, all or most of these kinds of deposit were in progress locally. But it may also be affirmed that in certain geological periods there was a predominance of one or more over very great areas: and that in any particular area, even of considerable size, there may be definite alternations of these different kinds of material characteristic of particular periods, Again, along certain lines of the earth's crust, the beds deposited by water have been folded and crushed together, probably by the contraction of the earth's shell in cooling, and along these lines they have been changed, in the way of hardening and becoming crystalline or in being chemically recompounded—alterations which are usually known as metamorphic. But still further, some kinds of deposit are much more liable to such metamorphic changes than others. More especially the beds of igneous origin, from their containing abundance of basic matter, as well as of silica, very readily change under the influence either of heat or water, becoming it may be highly crystalline, or having new mineral substances formed in them by new combinations, or on the other hand, when acted on by water, combining with it and forming hydrous silicates.

One other curious coincidence it is necessary to mention.—It is where the greatest deposits of sediments are going on along coasts or in the course of currents, that crumpling and bending of the crust are most likely to occur, and igneous ejections to be thrown out; and conversely, where igneous ejections are piled up, coasts may be forming or currents deflected, so as to cause at these points the greatest deposit of sediment.

These considerations are sufficient to shew the true value of mineral character, first as a means of distinguishing rocks of different nature and origin, and secondly of separating rocks of different ages within limited localities; with its entire worthlessness when applied to distinguish the ages of beds in widely separated localities. There are in America rocks as widely apart in time as the Huronian of the East and the Carboniferous of the West, which are scarcely distinguishable in mineral character; there are rocks of identical age, as for instance the Lower Silurian of New York and Western Canada and that of Nova Scotia and of Cumberland, which are as unlike in mineral character as it is possible for rocks of the most diverse ages to be.

But can we trust implicitly to stratigraphy? Certainly, when we find one rock directly superimposed on another we know that it is the newer of the two. But when we find old rocks slid over new ones by reversed faults, when we find sharp folds overturning great masses of beds, and when we find portions of beds hardened, altered, and become more resisting, standing up as hills in the midst of the softer materials, perhaps of the same age, which have been swept away from around them, then we have the real difficulties of stratigraphy.

We may have difficulties in fossils as well. Nothing is more common than to find in the modern ocean areas traversed by cold currents which have very different animals living in them from those in the same latitude where the water is warmer. The same thing occurs in older formations. The abundant corals and large shell-fishes in our Montreal limestone of the Trenton age, show a condition of things in which the great area of Central North America was covered with warm waters from the south. teeming with life, and was sheltered from the northern currents of cold and muddy water. But in the Utica shale which succeeds, we have the effect of these cold currents flowing over the same area, loading it with mud, over which lived Graptolites and old-fashioned northern Trilobites like *Triarthrus Beckii*, instead of the rich life of the Trenton. This is a mere change to a cold or glacial age.

Now when I inform you that all these causes of error embarrass the study of the Quebec group of Sir William Logan, you will be able to appreciate the difficulties of the case. Crossing the narrow line, a mere crack of the earth's crust, the great reversed fault of Eastern Canada and Lake Champlain, we pass at once from the flat uniform deposits of the great continental plateau of America to entirely different beds, formed at the same time along its Atlantic margin. These beds were affected by volcanic ejections mixing them with ash rocks and causing huge earthquake waves, which tore up the rocks of the sea-bottoms and coasts, and formed great irregular beds of conglomerate, sometimes with boulders many feet in length. In the intervals of these eruptions the area was overflowed by cold Arctic currents carrying sand and mud, sometimes altogether barren of fossils, or again loaded with cold-water creatures like the Graptolites, which occur in vast quantities in some of the beds. Alternating with all this were a few rare lucid intervals, when fossiliferous limestones, just sufficiently like those of the great interior plateau to enable us to guess their similar age, were being produced here and there. Farther, this heap of most irregular and peculiar deposits was that along which subsequent flexures and igneous eruptions and alterations of beds both by heat and heated waters were most rife, all the way down to the Devonian period.

At first the real conditions of this problem were hidden from Sir William Logan, by the error of supposing, with most of the geologists of the United States, that the great reversed fault was a true stratigraphical superposition, and consequently that these strange deposits were newer than those to the west of them. But so soon as the actual nature of the case was made manifest, and this was first due to a right apprehension of the fossils, for which Mr. Billings deserves much of the credit, Sir William at once and for ever apprehended the real conditions of the problem, and set himself to work it out on the true line of investigation.

In evidence of this, and as presenting as clear a view of the whole matter as any we can give, up to the present time, I quote from a note by Sir William appended to Mr. Murray's report on Newfoundland for 1865, and which is less known than his utterances on this subject published in the Canadian reports:

"The sediments which in the first part of the Silurian period were deposited in the ocean surrounding the Laurentian and Huronian nucleus of the present American continent, appear to have differed considerably in different areas. Oscillations in this ancient land permitted to be spread over its surface, when at times submerged, that series of apparently conformable deposits which constitute the New York system, ranging from the Potsdam to the Hudson River formation. But between the Potsdam and Chazy periods, a sudden continental elevation, and subsequent gradual subsidence, allowed the accumulation of a great series of intermediate deposits, which are displayed in the Green Mountains, on one side of the ancient nucleus, and in the metalliferous rocks of Lake Superior, on the other, but which are necessarily absent in the intermediate region of New York and central Canada.

"At an early date in the Silurian period, a great dislocation commenced along the south-eastern line of the ancient gneissic continent, which gave rise to the division that now forms the western and eastern basins. The western basin includes those strata which extended over the surface of the submerged continent, together with the Pre-chazy rocks of Lake Superior, while the Lower Silurian rocks of the eastern basin present only the Pre-chazy formations, unconformably overlaid, in parts, by Upper Silurian and Devonian rocks. The group between the Potsdam and Chazy, in the eastern basin, has been separated into three divisions, but these subdivisions have not yet been defined in the western basin. In the western basin the measures are comparatively flat and undisturbed; while in the eastern they are thrown into innumerable undulations, a vast majority of which present anticlinal forms overturned on the north-western side. The general sinuous north-east and south-west axis of these undulations is parallel with the great dislocation of the St. Lawrence, and the undulations themselves are a part of those belonging to the Appalachian chain of mountains. It is in the western basin that we must look for the more regular succession of the Silurian rocks, from the time of the Chazy, and in the eastern, including Newfoundland, for that of those anterior to it."

In studying these rocks, as Sir William well knew that the great line of disturbance and igneous action lay to the east, as he further knew that in this belt of country rocks all the way up even to the Carboniferous had been profoundly altered, he was not surprised to find that in tracing the Quebec rocks to the south and east, the clay slates, still holding the same fossils, became micaceous or nacreous slates, the bituminous shales graphitic slates, the limestones crystalline marble; and that even serpentine, chloritic slate and hard felspathic rocks appeared to take the place of ordinary aqueous sediments. Consequently he arrived at the large generalizations on the subject embodied in his map of Canada, and to which I believe he adhered to the last.

Was he right in these generalizations? In part, at least, it is certain that he was. I have myself, following in his track, seen distinct Lower Silurian fossils in the nacreous slates and graphitic slates of the Townships, and I have seen these slates alternating with hard quartzites, and felspathic and brecciated rocks, and so far as could be made out by stratigraphy, with chloritic rocks, crystalline dolomite, soapstones and serpentine, these rocks seemingly representing the shales of Point Levis if not still newer members of the series. Dana has recently shown that rocks in Connecticut, usually referred to the Quebec group, or even to the Lower Taconic series of Emmons, and often in a highly crystalline state, actually contain fossils newer than those of the Quebec group, or of Hudson River age.* Murray in Newfoundland has found the most unequivocal superposition of serpentine and chloritic slate on fossiliferous rocks of the Quebec group, and intervening in age between them and the Hudson

* American Journal of Science, May, 1879. One of the fossils recognized by Dana seems to be the *Stromatopora compacta* of Billings really a *Stenopora*, known in Canada both below and above the Levis,

River group, a point to which we must refer subsequently; and there is nothing incredible or even very unlikely in this. On the other hand, knowing the complexities of all the parts of this troubled sea of eastern palæozoic rocks which I have studied, I cannot deny that there may exist crests of beds older than the Quebec group projecting locally and perhaps largely through these rocks. I am the more inclined to believe this, since there is the best reason to hold that the unaltered members of the Quebec group, as mapped by the Survey on the south shore of the St. Lawrence, include beds ranging all the way from the Lower Cambrian up to the Chazy. Similar, perhaps older, beds, no doubt exist largely, mixed with igneous outflows and breccias, in the hills of the interior.

But if any man thinks proper to put down a hard and fast line on the map of Eastern Canada, and to maintain that all the crystalline rocks which apparently project through and rise above the Quebec group, are of greater age, I must decline to go with him in this assertion, since I feel certain that such an extreme view cannot be in accordance with facts. No one, however, I feel persuaded, will now go so far as this: but I believe the pendulum has already swung farther than it should in this direction, and must go back again nearer to Sir William Logan's position. Facts in support of this conclusion rise before my mind as I write, and may be brought forward on some future occasion, but they would involve a series of papers for their full elucidation.

We have had presented to us ably and well by Mr. Selwyn, Mr. Macfarlane, and Dr. Hunt, conclusions differing more or less widely from those of Sir William, and from each other. There are no doubt important elements of truth in them all, but when these are fully and fairly sifted, the unprejudiced geologist will conclude that while they may modify the results of Sir William's work, they by no means overthrow them; and that we are still a long way from the solution in all their details of the problems which occupied Sir William to the last, and which he left only partially solved.

We may now sum this matter up, in so far as Sir William Logan's work is concerned, and that of Richardson as his assistant, and of Hall and Billings in the department of Palæontology. Their researches have established :—(1) The general diversity of mineral character in the Palæozoic sediments on the Atlantic slope as compared with the internal plateau of Canada. In those results Bailey, Matthew, and Hartt in New Brunswick, and the writer in Nova Scotia, have also borne some part. (2) The establishment of the Quebec group of rocks as a series equivalent in age to the Calciferous of America, and to the Arenig and Skiddaw of England, and the elucidation of its peculiar fauna. (3) The tracing out and definition of the peculiar faulted junction of the coastal series with that of the interior plateau, extending from Quebec to Lake Champlain. (4) The definition in connection with the rocks of the Quebec group, by fossils and stratigraphy, of formations extending in age from the Potsdam sandstone to the Upper Silurian, as in contact with this group, in various relations, along its range from the American frontier to Gaspé; but the complexities in connection with these various points of contact and the doubts attending the ages of the several formations have never yet been fully solved in their details. (5) The identification of the members of the Quebec group and associated formations with their geological equivalents in districts where these had assumed different mineral conditions, either from the association of contemporaneous igneous beds and masses, or from subsequent alteration or both. It is with reference to the results under this head, the most difficult of all, that the greater part of the objections to Sir William's views have arisen.

Let us now shortly examine Mr. Selwyn's new results, with reference to these conclusions, especially to the last.

The first point deserving of notice here is the inability of Mr. Selwyn to recognize in the extension of the Quebec group eastward and westward of Quebec, those subdivisions which have been named the Levis, Lauzon, and Sillery. Originally Sir William recognized two divisions only, the Levis and Sillery. Subsequently he introduced, on the ground merely of convenience, the intermediate Lauzon; though apparently not regarding the threefold division as at all important, but merely as provisional.*

Of those subdivisions the most important is the Levis, which forms the fossiliferous and most readily recognized horizon of the Quebec group. About the precise base of this division, held to be the lowest of the group, there is some uncertainty, Sir William has referred to it as resting on Potsdam rocks in the vicinity of Lake Champlain, and farther east on older shales and limestones; and Mr. Richardson has endeavoured to separate

* Report of 1866, p. 4.

from it certain sandstones and associated beds on the Lower St. Lawrence. More especially I may refer to the sandstones and shales near Metis, holding *Astropolithon*, *Scolithus*, and *Arenicolites spiralis*, and to beds near Matane holding species of *Conocephalites* of very primitive type. In Newfoundland also, where the sequence of these beds is better seen than elsewhere, there are, according to Richardson and Billings, 2000 feet of beds under the typical Levis and over the Lower Calciferous, holding fossils unquestionably of the second fauna of Barrande, or Lower Silurian, and below them there is a great thickness of Calciferous and Potsdam. All these beds must exist in the Quebec group districts of Canada, folded up along with the Levis, and as yet very imperfectly separated from it, nor is it at all unlikely that in some localities they may have been confounded with the Lauzon and Sillery.

With regard to the distinction of these last-named formations as upper members of the Quebec group, we must agree with Mr. Selwyn that in the present state of our knowledge they cannot be clearly separated from the Levis or from one another. Nevertheless it is true that on the typical Levis there rest sandstones and shales of considerable thickness, not holding its characteristic fossils, and forming an upper member of the Quebec group, as yet not well defined, but representing in nature the Lauzon and Sillery of Logan.

In the next place, Mr. Selwyn is disposed to separate from the Quebec group the greater part of those altered and crystalline rocks associated with it, and which appeared to Sir William Logan to be metamorphosed equivalents of this group, and largely of its upper or Sillery division. Of these rocks he forms two series, which however he regards as closely associated, and probably not unconformable with each other.

The first and nearest in age to the Quebec group is defined as including "felspathic, chloritic, epidotic and quartzose sandstones, red, gray and greenish siliceous slates and argillites," with "breccias and agglomerates, diorites, dolerites, and amygdaloids," as well as serpentine, dolomite, and calcite. In short this formation is one of mixed igneous and aqueous origin, non-fossiliferous, except in the case of a few microscopic fragments, and mostly crystalline. As regarded by Sir W. E. Logan, these rocks, in consequence of their apparent conformity with the Levis series, and their apparent superposition in some sections, were held to be an upper member of the Quebec group, and were mapped as Sillery. They were thus placed in the same position with the serpentine and chloritic formation of Newfoundland, as described by Murray, with the Cobequid series as I have described it in Nova Scotia,* and with the Borrowdale igneous rocks resting on the English equivalents of the Levis beds as defined by Ward in Cumberland.

Mr. Selwyn, on the other hand, thinks that the main mass of these peculiar rocks either comes out unconformably from beneath the Levis series or is separated from it by a fault, and is in all probability older, though the obscure traces of fossils found in some of the beds would indicate that they are not older in any case than Lower Silurian or Upper Cambrian.

It is obvious that with reference to a formation so greatly disturbed, either of these theoretical views may be correct, or that there may be two crystalline series, one below and another above the Levis beds. Where I have had opportunity to observe the formation, at Melbourne, and in a few other places, I have seen no reason to dissent from Sir W. E. Logan's view; but at that time Mr. Selwyn's explanation was not before my mind, nor have I examined the sections on which he chiefly relies.

Had Sir W. E. Logan lived, it was his intention to have, at his own cost, bored through the crystalline rocks at some selected site, in order to obtain positive proof of the subterposition of the Levis beds. This expense is not now likely to be incurred, but the whole question will in course of time be settled by the careful re-examination and mapping, which now that these new views have been suggested by the head of the Geological Survey, the district is likely to receive.

Mr. Selwyn's third division, supposed to be still older, possibly Lower Cambrian, in some respects resembles the second, but is predominently slaty and quartzose, though still with dolomites and other magnesian rocks. These would naturally fall into the place assigned to them, if the age attributed to the second series be admitted, otherwise they come into the period of the Sillery, or some newer formation, in an altered condition. I do not know that fossils have been found in these rocks, within the limits of Canada at least, but if they are really of Cambrian age, the richness of this fauna elsewhere in N. E. America would warrant

* Acadian Geology, third edition.

the hope that the age assigned to them may be indicated by fossils, while, if like some similar beds to the southward, they hold Silurian species, these also must in some places be recognizable; so that if they finally fail to afford fossil remains or yield Lower Cambrian species, this, with their mineral character and apparent distribution, would sustain Mr. Selwyn's view; while, on the other hand, the discovery of a few distinctive Silurian forms might suffice to overturn it.

It would appear that the third and second series of Mr. Selwyn, above mentioned, are the same with the rocks which in Hitchcock's map of New Hampshire are named Montalban and Huronian. The former term has however been applied by Dr. Hunt to a series newer than the Huronian, and possibly of Lower Cambrian age, so that if it is correctly used by Hitchcock, his so-called Huronian may be in reality Upper Cambrian or Lower Silurian. It is to be deprecated as not conducive to correct conclusions, that terms of this kind should be used to represent merely mineral resemblances, irrespective of those evidences of geological age derived from stratigraphy and fossils. It is due here to Dr. Hunt to explain that he has for many years on independent grounds regarded the beds of Mr. Selwyn's second and third groups as, for the most part at least, Huronian in age, and a similar conclusion was also arrived at from comparison with the older formations of Scandinavia, by Mr. Macfarlane. Thus in one way or another all these gentlemen dissent from Sir William's conclusions, while also differing from each other, a sufficient evidence of the complicated character of the problem with which he had to deal, and whose ultimate solution may embrace elements of all the generalizations which have been put forth.

Some suggestions may at least be offered toward the solution of these questions which deserve the attention of those who have been occupied with them. The first is that we should accustom ourselves to the anticipation that contemporaneous palæozoic rocks in the regions of the western lakes, of the plains of Ontario and Quebec, and of the eastern slope, are not likely to be identical in mineral character. Farther, that even in the central of these three regions we may expect differences in approaching certain parts of the older rocks. At Murray Bay, for example, on the border of the Laurentian, we find the Black River limestones in great part represented by coarse sandstones, and we find similar changes in the Chazy near Grenville. A third suggestion is, that in order to understand the eastern members of the Lower Silurian, it is necessary to be acquainted with the contemporaneous igneous ejections mixed with these rocks, and if possible to distinguish them from those of similar character so largely present in the Huronian. This I have attempted, though with only partial success, to effect for the Acadian Provinces. Another, to which Dr. Hunt has directed attention in his recent report in connection with the Survey of Pennsylvania, is the importance of inquiry as to which of the many successive movements and plications of the earth's crust occurring in palæozoic time, have most seriously affected the now so greatly plicated and disturbed rocks of the Quebec group. Still another, and one of the most important, is the study of the various kinds of alteration which these rocks have undergone. We have in eastern Canada rocks as young as the Devonian which have been sensibly affected in this way, and there can be no doubt that large areas of the Quebec group have suffered similar changes, and that on the one hand it is possible that these metamorphosed portions have been confounded with older series, or that on the other these older series have been inadvertently mixed with them.

The value to be attached to fossils is another point of much importance. Long experience has convinced me that in the Cambrian and Silurian ages this kind of evidence is the most conclusive of all; but then it must be rightly understood. As already observed, we must discriminate the animals characteristic of the cold Atlantic waters loaded with Arctic sediment, from those of the sheltered continental plateau. We must also bear in mind that oceanic and probably floating forms of low grade, like the Graptolites, have an enormous range in time, as compared, for example, with the Trilobites, and the same remark applies to some mollusks proper to sandy or muddy bottoms, like the Lingulæ and their allies, as compared with other mollusca.

All these precautions must be taken in the study of these rocks, and it involves no depreciation of the geologists above-mentioned, to say that the different conclusions at which they have arrived, depend very much on the different degrees of importance which they have attached to the various kinds of evidence accessible.

One word, before closing, respecting names. These are of little importance in themselves, but it is of consequence that they should not be needlessly changed, and that they should not be misapplied.

The name "Quebec Group," introduced by Sir William Logan, should be retained for that peculiar development of the rocks of the second fauna, eminently exposed and accessible in the vicinity of Quebec. to whatever extent its extensions east and west may be circumscribed; and whatever value may be attached to the local subdivisions into Levis, Lauzon and Sillery. On the one hand, the use of one of these terms, Levis, for the whole, leads to misconception; and the absurdity of the term "Canadian" (applied in one widely-known text book to the rocks of this age) becomes apparent when we see it made correlative with a purely local name like "Trenton," and when we consider that Canada is a region greater than the United States of America, and with equally varied geological structure.

The more recent developments in the geology of North America require, as Dr. Hunt and Mr. Selwyn have urged, that the Cambrian system should be recognized as a group altogether distinct from the Silurian; and whatever views as to the use of these names may ultimately prevail in England, for us the dividing line between the Cambrian and the Siluro-Cambrian or Lower Silurian, unquestionably comes about the horizon of the Potsdam. As to the formations older than the Cambrian, I am disposed to regard the Montalban and Taconian of Dr. Hunt as representing definite groups of rocks, which may however eventually prove to belong to the base of the Cambrian, with which equivalent strata in the Maritime Provinces of Canada seem to be associated. The Huronian series of Logan represents another great fact in the geology of North America, namely a period of immense igneous ejection and disturbance intervening between the Laurentian and the Cambrian. In the typical Huronian area of Lake Huron it unquestionably rests unconformably on the Laurentian, and is itself overlaid by rocks of Cambrian or still greater age. It has precisely the same mineral characters and position as far east as New Brunswick and Newfoundland, and as far west as the Pacific slope,* and is thus one of the most

* Clarence King's Report of the 40th Parallel. The rugged features and precipitous sides of the Laurentian and Huronian exposures in this region correspond with Logan's view of the steep slope of the Laurentian land at the time of the deposition of the Quebec Group rocks.

widely diffused of American formations, though I believe it has locally been confounded with rocks of similar mineral character but of newer date. The upper Laurentian of Logan, the Norian of Hunt, is entirely different in mineral character from the Huronian, and stratigraphically is related to the Middle Laurentian rather than to the Huronian, notwithstanding local unconformity. The Lower Laurentian of Logan may now, since the explorations of Vennor,* be safely divided into a lower and middle group, the former being however nothing more than the great gneissic formation recognized by Logan as the Trembling Mountain gneiss, which forms the base of his well-known Laurentian section, and the Bojian gneiss of European observers. The idea that the Middle Laurentian, the horizon of Eozoon Canadense and of the great Phosphate and Graphite deposits, is identical with the Hastings group, or with the Huronian, has, I am fully convinced, after some study of the Lake Huron, Madoc and St. John exposures of these formations, no foundation in fact. There seems, however, good reason to believe that the gap between the Lower Laurentian of Lake Huron and the Huronian, is to be filled not merely by the Middle Laurentian and the Norian, but by such rocks as those described by Dr. Bigsby, Prof. Bell and Dr. G. M. Dawson on the Lake of the Woods and other regions west and north of Lake Superior, and at present included in the Huronian, to the base of which many of them no doubt belong.†

I should not have occupied your time so long with these matters, but for their great importance geologically, and the able papers in which they have been brought under our notice, and for the circumstance that I have been renewing my studies of these rocks, in the hope of contributing some notes on Sir William Logan's share in their investigation, to a biographical sketch of that eminent geologist now in progress under the care of our associate, Dr. Harrington, to whom it has been committed by Sir William's executors.

Mr. G. L. Marler, Chairman of the Council, then read the following report :—

Your Council have to report on the proceedings of the past year, which has just closed. In doing so they have to remark

* Reports Geological Survey of Canada.

† G. M. Dawson's Report on 49th Parallel. Bell, Reports Geological Survey of Canada.

that, owing to several causes, your finances are not in such a prosperous state as formerly. The yearly receipts from members' fees have much fallen off, and the Government having delayed the payment of the annual grant, retrenchment has been forced on your Society, and they have been obliged to do away with the services of Mr. Caulfield, and reduce the allowance to Mr. Passmore to the amount given him when first engaged.

The Council have also to report that several urgent repairs have been made to the building, and that much yet remains to be done to put it in a thorough state of repair; and recommend to the incoming Council to have the roof put in order. These improvements have enabled your Council to provide accommodation for several kindred Societies. The aquarium room has been done away with, and its space filled with shelves and cases—and this has made room for placing specimens which were lying in boxes on your premises.

Your Council would recommend the desirability of getting a members' register, which is much needed, and to see that all members receive regularly the *Naturalist* from the publisher, as several complaints on this matter have been made during the past year; and also that revision of the exchange list be carefully made.

The usual and regular Sommerville Lectures have been given to the number of six.

1. On the various forms of Musical Composition as determined by the great masters, their beauties, uses and abuses. By Fred. E. Lucy Barnes, Esq., R.A.M.

2. On our Great West as a home for the Emigrant. By Prof. Robert Bell, M.D.

3. On the Haida Indians of the Queen Charlotte Islands. By George M. Dawson, Esq., D. Sc., F.G.S.

4. On the Physiology of Digestion. By Dr. F. W. Campbell, L.R.C.P.

5. On Canada at the International Exhibition at Paris. By William Hamilton Merritt, Esq., A.R.S.M.

6. On the Physiology of Respiration. By Dr. Vineberg.

A 7th was announced to be given by Dr. Hunt, but was not delivered owing to his illness.

These lectures have been attended by large numbers, and were of high merit and scientific character. The thanks of your Society are due to the gentlemen who so kindly and at so much trouble gave them.

Your Council have also to report that the usual annual field day took place on the first June, 1878. The party numbered over 118 members and friends. The day was a most favourable and enjoyable one. The party proceeded by rail to St. Jerome, where they were kindly received by the Rev. Father Labelle and a number of gentlemen of that village, to whom the cordial thanks of the Society are due for their kindness on that occasion, especially for the address of welcome by Father Labelle. Prizes were awarded for collections. No part of the country could be more suitable for a field day than St. Jerome and its environs, it being full of interest to your members. The receipts of the trip scarcely covered the expenditure, a small sum being required from the funds of the Society to cover the deficiency, $3.05.

CURATOR'S REPORT.

Mr. Caulfield, the Curator, submitted the following report:—

The entire zoological collection has been closely examined and cleaned, and any specimens showing traces of museum pests have been thoroughly disinfected.

The cases containing the fishes, reptiles and exotic birds have been cleaned and re-papered, but owing to the coldness of the museum the work had to be suspended, leaving the papering of the cases containing the mammals and Canadian birds unfinished.

The alcoholic preparations in the cases upstairs have also been examined. Some of the common Canadian batrachians which had been bleached by long exposure to light have been removed, and the jars containing the remainder of the specimens have been cleaned and re-filled with fresh alcohol.

The miscellaneous collections in the old wall case in the aquarium room have been taken out, cleaned and temporarily arranged in the new wall cases. The collection of fossils presented by the late Sir G. Duncan Gibb has been cleaned and placed in the new table cases.

The entomological collection is in good order and free from dermestes, &c. The herbarium is also free from insects, but needs replenishing, as many of the specimens are old and faded.

The issuing of circulars to members for the monthly meetings has been attended to, and the cleaning of the building at regular intervals has been provided for.

The additions to the museum during the past session have been as follows:—

R. J. Fowler, Esq.—The large mouthed black bass, *centrarchus nigricans*.

— Loomis, Esq. of Sherbrooke.—Fossiliferous marble, Dudswell mine, District St. Francis.

Mr. Selwyn.—Canadian minerals.

By purchase:—

Pair of sea trout, *salmo Canadensis*, Smith.

Sculpin, or bull-head, *cottus*.

Sharp nosed sturgeon, *Accipenser oxyucuns*.

The Treasurer, Mr. Shelton, stated that the reserve funds of the Society had been largely drawn upon in consequence of the delay of the Quebec government in paying over the annual grant.

A piece of Canadian black marble, richly studded with curious fossils, was exhibited. It was a present from Mr. Loomis, High Constable of Sherbrooke, and had been extracted from the Dudswell mines, where it is to be found in large quantities; it is suitable for mantlepieces.

Mr. E. E. Shelton then read the Treasurer's report. (See p. 188.)

Principal Dawson stated that Mr. Thomas Currie, aided by himself, had been employed upon the collections in the museum since the departure of Mr. Caulfield.

It was moved by Mr. Muir, seconded by Mr. Joseph, "That the reports now read be approved and printed in the *Canadian Naturalist*." Carried.

The election of officers for the ensuing year was then proceeded with, and resulted as follows:—

President,—Mr. A. R. C. Selwyn, F.G.S.

Vice-Presidents,—Principal Dawson, Dr. De Sola, Prof. Harrington, Mr. Whiteaves, Mr. G. L. Marler, Dr. Sterry Hunt, Mr. H. Joseph, Mr. Robb, Prof. P. J. Darey.

Corresponding Secretary,—Dr. J. Baker Edwards.

Recording Secretary,—Mr. Frank W. Hicks.

Treasurer,—Mr. G. L. Marler.

Council.—Messrs. Muir. Brissette, Goode. Dr. G. M. Dawson, Dr. Bell, Mr. Shelton, Rev. Mr. Empson and Major Latour.

The following *Library Committee* was also elected:—Messrs. Hicks, Donald, Brissette. Bemrose, and Dr. McConnell.

A letter was read from Major de Winton. informing the Society that His Excellency the Governor General, Patron of the Society. would visit the museum during the approaching visit to Montreal.

A letter was also read from the Ottawa Field Naturalists' Club, suggesting that the Society hold its annual field meeting at Calumet. when the two Societies might exchange courtesies. The Society had replied acceding to this proposal.

REPORT OF COMMITTEE ON MONUMENT TO FREDERICK PURSH.

At the last annual meeting of the Natural History Society, mention was made of the effort in progress. under the care of a Committee of our Council. to erect a monument over the neglected remains of one of the early scientific explorers of Canada, to whose labours the botany of this country owes very much. This labour of love has now been completed, and a neat monument, paid for by the subscriptions of members of the Society, now marks his resting place in Mount Royal Cemetery. The following notes on the life of Pursh. prepared originally by the late Dr. Barnston, should now be placed on record in the *Naturalist*, as a further tribute to his memory, and a reason for the interest taken in the matter by this Society.

Frederick Pursh was a German by birth and education. He pursued a successful course of study in Dresden, and acquired, at an early age, a taste for science and a peculiar fondness for botanical and horticultural pursuits. He contemplated with pleasure and admiration the many beautiful and singular flowers, the fine shrubs and ornamental trees that adorned the gardens and pleasure grounds, and which were natural productions of North America. This excited in his mind a strong desire to visit the New Continent—to observe in their natural soil and climate these same plants. the study of which had afforded him so much gratification, and to make such discoveries as circumstances might throw in his way. Accordingly, in 1799 he embarked for the United States, where he at once commenced his researches as a scientific and practical botanist. He devoted his time to the field, the forest and the glen, and enriched his own extensive collections by valuable additions from the herbaria of the United States botanists with whom he became acquainted. His labors, however, were not confined simply to the formation of an herbarium. He rendered his researches of great value by introducing into the garden many beautiful herbs and shrubs whose cultivation has since been greatly extended. Having thus labored assiduously for a period of twelve years, during which time he discovered many new and rare plants, and ascertained the soil, situation and range of country in which each species was found, he proceeded to England, with the intention of publishing his researches. The materials he now possessed, together with the information obtained from collections which he consulted in England formed the basis of his "*Flora Americæ Septentrionalis*," in two volumes—a work which immediately gave him a high position among men of science, and secured to his name an authority on American botany that will be always recognized.

The success of the publication and the interest excited by his discoveries induced him, under favorable auspices, to further prosecute his researches in the Canadas—a country then presenting a wide field for original botanical investigations. He accordingly arrived in the Lower Province, with the view of forming a complete herbarium of Canadian plants—of ascertaining the natural resources of the soil, and improving the system of horticulture. His labors, however, were not of long duration and not without many drawbacks. After having botanized a large portion of Eastern Canada, and made a considerable collection of plants (which were subsequently destroyed by fire), he died in Montreal in July, 1820—so destitute of means that the expense of his burial and other outlays were defrayed by his friends.

Pursh possessed a happy temperament, a kind and generous disposition, and was a universal favorite among gardeners, whose interests he served by every means in his power. The remains when disinterred were identified by the following inscription, which was clearly preserved on the plate attached to the coffin:

FREDERICK PURSH.

Died 11th July, 1820.

AGED 46 YEARS.

The spirit with which he entered into his work is shown by the following paragraph from the "*Flora Americæ Septentrionalis*":

"Among the numerous useful and interesting objects of natural history discovered in the vast extent of the new continent none claim our attention in a higher degree than the vegetable productions of North America. Her forests produce an endless variety of useful and stately timber trees, her woods and hedges the most ornamental flowering shrubs, so much admired in our pleasure grounds, and her fields and meadows exceedingly handsome and singular flowers different from those of other countries. All these are more or less capable of being adapted to a European climate, and the greater part of easy cultivation and quick growth; which circumstances have given them, with much propriety, the first rank in ornamental gardening.

"A country so highly abundant in all the objects of my favorite pursuits, excited in me, at an early period of life, a strong desire to visit it, and to observe in their natural soil and climate the plants which I then knew, and to make such discoveries as circumstances might throw in my way. This plan I carried into execution in the year 1799, when I left Dresden, the place where I had received my education, and embarked for Baltimore in Maryland, with a determination not to return to Europe until I should have examined that country to the utmost extent of my means and abilities. In 1811, after an absence of nearly twelve years, I returned to Europe with an ample stock of materials towards a Flora of North America, an attempt at which I now venture to lay before the public, with a flattering hope that a generous allowance will be made for its unavoidable imperfections, when the extent of the undertaking is considerd; and that it will be accepted, as it really is intended, as only the ground work of some future more perfect work upon the subject."

In this introduction he gives an account of his travels, which shows the immense amount of pains taken to gather correct information. On his arrival he made the acquaintance of several botanists whose observations were of great assistance to him. In the beginning of 1805 he set out for the mountains and western territories of the Southern States, beginning at Maryland and extending to the Carolinas (in which tract the interesting and high mountains of Virginia and Carolina took his particular attention), and returning late in autumn through the lower countries along the sea-coast to Philadelphia. In 1806 he went in a like manner over the Northern States, beginning with the mountains of Pennsylvania and extending to those of New Hampshire (in which tract he traversed the extensive country of the lesser and great lakes) and returned as before by the sea coast. Both these tours he made on foot, travelling over an extent of more than three thousand miles each season, with no other companions than his dog and gun, frequently taking up his lodgings in the midst of wild mountains and impenetrable forests, far remote from the habitations of man. After his return, while making arrangements for the publication of his materials, he was called upon to take the management of the Botanic Garden of New York, and in 1807 took charge of that establishment. In 1810 he took a voyage to the West Indies, visiting the Islands of Barbadoes, Martinique, Dominique, Guadaloupe and St. Bartholomew's, from which he returned in the autumn of 1811. He next went to London, Eng., where he very soon became acquainted with those who were very much attached to the science of botany, amongst whom were Sir Joseph Banks and A. B. Lambert, Esq., who greatly assisted him in the publication of his work. On its completion he came to Canada, where he died.

Pursh was interred in the old cemetery in Papineau road. There his remains lay neglected till 1857, when the facts becoming known to the late Dr. Barnston and other gentlemen connected with the Botanical Society of Montreal, the bones were removed to the Mount Royal Cemetery, and an effort was made to secure means to erect a suitable monument. The untimely death of Dr. Barnston arrested this monument; and with his death the Botanical Society itself became extinct. Attention was again directed to the subject in 1877, principally at the instance of the late Dr. John Bell, and a Committee of the Natural History Society, consisting of the President, Treasurer, and members of the Council, were enabled to carry this tribute to a too long neglected man of science to a successful issue. It should be added that, on the request of the Committee, the Trustees of the Mount Royal Cemetery liberally contributed to the object by the grant of a lot in a retired and beautiful portion of the cemetery, such as a lover of nature like Pursh might have himself selected as his last earthly resting place.

Dr. THE NATURAL HISTORY SOCIETY OF MONTREAL *in account with* E. E. SHELTON, *Treasurer.* *Cr.*

1878—'79.		1878.	
To cash paid Printing and advertising	$77.05	By balance on hand	$282.97
" " Mr. Caulfield, salary	233.75	" Annual Government grant	750.00
" " Mr. Passmore, salary	400.00	" Members' yearly subscriptions	469.00
" " Do. attendance	9.75	" Entrance fees	36.70
" " Messrs. Foote and Wilson, commission	13.25	" Rent of rooms	337.00
" " Coal and wood	128.64	" Contributions Pursh monument	93.00
" " Gas bill	92.90	" 4 Aquaria sold	24.00
" " City taxes	128.51	" Interest on bank deposits	7.71
" " Insurance	35.00		
" " Repairs and petty expenses	174.91		
" " Interest Royal Institution	75.00		
" " Dawson Brothers	235.20		
" " Shearer & Co., cupboards, &c	69.20		
" " Pursh Monument	90.00		
" Balance on hand	237.22		
	$2000.38		$2000.38

LIABILITIES.

Mortgage Royal Institution	$1000
Due Dawson Bros	175
	$1175

Montreal, May 19. 1879.

Examined, audited and found correct.

G. L. MARLER, M. H. BRISSETTE, } *Auditors.*

MISCELLANEOUS.

At the meeting of the London Geological Society, held March 12th, the following papers among others were read:—*The gold-leads of Nova Scotia*, by Henry S. Poole, F.G.S., Government Inspector of Mines. The author remarked upon the peculiarity that the gold-leads of Nova Scotia are generally conformable with the beds in which they occur, whence Dr. Sterry Hunt and others have come to the conclusion that these auriferous quartz veins are interstratified with the argillaceous rocks of the district. With this view he does not agree. He classified the leads in these groups according to their relations to the containing rocks, and detailed the results of mining experience in the district, as showing the leads to be true veins by the following characters: (1) Irregularity of planes of contact between slate and quartz; (2) The crushed state of the slate on some foot-walls; (3) Irregularity of mineral contents; (4) The termination of the leads; (5) The effects of contemporary dislocations; (6) The influence of strings and offshoots on the richness of leads. The author further treated of the relative age of the leads and granite, and combated the view that the granites are of metamorphic origin, which he stated to be disproved by a study of the lines of contact. He also noticed the effects of glaciation on the leads, and the occurrence of gold in carboniferous conglomerate.—*On conodonts from the Chazy and Cincinnati groups of the Cambro-Silurian, and from the Hamilton and Genesee-shale divisions of the Devonian, in Canada and the United States*. by G. Jennings Hinde, F.G.S. After a sketch of the bibliography of the subject, the author described the occurrence of conodonts. In the Chazy beds they are associated with numerous *Leperditiæ*, some trilobites and gasteropods; in the Cincinnati group with various fossils; and in the Devonian strata principally with fish-remains; but there is no clue to their nature from these associated fossils. They possess the same microscopic lamellar structures as the Russian conodonts described by Pander. The various affinities exhibited by the fossil conodonts were discussed; and the author is of opinion that though they most resemble the teeth of myxinoid fishes, their true zoological relationship is very uncertain. The paper concluded with a classification of the conodonts from the above deposits.—*On Annelid Jaws from the Cambro-Silurian, Silurian and Devonian formations in Canada, and from the Lower Carboniferous in Scotland*, by G. Jennings Hinde, F.G.S. After referring to the very few recorded instances of the discovery of any portions of the organisms of errant annelids as distinct from their trails and impression in the rocks, the author noticed the characters of the strata, principally shallow-water deposits in which the annelid jaws described by him are imbedded. A description was given of the principal varieties of form and of the structure of the jaws. They were classified from their resemblance to existing forms under seven genera, five of which are included in the family Eunicea, one in the family Lycoridea, and one among the Glycerea. The author enumerated fifty-five different forms, the greater proportion of which are from the Cincinnati group.—*Nature.*

Convoluta Schultzii.—An important line of demarcation between the vegetable and animal world has been removed by recent investigation. Plants assimilate carbonic acid, give off oxygen, and form starch. By experiments on a species of Planaria, a flat worm, described as *Convoluta Schultzii*, Mr. P. Geddes has demonstrated that that animal disengages oxygen in large quantity, decomposes carbonic acid, and produces starch. This worm abounds in the shallow water on the margin of the sea, and on exposure to sunlight pours forth a stream of bubbles containing, as proved by analysis, from forty-five to fifty-five per cent. of oxygen. And on subjecting a number of Planaria to chemical treatment, a quantity of ordinary vegetable starch was obtained. Pointing out the significance of these facts in the *Proceedings* of the Royal Society, Mr. Geddes says: 'As the *Drosera* and *Dionæa* [two species of well-known vegetable Fly-traps], which have attracted so much attention of late years, have received the striking name of Carnivorous Plants, these Planarians may not unfairly be called Vegetating Animals, for the one case is the precise reciprocal of the other. Not only does the *Dionæa* imitate the carnivorous animal, and the *Convoluta* the ordinary green plant, but each tends to lose its own normal character.'—*Chambers's Journal.*

SIMPLE METHOD OF CONVERTING IRON INTO STEEL.—After many years of trials and experiments to convert iron into steel by a short and simple process, the endeavour has been crowned by success. In Cleveland, that north-eastern corner of Yorkshire, where iron ore is as abundant as salt in the sea, excitement prevails, and years of prosperity are anticipated; and it may fairly be assumed that all ironstone districts will be stimulated into activity by this last metallurgical discovery. As is pretty well known, the long-standing difficulty had been to get rid of the phosphorus present in the iron, and many were the ingenious devices put in practice to overcome it. At length Mr. Sidney G. Thomas, F.C.S., commenced a series of experiments on the effect of different materials as a lining for the 'converter' —the receptacle in which the molten metal is subjected to the blast. Experience had demonstrated that the usual siliceous lining favoured retention of the phosphorus; but what other could be devised that would resist the intense heat? By perseverance the alternative—a mixture of limestone and silicate of soda—was discovered. This expelled the phosphorus. The preliminary results, necessarily on a small scale, were confirmed by large experiments made at the Blaenavon Iron works, in Wales; and now the process has been adopted by one of the leading firms in the Cleveland district, by whom it will be fully developed, and the conversion of 'pig' into good steel, free from phosphorus, will become an everyday operation. Shall we see as a consequence modification and quickening in the manufacture of machinery and ships; and will cheap steel have any effect on the trade of Sheffield and Birmingham?—*Ibid.*

GEOLOGICAL DISCOVERY AT CHARING CROSS, LONDON.—An interesting geological discovery has just been made in the heart of London. In making the excavations at Charing Cross for Messrs. Drummond's new bank, the workmen, at depths varying from fifteen to thirty feet, came upon the fossil remains of several extinct animals. They include elephant tusks and molars (probably the mammoth *Elephas primigenius*), a portion of what appears to be the horn of the great extinct Irish deer (*Megaceros Hibernicus*), along with other remains of ruminating animals not identified. All the remains are those of herbivorous quadrupeds, but there is among them no bone or tooth of hippopotamus or rhinoceros, though theses huge beasts are known from discoveries made at Brentford, Crayford, and other localities in the Thames Valley, to have been in times long gone by the companions of the Thames Valley mammoths. The specimen in this collection which has specially attracted the attention of gentlemen learned in the study of fossil osteology is the terminal point of an elephant tusk, unusually sharp at the point and highly polished, and from the surface of which a very thin skin of ivory peels off, exposing a strongly and regularly longitudinally channelled surface beneath.

A New Chemical Industry.—A lecture was, a short time ago, delivered by Prof. Roscoe, at the Royal Institution, on a new chemical industry which has originated and developed in France to a considerable extent within the last two or three years. M. Vincent, *répétiteur* at the Ecole Centrale at Paris, and directing chemist of the great distillery works at Courrières, has succeeded in putting to good use what has hitherto been a waste product. Instead of burning the residue of beet-root molasses—after the alcohol has been distilled from it—in the open air for the purpose of obtaining the potash salts it contains, he performs the calcination in closed retorts, in order to secure the products of distillation. Among those he found a large quantity of trimethylamine, which can be easily worked up into chloride of methyl. This gaseous body, reduced through pressure to a liquid, is an excellent material for frigorific purposes. By its own evaporation the bulk of the liquid acquires a temperature of —23° C., and when the evaporation is assisted by the passage of dry air through the liquid the temperature is brought as low as —55° C. Prof. Roscoe was able to freeze in this way a mass of mercury of several pounds weight into a hard solid, which he hammered like a piece of lead. The other and more important use of chloride of methyl is in the manufacture of those beautiful dyes known as methylated anilines. They had been known before, but the cost of their production was so high that their consumption was only limited. The cheapening of the chloride of methyl has greatly extended and will continue to extend the preparation of those colours.—*Athenæum.*

Published July 30, 1879.

CANADIAN NATURALIST

AND

Quarterly Journal of Science.

ON THE ORIGIN OF SOME AMERICAN INDIAN TRIBES.

By John Campbell, M.A.,

Professor of Church History, Presbyterian College, Montreal ; Délégué Régional de l'Institution Ethnographique ; Correspondant de la Société Americaine de France, &c.

SECOND ARTICLE.

In the former paper I indicated the existence of a broad line of distinction dividing the aboriginal languages and peoples of this continent into two well-defined groups, the one Malay-Polynesian, the other Turanian in origin. It is with the latter that I now propose to deal. The Turanians of America stand in geographical relation to Canada chiefly through the Wyandot-Iroquois family, two important divisions of which, the Hurons and the Six Nations, occupy no inconspicuous position in the early history of the country. Originally this family extended as far south as the Carolinas, and the isolation of the northern Iroquois in the midst of an Algonquin area is due to that intrusive character and love of conquest which made the warlike Mohawk and his fellows the terror of other Indian tribes. The Assineboins or Stone Indians, whose name is Algonquin, are also Canadian, dwelling upon the banks of the Red River and its tributaries, but they are Dacotahs belonging to the great family commonly known as Sioux, most of whose tribes are found west of the Mississippi. Mr. Lewis H. Morgan, who has investigated many questions relating to the aboriginal population of America, maintains that the Wyandot-Iroquois and the Dacotahs are branches of the same original stem, and all that I know of the two families confirms his opinion. A third great family which has no representative in the Dominion is brought into relation with the Iroquois and Dacotah classes by Dr. Latham, who, for comprehensiveness of view and extent of knowledge, has found no superior in the field of American ethnology. This is the Cherokee-Choctaw family, whose tribes, among which Dr. Latham counts the Catawbas, Woccoons and Caddos, originally extended from Tennessee to Florida. I unhesitatingly state that the Iroquois, Dacotahs and Cherokee-Choctaws are of Turanian or Northern Asiatic origin.

Commencing with grammatical forms, these families agree in making use of postpositions exclusively, thus differing from the Algonquin and its parent Malay, and agreeing with all the varieties of Turanian speech. In the order of the verb, a second point of difference from the former and of accordance with the latter languages equally marks Iroquois, Dacotah and Choctaw; the temporal index follows the verbal root. The accusative precedes the governing verb in Dacotah and Choctaw, and, as I have already stated, the same principle finds illustration in Iroquois. This is one of the radical distinctions which characterize the Turanian as contrasted with the Malay grammatical system. Once more, the Iroquois, Dacotah and Choctaw languages prepose the genitive to its governing noun, which, as Dr. Edkins says in China's Place in Philology, is essentially Turanian. In the use of postpositions, the postposition of the temporal index to the verbal root, the preposition of the accusative to its verb, and of the genitive to its nominative, four important features in a grammatical system, the Iroquois, Dacotah and Choctaw languages cut themselves off from all Malay Polynesian relationship and claim affinity with the great Turanian family. But the great Turanian family is very large and very widely spread over Europe and Asia. Its Finnic class includes the Finn, Lapp, Esthonian, Vogul, Mordwin, Magyar, and other European and Western Asiatic dialects. In its Turkic class we find the Turk, Uigur, Kirghis, Bashkir, Yakut, and many more. The Mongol contains the Mongol, Khalkha, Kalmuk, Buriat, &c.; and the Tungusic, the Tungus, Lamute and Mantchu. Then in Thibet, Hindostan, and the Indo-Chinese area, many classes are found, the most important and best known of which is the Dravidian, embracing the Tamil, Telugu, and other dialects of southern India. Leaving the Siberian Samoyeds, Yukahiri and Yeniseans out of account, we find in north-eastern Asia an extensive group of languages spoken by the peoples whom Dr. Latham has classed as Peninsular Mongolidæ, languages that in all their leading features are Turanian. Such are the Koriak-Tchucktchi, the Kamtchatdale, Corean, Aino and Japanese, concerning which Dr. Latham says: "they have a general glossarial connection with each other; the grammatical structure of only one of them, the Japanese, being known." He also adds: "What applies to the language of the Peninsular tribes applies to their physical appearance also."

It being granted that the Iroquois, Dacotahs and Choctaws are Turanian, to which of the Turanian classes, Finnic, Turkic, Mongolic, Tungusic, Dravidian, or Peninsular, do they belong? Were they very ancient peoples like the Peruvians, grammar could not settle the question, owing to changes that have taken place in the systems of some Turanian languages. These changes principally affect the pronoun. Thus Dr. Edkins points out the fact that in the Mongol class alone the Buriat renders "I kill" by *alana-p*, while with the Eastern Mongol it is *bi-alana*; the pronoun being in the one case terminal, in the other a prefix. Dr. Edkins regards the latter as the older form, but, apart from the analogous case presented in a comparison of the Latin with its modern representatives, the occurrence of the *alana-p* form in the ancient dialects of Peru seems to give it the prior claim to antiquity. Now the Iroquois, Dacotah and Choctaw systems prefix the personal pronouns. In the Finnic, Turkic and Dravidian Turanian classes the pronoun is terminal, as in the Quichua of Peru. In some of the Mongol dialects, in the Tungusic and Peninsular classes, the pronoun occupies the same initial position as in the North American languages of Turanian origin. But Dr. Latham says "in his most typical form the American Indian is not Mongol in physiognomy"; and certainly none of the tribes we are now considering have anything in common with the Tungus, apart from a common grammatical system. Once more I quote Dr. Latham: "In the opinion of the present writer, the Peninsular languages agree in the general fact of being more closely akin to those of America than any other." Many writers on the Tchuktchi-Koriaks of the Peninsular area have compared them with American tribes, such as Von Matiushkin, who says: "They are distinguished from the other Asiatic races by their nature and physiognomy, which appears to me to resemble that of the Americans." Mr. Baldwin, in his Ancient America, asserts that "Our wild Indians have more resemblance to the nomadic Koraks and Chookchees found in Eastern Siberia, throughout the region that extends to Behring's Strait, than to any people on this continent. Those who have seen these Siberians, travelled with them, and lived in their tents, have found the resemblance very striking; but I infer from what they say that the Korak or Chookchee is superior to the Indian." Mr. J. Mackintosh, whose book on "The Discovery of America and the Origin of the Indians," was published at Toronto in 1836, exhibited many interesting parallels between the American Indians and the Koriaks, but as he considered the former as one people and united the latter with the Tungus, his parallels are practically useless. So common is the statement that the languages of the Tchucktchis and Esquimaux are virtually one, that in my article on the affiliation of the Algonquin languages I was misled by the universal consensus into a homologation of it; but the exploring expeditions undertaken by the United States government have proved that the statement is unfounded, and that the Tchucktchis of Asia differ from the Esquimaux physically as well, being taller and thinner, with redder complexions and more prominent features, in every respect a superior body of men. The error arose in confounding the Aleutans and Kadiaks with the Esquimaux or Innuit, for the identity in language of these peoples with the Tchucktchis is beyond doubt.

While the Iroquois traditions, according to Dr. Oronhyatekha, assert the autochthonic origin of that people, those of the Dacotahs and Choctaws, as related by Catlin and others, refer to a migration from the north-west, where they dwelt for a time amid snow and ice. It is evident that the original home of Dacotahs and Choctaws was that also of the Wyandot-Iroquois, and that the autochthonic theory is of a piece with the same doctrine among the ancient Greeks, a mere form of national vanity. Iroquois, Dacotah and Choctaw grammar agrees in all points, even to the preposed pronouns, with that of the Peninsular languages. The tall muscular form, red complexion and prominent features of the Tchucktchis agree with the physical appearance of the three American families. The encroaching, warlike, indomitable spirit of the Koriaks, of whom the Tchuktchis are a branch, can find no better parallel than among the three warrior peoples of North America. Some of the Koriak tribes flatten the head; so did the Choctaws, the Catawbas, and some of the Dacotahs. I know of no Mongolic or Tungusic peoples—the only others with whom grammatical forms permit us to compare the Iroquois, Dacotahs and Choctaws—who practised this artificial compression of the skull. All these facts tell powerfully in favour of a peninsular derivation. Add to this the fact that the three American families were sun worshippers, and that their religion thus agrees with that of the Koriaks, Ainos and Japanese; that Arioski, the Koriak war-god, corresponds to the Wyandot-Iroquois Areskoui, and the Japanese Jebisu, to the Choctaw or Muskogulge Eefeekesa, and the evidence becomes irresistible.

In one of the families under consideration, tribal names serve to confirm the connection with Peninsular peoples. This is the Cherokee-Choctaw. In the Cherokees we readily recognize the Koriaks, who call themselves Koraeki, and in the Choctaws it is not hard to find the Tshekto, as the so-called Tchuktchi are properly designated. Now the Koriak-Tchuktchis and the Choctaws agreed in flattening the head, as we have already seen. They also agree in being great lovers of manly sports, and I cannot but think that "the game resembling prisoners bars" with which Martin Sauer in his account of the Tchuktchi connects "their dexterity in throwing stones from a sling," is the well known "ball play" or "lacrosse," in which the Choctaws specially excel, but which is also common to the Iroquois and Dacotahs. A game closely resembling lacrosse is played in Japan.

There are many Koriak-Tchuktchi words in Choctaw and Cherokee, such as the Tchuktchi *ischtamat* 4, *tahlimat* 5, *awinljak* 6, *kolle* 10, in which we recognize the Choctaw *ushta*, *tahlapi*, *hannali* and *pokoli*. Others are *annakh* father, the Choctaw *unky*; *ikahlik* fish, the Choctaw *kullo* and Cherokee *agaula*; *ijuk* foot, the Choctaw *iyi*; *nujak* hair, the Choctaw *nutakhish*; *unnjuk* night, the Muskogulge *nennak*; *kiuk* and *wegim* river, the Choctaw *hacha*, *okhina*; *matschak* sun, the Chickasaw *neetakhassch*; *utut* tree, the Muskogulge *ittah*; *aganak* woman, the Cherokee *ugeyung*; *imagh* sea, the Cherokee *amaquaohe*; *unako* tomorrow, the Choctaw *onahe*, &c. But so far as I am able to judge from the materials at my disposal, the Cherokee-Choctaw vocabulary has greater affinity to the Japanese and Loo Choo than to the Koriak-Tchuktchi. Thus, in Japanese the words denoting bone and boat or canoe are nearly identical, the former being *fone*, the latter *fune*. Now in the Choctaw, strange to say, *foni* is bone and *peni* boat. The day is *nitchi* in Loo Choo and the sun is *nitji* in Japanese, and these correspond to the Choctaw *neetak* and the Muskogulge *neetahusa*. Man is *hito*, *otoko* in Japanese, and *hatak* in Choctaw; while woman is *tackki* in Loo Choo and *tekchi* in Choctaw. The Choctaw *eebuk* and the Chickasaw *skoboch* head, find their equivalents in the Loo Choo *bosi* and the Japanese *kubi*. So, house is *chookka* in Choctaw and *chukutsche* in Japanese; rain being *ema* in the former and *ame* in the latter. These instances will suffice to indicate, what I have more fully set forth in the Canadian Journal, the radical unity of the Cherokee-Choctaw and Peninsular vocabularies. What better proof of a common origin could be demanded than that which is presented in a comparison of the Japanese *otoko-no-fone*, "the man's bone," with the Choctaw *hatak-in-foni;* or of the Loo Choo *takki-noo-eebee*, "the woman's finger," with the Choctaw *tekchi-in-ibbak*? The Japanese past tense in *ta* and the Loo Choo in *tee*, which find their equivalent in the Choctaw *tok*, illustrate the final check that marks the *ibbak* of the latter as compared with the *eebee* of the former, and refer the philologist to the allied Koriak Tchuktchi which abounds in such terminations. While it is true that the Koriaks have been frequently regarded as the parent stock of American tribes in general, I am not aware that any writer has ever specifically placed them in relations with the Cherokee-Choctaw confederacy. To find Koriaks in Alaska has been deemed a reasonable enough thing, but snow in harvest would have been thought as likely a phenomenon as Tchuktchis in Tennessee. Thus we find Chateaubriand gravely asserting that the Chickasaws, a Choctaw tribe, came from Peru at the time that the Natchez immigrated from Mexico. Tennessee and Mississippi are the elephant of the Chickasaws and Natchez, Peru and Mexico their tortoise, but we ask in vain on what does the tortoise stand, for of all American populations the Mexican is the hardest to affiliate. I willingly admit that the Chickasaws, with all the other members of the Cherokee-Choctaw confederacy, belong to the same parent stock as the sun-worshipping Peruvians, but, inasmuch as this parent stock is found in the north-west, evidence of no common character would be required to render probable a retrograde movement from South to North America. To sum up the argument for the Peninsular Asiatic origin of the Cherokee-Choctaw family, we have found it to be proved by language in its grammatical and verbal forms, by tribal designations, physical features, moral character, religion, and at least one peculiar custom.

For the Wyandot-Iroquois family I have so far found no tribal designations in the Peninsular area that correspond, but the identity of the two war-gods Arioski and Areskoui undoubtedly links them with the Koriaks proper. This is confirmed by the many resemblances that are found to exist between the Cherokee (Koraeki) and Iroquois vocabularies, some of which are indicated in the Mithridates. Such are the Cherokee *gahnee* and the Cayuga *kanoh*, arrow; *oostekuh*, child, and the Tuscarora *yetyatshoyuh; choosa*, die, death, and the Mohawk *keahheyouh; keira*, *keethlah*, dog, and the Onondaga *tschierha* and Tuscarora *cheeth*; *cheela*, *cheera*, fire, and the Caughnawaga *ojeehlah* and Tuscarora *ot-cheere; atseeai*, man, and the Minekussar *itaatsin*, and Mohawk *ratsin; naune*, mountain, and the Wyandot *onontah*; *yahnogah*, tongue, and the Iroquois *honacha; ageyung*, woman, and the Tuscarora *ekening*. The relations of Iroquois and Peninsular words are numerous and close. The following is not a selection but a chance collation of them:

	Wyandot-Iroquois.	Peninsular.
arm	onentcha *Iroquois*.	oondee *Insu*.
axe	askwechia "	kvasqua *Kamtchatka*.
bad	washuh *Tuscarora*.	wasa *Loo Choo*.
	hetken *Iroquois*.	khatkin *Koriak*.
boat, canoe	gahonhwa "	cahani *Aino*, huni *Loo Choo*.
boy, son	yung *Oneida*.	iegnika *Tchuktchi*.
brother	jattatege *Onandaga*.	ototo *Japanese*.
child	kotonia *Iroquois*.	kodoma "
earth	ohetta "	ttati *Corea*, tjidsi *Japanese*.
eat	hiquekch "	ewa *Japanese*.
egg	onhonchia "	ngach *Kamtchatka*.
father	ata *Tuscarora*.	atta *Tchuktchi*, teti *Japanese*.
	hanec *Seneca*.	annakh *Tchuktchi*.
	lahkeni *Oneida*.	illiguin "
fire	yoneks *Tuscarora*.	annak "
fish	keyunk *Mohawk*.	sakkana *Japanese*.
foot	auchsee *Tuscarora*.	assi "
	achita *Wyandot*.	gitkat *Tchuktchi*.
come	karo *Mohawk*.	kuru *Japanese*.
go	higue *Iroquois*.	yuki "
hair	ahwerochia "	kurrazzee *Loo Choo*.
hand	chotta "	settoo *Kamtchatka*.
	osnonsa "	soan *Corea*.

	Wyandot-Iroquois.	Peninsular.
heart	hahweriacha *Iroquois.*	kokurro *Japanese.*
heaven, sky	toendi *Wyandot.*	ting "
	kiunyage, *Seneca.*	khigan *Koriak.*
man	eniha *Nottoway.*	aino *Aino.*
moon	kanaughquaw *Cayuga.*	kounetsou *Aino.*
	kelanquaw *Mohawk.*	geilgen *Koriak.*
mother	anah *Tuscarora.*	anak *Tchuktchi.*
mouth	agwaghsene *Mohawk.*	ekigin "
nose	yuungah *Wyandot.*	ehynga *Tchuktchi*, honna *Loo Choo*
river	joke *Nottoway.*	kiuk *Tchuktchi.*
small	ostonha *Iroquois.*	uieinan *Kamtchatka.*
snow	ouniyeghte *Mohawk.*	anighu *Tchuktchi.*
sun	hiday *Tuscarora.*	tida *Loo Choo.*
	onteka *Iroquois.*	nitji *Japanese.*
tongue	ennasa "	nutshel *Kamtchatka.*
water	hohnega "	mok, nouna *Tchuktchi.*
white	kearagea "	sheeroosa *Loo Choo.*
woman	yonkwe "	innago "
	otaikai *Wyandot.*	taekki "
	ekening *Tuscarora.*	aganak *Tchuktchi.*
sister	akzia *Onondaga.*	zia *Aino.*
finger	eniage "	ainhanka *Tchuktchi.*
basket	atere *Iroquois.*	teeroo *Loo Choo.*
tail	otahsa "	dzoo "
kill	kerios "	korossu *Japanese.*
write	khiatons "	katehoong *Loo Choo.*
copper	kanadzia "	kanujak *Tchuktchi*, sintju *Japanese.*
nail (finger)	ohetta "	kouda *Kamtchatka.*

Such are a few of the resemblances which lie on the surface, in connection with which, and this will equally apply to the Cherokee-Choctaw languages, it may be said that the Iroquois dialects are more closely related through their vocabularies to the Peninsular tongues than are the English and the German to one another. Like the Cherokee-Choctaw family, the Iroquois have also been found to agree with the Asiatic peoples in their grammatical forms, physical features, and religion. The sun or chief divinity, *matschak* in Tchuktchi, *nitji* in Japanese, and *neetakhasseh* in Choctaw, has appeared as *onteka* in Iroquois; and the Catawba *noteeh*, the Adahi *nestach*, the Cuchan *nyatch*, the Peruvian *inti*, and the Araucanian *antu*, *antuigh*, carry on the sun-worshippers of north-eastern Asia far into the southern continent. The warlike, intrusive Koriak, who has driven his relative the Kamtchatdale to the south of his peninsula, and almost exterminated the Yukagir, is, apart from all other considerations, the fittest Asiatic with whom to compare the similarly warlike and intrusive Iroquois.

The third family of North American Turanians, but really the first of the three in geographical order, and therefore probably the last in chronological, is the Dacotah. Some of its tribes contain the finest specimens of native humanity on the continent, and some have exhibited a degree of culture much in advance of other northern aborigines. They are essentially landsmen like the Iroquois and Choctaws, and, like them, never dreamed of an insular heaven. The past few years have shewn that even now they retain their old indomitable spirit, for they are to the United States what the Koriaks are to Russia. They have their traditions of a deluge, like the Iroquois, Choctaws, Cherokees and Caddos, traditions that do not appear in the Algonquin and Malay-Polynesian areas, but which flourish in Kamtchatka and other Peninsular regions. They are in fact unadulterated Turanians. Nor can they have long been occupants of American soil, for their language bears traces too clearly defined of a Peninsular origin to have stood the wear and tear of many centuries. Lieut. Clifford, R.N., in his short preface to the Loo Choo vocabulary in Basil Hall's voyages, calls attention to the fact that the infinitive or simple form of the verb in that language ends in *ng* preceded by a vowel, as in *coyoong* bite, *ooyoong* break, *nintoong* die. *simmatong* dwell, *katcheeming* shake, *irreechang* bake, &c. This is precssely what we find in the Dacotah proper or Sioux, as in *opetong* buy, *dowang* sing, *manong* steal, *nahong* hear, *echong* make, *asniyang* heal, &c. But in Kamtchatdale the simple form of the verb ends in *tsh*, a totally different form. Thus *kwatshquikotsh* is to see, *koogatsch* to cry, *kassoogatsh* to laugh, *ktsheemgutsh* to sing, *kanhilkitsch* to lie down, *kowisitch* to go, *koquasitch* to come, &c. But here again, in spite of the apparent diversity of the form from that of the Dacotah, evidence of relationship is manifest, for the Assiniboin, a Dacotah dialect, exhibits the Kamtchatdale form. Examples are *wunnaeatch* go, *eistimmatch* sleep, *aatch* speak, *wauktaitch* kill, *waumnahgatch* see, *aingatch* sit, *mahnnitch* walk, &c. This double identity in the form of a part of speech establishes a closer connection than that which is afforded by a common syntax, and links the Dacotahs unmistakeably with the stock to which the people of Loo Choo and the Kamtchatdales belong. Nor is the vocabulary wanting in confirmation of such a connection, as may be seen from the following brief comparison:

	Dacotah.	Peninsular.
arm	ada *Hidatsa*.	ude *Japanese*.
shoulder	hiyete *Dacotah*.	kada "
bad	shicha "	kuso "
bone	hidu *Hidatsa*.	cutsi *Loo Choo*.
boat	wata *Dacotah*.	agwat *Koriak*.
boy, son	eeneek *Winnebago*.	iegnika *Tchuktchi*.
blood	idi *Hidatsa*.	tji *Japanese*.
bull, buffalo	bisha *Upsaroka*.	woushe *Loo Choo*.
child	wahcheesh *Dacotah*.	vassasso *Insu*.
cold	sinnee "	anu *Tchuktchi*.
ice	cagha "	cigu *Koriak*.
day	cang "	gaunak *Tchuktchi*.
dog	shong *Assiniboin*.	ing *Loo Choo*.
ear	akuhi *Hidatsa*.	qui *Corea*.
father	ate *Dacotah*.	atta *Tchuktchi*.
fire	pytshi *Winnebago*.	pangitsh *Kamtchatka*.
fish	ho *Dacotah*, poh *Mandan*.	eo *Loo Choo*, iwo *Japanese*.
foot	siha *Dacotah*, itsi *Minetaree*.	assi, atschi *Japanese*.
good	shusu *Mandan*, uohta *Dacotah*.	jukka *Japanese*, hota *Corea*.
hair	pahhee " nijihah *Quappa*.	bode *Corea*, nujak *Tchuktchi*.
head	pahhih *Quappa*, nahsso *Winnebago*.	bosi *Loo Choo*, naskok "
heart	cangte *Dacotah*.	sing *Japanese*.
hot	dsashosh *Mandan*.	attisa *Loo Choo*.
man	wica *Dacotah*.	uika *Tchuktchi*.
	oeeteka "	otoko *Japanese*.
moon	minnatatche *Upsaroka*.	mangets "
mother	enah *Dacotah*.	anak *Tchuktchi*.
mouth	iiptshappah *Minetaree*.	jeep *Corea*.
neck	apeeh "	kubi *Loo Choo*.
night	hangyetu *Dacotah*.	unnjuk *Tchuktchi*.
small	ecat *Upsaroka*.	ekitachtu "
star	peekahhai *Otto*.	fosi *Japanese*.
sun	wee *Dacotah*.	fi "
water	midi *Hidatsa*.	meze *Loo Choo*.
	ninah *Winnebago*.	nouna *Tchuktchi*.
wife, woman	enauh *Osage*, wingy *Dacotah*.	innago *Loo Choo*.
	tawicu *Dacotah*.	takki "
	wakka-angka *Dacotah*.	aganak *Tchuktchi*.
lake	tehha *Winnebago*.	touga "
leaf	ape *Dacotah*.	ba *Japanese*.
grass	pezi "	phee *Corea*.
sick	yazang "	yadong *Loo Choo*.
white	ataki *Hidatsa*.	attagho *Kamtchatka*.
make	echong *Dacotah*.	ootchoong *Loo Choo*.
write	akakashi *Hidatsa*.	kaku *Japanese*.
die, death	tehe *Hidatsa*, tha *Dacotah*.	tokok *Tchuktchi*.
2	dopa *Hidatsa*.	dupk *Aino*.
3	none *Otto*.	nee *Loo Choo*.
5	kihu *Hidatsa*.	goo "
6	thata *Ioway*.	ittitse *Japanese*.
7	shagoa *Assiniboin*.	siz "
8	dopapi *Hidatsa*.	duhpyhs *Aino*.

In the above, as well as in other verbal comparisons made in these papers, it must be remembered that the scanty materials in my possession prevent anything like a full representation of the agreement between the languages compared. This is especially the case with the Assiniboin and Kamtchatdale, which have been found to agree so remarkably in the simple form of the verb. Sufficient evidence, however, has been afforded of the Peninsular origin of the Dacotahs.

The question naturally occurs, "At what point did the Turanian Americans first appear upon the continent?" That point can be no other than the termination of the Aleutan chain, which extends from the coast of Kamtchatka to the peninsula of Alaska or even to Cook's Inlet. There we find at least four different Indian families. One of them is the Esquimaux or Innuit, whose dialects do indeed contain many Peninsular (Tchuktchi, &c.) words, but whose affinities are greater with the Greenlanders on the one hand and the Asiatic Samoyeds on the other, the very word Innuit being the Samoyed *ennete*, man. Next come the Thlinkeets or Koljush, a people in some respects superior to the Esquimaux, in whose language the termination in *l* and *tl*, so characteristic of the Nahuatl or Mexican, first makes its appearance. These I would incline to associate with the Yukahiri of Siberia, and with the mask-using tribes of the Aleutan chain. Following the Thlinkeets appears a vast family of tribes extending from the Yukon to Mexico and from Cook's Inlet to the Algonquin Cree region about Hudson's Bay. These are the Tinneh Indians, whose name, derived from the word denoting man, language, physical appearance, character, dress and appliances, religion, manners and customs, connect them with the Siberian Tungus. And, lastly, we find in the north-western part of this same area a number of tribes known as American Tchuktchis, Tchugaz, Aliaskas, &c., who have generally been regarded as part of the Esquimaux stock, from which, however, they are well differentiated. These American Tchuktchis or Tchugaz possess a language identical with that of their Asiatic namesakes and constitute one family with them, the connecting links being found in the Aleutans proper, the Unalashkans and and the Kadiak tribes. A sketch of Aleutan grammar furnished by Governor Furnhelm, is contained in the first volume of Contributions to American Ethnology, but as it is so vague as to supply absolutely no information in regard to cardinal points of syntax, the vocabulary must be our test of relationship between the Aleutan and Peninsular languages. In numerals the Asiatic Tchuktchis agree with the Kadiak and Tchugaz of America.

	Tchuktchi	American.
1.	ataschek	attutschik *Kadiak*, *Tchugaz*.
		atakan *Aleutan*, atokeu *Unalashkan*.
2.	malgok	mallok, ulcha *Kadiak*, atlcha *Tchugaz*,
		allak *Aleutan*, arlok *Unalashkan*.
3.	pingaju	pingaiun *Kadiak*, pingaijua *Tchugaz*,
		kaukus *Aleutan*, kankoo *Unalashkan*.
4.	ischtamat	schtamu *Kadiak*, tschitaami *Tchugaz*,
		setschen *Aleutan*, seecheen *Unalashkan*.
5.	tatlimat	tadlimu *Kadiak*, talliimi *Tchugaz*,
		tschan *Aleutan*, chaan *Unalashkan*.
6.	awinljak	agvinligin *Kadiak*, achoinlign *Tchugaz*,
		atun *Aleutan*, atoon *Unalashkan*.
7.	malguk	malchungin *Kadiak*, malchomin *Tchugaz*.
		olung *Aleutan*, ooloon *Unalashkan*.
8.	pigajunga	ingeljulin *Kadiak*, *Tchugaz*,
		kaltschin, kamtshing *Aleutan*, kancheen *Unalashkan*.
9.	agbinlik	koljungojan *Kadiak*, *Tchugaz*.
		schyset *Aleutan*, seecheen *Unalashkan*.
10.	kulle	kollin *Kadiak*, koln *Tchugaz*, hasuk *Aleutan*.

The ordinary vocabulary exhibits the near relationship of the transitional Aleutans and their American cousins with the Peninsular family.

	Peninsular.	Aleutan, etc.
arm	ude *Japan*, setto *Kamtchatka*.	tsha *Aleutan*, aiigit *Kadiak*.
arrow	eea *Loo Choo*.	kio *Aliaska*.
belly	ksoch *Kamtchatka*.	aksyek *Kadiak*.
blood	auka, aukwe *Tchuktchi*.	auk *Kadiak*, auku *Tchugaz*.
	messou *Kamtchatka*.	amgyk *Aleutan*.
boy, son	paca, pahatsh "	abagutaga, awakutta *Kadiak*.
	iegnika *Tchuktchi*.	anekthok *Aleutan*, tanoghak "
black	tanjachtu "	tannechtuk *Kadiak*, tannacktok *Tchugaz*.
brother	kiodai *Japan*.	choyotha *Aleutan*, ooyitaga [*Kadiak*.
	ani "	angaga *Kadiak*.
copper	kanujak *Tchuktchi*.	kanujak *Aleutan*, *Kadiak*, kannah [*Tchugaz*.
cold	kanjukakok "	kinakak *Aleutan*.
ice	cigu *Koriak*, tshikuta *Tchuktchi*.	caguk *Tchugaz*, tsiku *Kadiak*.
death	tokok *Tchuktchi*.	tokok " tokook "
day	gaunak, aghynak *Tchuktchi*.	achanak " chanak "
dog	kossa *Kamtchatka*.	uikuk *Aleutan*, aikok "
earth	nana *Tchuktchi*.	nuna *Tchugaz*, *Kadiak*.
	nutenut *Koriak*.	tannak *Aleutan*, tannok *Unalashka*.
	tjidsi *Japan*.	tshekak *Aleutan*.
eat	kamoong *Loo Choo*.	kaangen "
eye	lilengi *Koriak*.	ingelak *Kadiak*.
egg	manni *Tchuktchi*.	mannek "
father	atta, attaka "	ataga *Kadiak*, ataaka *Tchugaz*.
		athan *Aleutan*, adan *Unalashkan*.
fire	eknok *Tchuktchi*, finoko, *Japan*.	kignak " knok *Kadiak*.
fish	ikahlik *Tchuktchi*.	ikalljuk *Kadiak*.
foot	ijuk *Tchuktchi*, atschi *Japan*.	iuch, idchuk "
	gitkat "	kita *Aleutan*.
give	tunni "	tunnu *Kadiak*, tuneechoo *Tchugaz*.
	ozagadi *Loo Choo*.	agada *Aleutan*, akatscha *Unalashka*.
good	matschinka *Tchuktchi*.	matschiskuk *Aleutan*.

	Peninsular.	Aleutan, etc.
girl, daughter	pannika *Tchuktchi.*	punniaka *Kadiak.*
hair	nujet "	noget " nuett *Tchugaz.*
beard	ugnit "	ugnit " ungit "
head	naskok "	naskok " *Tchugaz.*
life	inotji, *Japan.*	anghogikoo *Aleutan.*
man	otoko "	toioch "
	uika *Tchuktchi*, ickkega *LooChoo.*	ugig *Aleutan*, nika *Kadiak*, &c.
moon	tsuki *Japan.*	tugidak *Aleutan.*
	tankuk *Tchuktchi.*	tangeik *Tchugaz.*
mother	anak "	anak *Aleut.* annaga *Kadiak*, *Tchugaz*
night	unnjuk "	amgik " unuk " "
no	poodong *Corea.*	pedok *Kadiak.*
nose	chynga *Tchuktchi*, kaankaang *Kamtchatka.*	anghosin *Aleutan*, knak *Kadiak.*
woman	innago *Loo Choo.*	angagenak *Aleutan.*
	aganak *Tchuktchi.*	aganak *Kadiak.*
	nulliak "	nuleka "

Such examples may be multiplied indefinitely. From those that have been given it appears that the Aleutan and Unalashkan, while differing in some respects from the Kadiak and Tchugaz, still exhibit ample evidence of a common derivation with them from the Peninsular family. Many of the words in all of these languages are found in the Innuit or Esquimaux dialects, but in spite of this it may be said that there is between the Aleutan-Kadiak and the Esquimaux a radical difference in vocabulary. Still they have largely influenced each other, and traces of this influence are not wanting in the Dacotah and other southern languages of Turanian origin. Thus the Dacotah *tipi*, Yankton *teepee*, Assiniboin *teib*, house or tent, is undoubtedly the Esquimaux *topek*, *tupek*, and many like examples of Innuit influence might be afforded.

The relations of the Transitional Turanians, as we may term the Aleutans, Kadiaks or Kaniagmutes, &c., with the Dacotahs, admit of ample illustration from the vocabulary.

	Transitional.	Dacotah.
bad	kabigwaskak *Kadiak.*	kubbeek *Upsaroka.*
boy, son	awakutta "	skakatte "
	anekthok *Aleutan.*	eeneek *Winnebago*, &c.
cold	tshikok *Tchugaz.*	tasaka *Dacotah.*
	kinakak *Aleutan.*	shineehush *Mandan.*
	potsnatok *Kadiak.*	oisnaitch *Assiniboin.*
day	chanak "	cang *Dacotah.*
	hunnukhpak " (to-day)	aungpa *Yankton*, anipa *Dacotah.*
dog	piuchta *Tchugaz.*	biska *Upsaroka.*
eat	pittooaga *Kadiak.*	wota *Dacotah*, wautah *Assiniboin.*
eye	thack *Aleutan.*	eshtike *Dacotah.*
father	ataka *Kadiak.*	ate "
	athan *Aleutan.*	tantai *Minetaree.*
foot	itiat *Kadiak.*	itsi "

	Transitional.	Dacotah.
good	assiktok *Kadiak.*	itsicka *Upsaroka.*
great	taangoellik *Aleutan.*	tangka *Dacotah.*
	angoch *Kadiak.*	honska "
hand	shuwanka "	onka *Mandan.*
head	naskok "	nahsso *Winnebago*, naso *Otto*, &c.
heart	kanogh *Aleutan.*	cangte *Dacotah.*
husband	oogeen "	eekunah *Winnebago.*
knife	mina *Aliaska.*	meena *Yankton.*
man	uika *Kadiak.* ugig *Aleutan.*	wica *Dacotah*
	toioch *Aleutan.*	oeeteka "
mother	annak "	enah "
night	unuk *Tchugaz.*	hangyetu "
nose	padzsheeguak *Kadiak* (nostril)	pute, pasu *Dacotah*, peso *Otto.*
rain	kedak "	hade *Hidatsa.*
tree	kunnakat "	cang *Dacotah.*
wood	opohak "	pazu "
woman	angagenak *Aleutan.*	wingyan "
name	assia *Aleutan*, atcha *Kadiak.*	caze *Dacotah*, dazi *Hidatsa.*
die, death	tokok *Tchugaz.*	tehe *Hidatsa.*
see	tangha *Kadiak.*	tongwang *Dacotah.*

Similar relations appear in the Wyandot-Iroquois.

	Transitional.	Wyandot-Iroquois.
boat	kaiyakh *Kadiak.*	gya *Huron.*
mother	choyotha *Aleutan.*	caukotka *Tuscarora.*
	ooyitaga *Kadiak.*	jattatege *Onondaga.*
copper	kanooyat "	kanadzia *Iroquois.*
come	taieechook "	dague *Iroquois.*
day	ukhno "	eguisera *Mohawk.*
drink	taangatha *Aleutan.*	uttanote *Seneca.*
fire	kunok *Tchugaz.*	yoneks *Tuscarora.*
foot	kita *Aleutan.*	achita *Huron*, sita *Iroquois.*
give	akatsha *Unalashka.*	wahetky *Iroquois.*
go	itsha *Aleutan.*	yehateatyese *Mohawk.*
	achook *Kadiak.*	higue *Iroquois.*
hand	shuwanka, aiigit *Kadiak.*	sesnonke *Mohawk*, chotta *Iroquois*
head	angloon "	onoalagone *Iroquois.*
leg	irruhka "	orusay *Tuscarora.*
life	anghogikoo *Aleutan.*	yonhe *Mohawk.*
moon	eghaloak *Kadiak.*	kelanquaw "
nose	anghosin *Aleutan.*	enuchsake *Cayuga.*
river	kuik *Tchugaz.*	kaihyoehakouh *Mohawk.*
snow	kanneek *Aleutan.*	ouniyeghte "
speak	yukhten *Kadiak.*	haguetaa *Iroquois.*
star	sthak *Aleutan.*	ojistok *Mohawk.*
tongue	aghnak "	honacha *Iroquois.*
tooth	choodit, hutuka *Kadiak.*	otoatseh *Tuscarora.*
	noontinga *Tchugaz.*	onotchia *Iroquois.*
water	nunak "	ohneka "
	taangak *Aleutan.*	tsandoosteek *Huron.*
wind	kaiyaik *Kadiak.*	gao *Iroquois.*
woman	aiyagar *Aleutan.*	echro "
	angagenak "	onheghtye *Mohawk.*
	aganak *Kadiak.*	ekening *Tuscarora.*
god	aghuguch *Aleutan.*	ocki *Huron.*
salt	attagook *Kadiak.*	hotchiketa *Iroquois.*

The same are found in the Cherokee-Choctaw.

	Transitional.	Cherokee-Choctaw.
arm	ipik *Kadiak.*	sakpa *Muskogulge.*
blood	auk "	issish *Chickasaw.*
	amgyk *Aleutan.*	homma *Choctaw.*
boy, son	abagutaga *Kadiak.*	pooskoos "
bird	cissu *Aleutan.*	hushi "
goose	llak "	shilaklak "
mother	angaga *Kadiak.*	nocksish "
child	ooskulik *Aleutan.*	ulla "
dog	pewatit *Kadiak.*	ophe "
ear	tottusak *Aleutan.*	istehuchtsko *Muskogulge.*
fish	ikalljuk *Kadiak.*	kullo *Choctaw*, agaula *Cherokee.*
go	annowa "	angya *Choctaw.*
good	assiktok *Tehugaz.*	seohstaqua *Cherokee.*
head	ischigi *Aleutan.*	ecan *Muskogulge.*
man	tsioch "	atseeai *Cherokee.*
moon	tangeik *Tehugaz.*	teenœnentoghe "
mountain	ingajek *Kadiak.*	nunichaha *Choctaw.*
night	unuk "	nennak *Muskogulge.*
river	kuik "	hucha *Choctaw.*
sun	madzshak "	neetakhasseh *Chickasaw.*
tongue	aghuak *Aleutan.*	yahnogah *Cherokee.*
	ooloo, uloka *Kadiak.*	soolish *Chickasaw.*
death, die	aschalik *Aleutan.*	selle, illi *Choctaw.*
tooth	noontinga *Tchugaz.*	noteeh *Muskogulge.*
wood	opohak *Kadiak.*	upi *Choctaw.*
woman	aganak "	ageyung *Cherokee.*
shoes	ihlhuchik "	shulush *Choctaw.*
to-morrow	wunnaho "	onaha "
sea	immak *Tchugaz.*	amaquaohe *Cherokee.*

The Kadiak and Tchugaz numerals being almost identical with those of the Tchuktchi, exhibit intimate relations with those of the Choctaw. The Aleutans, Kaniagmutes, Tchugaz, Unalashkans, &c., may therefore be regarded as the latest wave of the Peninsular tide of migration, which from a remote period has been pouring in no stinted flow into the American continent, from the time when the Fuegians of the Chileno family in the far south first left their Asiatic home till the present day.

Within the limits of this article I have space barely sufficient to give an outline of the argument which carries the Peninsular family far into South America. The sun-worshipping Natchez of Mississippi, and the Cuchan, Maricopa and Dieguno tribes of New Mexico, as well as the Catawbas, Woccoons, Adahis, Uches and Caddos, to whom I have already alluded, all belong to the line of Peninsular migration, and the extinct mound-builders, if extinct they be, as sun-worshippers must have been of the same parent stock. But for the present I must pass them by as ethnologically of less importance than the South American members of the family. In New Granada we meet with the Muyscas of Bogota, a sun worshipping race whose solar hero, the god Pesca or Bochica, is the Muskogulge Eefeekeesa and the Japanese Jebisu or Zhizobogats. But their solar deity proper is Zuhe, the same as the Huron Iouskeha and the Aleutan Agugux. They also worship Toca, the Huron Atahocan, and, perhaps, the Kamtchatdale Hutka; as well as Aghajun, the Koriak Anggan. Their tradition of the deluge is well defined, and agrees with that of the Kamtchatdales, Dacotahs, Iroquois, Cherokees, Choctaws, Uches, Caddoes and Peruvians. The Muysca verb ends in *scua* or *suca*, and is thus not unlike the Kadiak in *ok* or *tok*. In the use of postpositions; the order of the verb, as 1st. pronoun, 2nd. verbal root, 3rd. temporal index; the preposition of the accusative to the verb and of the genitive to its governing noun: the Muysca completely accords with the Peninsular and allied North American languages. For the agreement of its vocabulary with those of the Peninsular, Dacotah, Iroquois, Choctaw and Peruvian languages, I must refer to the comparative tables in the Canadian Journal. More important than the Muysca are the dialects of Peru, the Quichua, Quitena, Aymara, Cayubaba, Sapibocono, Atacamena, &c., and they deserve more than a passing notice.

The Peruvians, one of the oldest and perhaps the most civilized of native American peoples, have long been known as *par excellence* the sun worshippers of America. The sun, Inti among the Quichuas or Incas, is the same god as the Japanese Nitji, the Loo-Choo Nitchi, the Iroquois Onteka, the Cherokee Anantoge, the Choctaw Neetak, the Catawba Noteeh, the Adahi Nestach, the Coco-Maricopa Nyatz, and the Araucanian Antu, Antaigh. This name seems to have been the peculiar property of the Turanian worshippers of the solar orb. Another Peruvian god, like Pesca or Bochica of the Muyscas the hero of a deluge, was Apachic or Pachacamac, and in him we recognize the Muskogulge Eefeekesa and the Japanese Jebisu. Eruchi was the Sapibocono, and Huiracocha the Quichua war-god, and these again recall the Iroquois Areskoui and the Koriak Arioski. The Peruvian Chinchas practised the artificial compression of the skull like the Choctaws, Catawbas, Natchez and Koriaks. The Quichuas and other Peruvian tribes embalmed their dead like the Ainos. The umbrella was a mark of dignity in ancient Peru as in Japan. The astronomical system of the Incas was virtually that of the

Muyscas, concerning which Dr. Hawks, in his Narrative of Commodore Perry's Expedition to Japan, says, alluding to the Japanese system: "We cannot leave it without the remark that on a comparison of it with that of the Muiscas, an ancient, semi-civilized and now extinct race that once inhabited the plains of Bogota in New Granada, the resemblances were so striking that they produced on our mind a conviction that the astronomical systems of the two peoples were substantially the same." There can be no doubt that the ancient civilization of Peru was that of Japan, and that the connecting links between the two countries are to be found in the mysterious mounds that mark the line of Peninsular migration in America. In confirmation of this I may state that Mr. Donald of this Society has recently called my attention to the fact that similar mounds have lately been discovered in Japan. Physically, so far as we have the means of judging, there seems to have been little in common between the Peruvians and the North American Turanians, and the skull of the former has been shown by Dr. Daniel Wilson of Toronto and other craniologists to be almost without parallel for smallness of capacity, a peculiarity that links it in some degree with that of the Kentucky mound-builders. But language in such a case must be our main test of relationship. In regard to grammatical forms, we find that the Peruvian languages employ post-positions, and that they place the possessive before its governing noun and the accusative before the verb, thus agreeing with all the languages that have so far occupied our attention. The Quichua has been said to differ from other American tongues in the possession of a full declension of the noun, but the same may be found in the Japanese and all its related languages, if we regard the postposition as inseparable from its regimen. The Quichua case terminations are simply cohering post-positions. The Aymara genitive answers perfectly to that of the Loo Choo, as in "the man's head," which is *chacha-na-ppekei* in the former, and *ickeega-noo-bosi* in the latter. In the Peruvian dialects, however, the place of the pronoun is terminal instead of initial as in the Japanese, so that the Quichua verb, as the Rev. Richard Garnett has shewn, corresponds with the Dravidian and thus with the Finnic and Turkic in its order of verbal root, temporal index and pronominal suffix. The Peruvians, therefore, must have separated from the Peninsular stem when the verb in the Japanese and its allied languages was still in the Ural-Altaic stage of development. The Peruvian vocabulary confirms the theory of a Peninsular origin.

Peruvian.	Peninsular.
all..........kuna, *Quichua.*	ignea. *Loo Choo.*
bread.......canco, "	gamga. *Kamtchatka.*
dark........tutayasca "	dochsae, "
brother.....hauquey "	wiki *Loo Choo*, aki *Tchuktchi.*
child........huahua "	qua *Loo Choo.*
clothes......aesu *Atacama.*	chouksa *Corea.*
die, death ..huanhu *Quichua.*	gang *Loo Choo*, sinu *Japanese.*
day.........chine *Sapibocono.*	gaunak *Tchuktchi.*
ear..........aike *Atacama.*	qui *Corea.*
earth.......idatu *Cayubaba.*	ttati "
dust....... turo *Quichua.*	duro *Loo Choo.*
eye.........naira *Aymara.*	netra *Japanese.*
nahui *Quichua.*	ni *Loo Choo.*
father......tayta "	teti *Japanese.*
itica *Atacama.*	attaka *Tchuktchi.*
fire.........nina *Quichua*, &c.	annak "
fish.........challua "	ikahlik "
kanu *Aymara.*	sakkana *Japanese.*
forehead....mati *Quichua*, emata *Sapibocono.*	omote "
goat........paca *Aymara.*	fija *Loo Choo.*
hair.........naccuta "	nujet *Tchuktchi.*
hand........tachlli "	tatlichka "
head........ppekei "	bosi *Loo Choo.*
heart...... sonceo *Quichua.*	sing *Japanese.*
knife.......calhua "	khul *Corea.*
man........kkari " &c.	guru *Kurile.*
kosa "	quaskeo *Kamtchatka.*
chacha *Aymara.*	ickkeega *Loo Choo.*
hake "	okkai *Aino.*
moon.......quilla *Quichua.*	geiligen *Koriak.*
mother......mamay "	umma *Loo Choo.*
mouth......khaipe *Atacama.*	jeep *Corea.*
nose........cenca *Quichua.*	chynga *Tchuktchi.*
sun.........inti " &c.	nitji *Japanese.*
water.......unu "	nouna *Tchuktchi.*
white.......yurac "	sheeroosa *Loo Choo.*
year........huata "	hiout *Tchuktchi.*
honey......nuski " &c.	mits *Japanese.*
learn.......yachachi "	kieku "
sister.......nana "	ane "
raise........haka *Aymara.*	aghe "
month......quiz *Quichua.*	gwautsee *Loo Choo.*
strike.......takay "	taksu *Kamtchatka.*
copper......anta "	sintju *Japanese.*
sea.........mamacocha "	mok, imagh *Tchuktchi.*
tiger........uturunca "	tora *Japanese.*
shoes.......usuta "	kwutsu "
breast......nunu "	mune *Loo Choo.*
huntux *Atacama.*	ingatah *Kamtchatka.*
flesh........aycha *Quichua.*	shishi *Loo Choo.*
yellow......carhua "	cheeroo "
leg..........chanca "	shanna "
ice..........casa "	cigu *Koriak.*
grass........cachu "	coosa *Loo Choo.*
lip..........sirpi "	seeba "

In the vocabularies published in the Canadian Journal, to which I have had so often to refer, will be found, together with a fuller illustration of the agreements between the Peruvian and Peninsular languages, others as complete with the Transitional Aleutan, &c., the Dacotah, Iroquois, and Choctaw-Cherokee. They are all members of one family. Finally the Chileno languages, embracing the Araucanian of Chili, the Puelche of the Pampas, the Patagonian and Fuegian, have all their grammatical and verbal relations with the Peruvian, and thus connect with the Peninsular stock of Asia. These dialects, like the Peruvian, exhibit evidence of great antiquity, although mere geographical position cannot determine that they are spoken by earlier immigrants than the civilized Quichuas, across whose lines they may possibly have passed on their way to a more southern home. They also were worshippers of the sun, and their gods Ngen, Eutagen, Pillan, and Toquichen, are the last representatives of the Koriak Anggan, the Kamtchatdale Hutka and Billukai, and the Huron Atahocan, the latter appearing also in Peru as the Quichua Atahuanca. Their Toquis or Governors are the Tokoks or Chiefs of the Aleutans, terms recalling the Tagus or chief magistrate of the ancient Thessalian States. The Araucanians also are the Koriaks and Iroquois of South America, indomitable warriors, the memory of whose valour is embalmed in a Chilian epic poem, thus preserving the martial character of one branch of the Peninsular family, as the Peruvians did the civilization of another. The Kamtchatdale and the Fuegian may perhaps illustrate a third and degraded class of tribal characteristics. But on the whole the family is a noble one, worthy of a better fate than that which has overtaken all its American representatives, if we except the Cherokee-Choctaw confederacy, which has risen to higher things.

It may be asked whether the Peruvian dialects, seeing that their grammatical forms agree with those of the Ural-Altaic and Dravidian languages, should not be connected with these rather than with the Peninsular tongues. Now it is true that in the Peruvian and Iroquois numerals there are Finnic and Turkic forms, such as the Peruvian *pisca* and Iroquois *wish*, *wisk*, 5, which are the Turkish *besh* and Yakut *bes*, as well as the Finnic *viisi*, the Esthonian *wiis*, and Tcheremissian *vis*. The Aymara *ppekei* head, also is the Turkish *bash* and Yakut *bas*, and the Finnic *poja* and Maggar *fej*, while the Iroquois presents in the two remarkable forms *iokennores*, rain amd *kanadra*, bread, the undoubted equivalents of the Turkish *yaghmur* and the Magyar *kunyer*. But in spite of these resemblances, which it cannot be denied do attest connection if not relationship, a careful comparison of the Peruvian and Iroquois vocabularies with those of the Ural-Altaic languages has convinced me that the connection is one which must be established through the Peninsular forms of speech, with which the American languages have relations vastly more intimate and numerous than with the Finnic or Turkic classes. The Iroquois again is in no respects a Tartar, nor is there any native Finnic or Turkish civilization with which that of the Peruvians may be compared. As for the Turanians of southern Asia, even in the valuable comparative tables of Hyde Clarke, but a distant resemblance to the Peruvian appears in their vocabularies, and we possess not a shred of evidence to show that they ever became a maritime people or occupied the line of Malay immigration to the coasts of America. Dacotahs, Iroquois, Choctaws, Muyscas, Peruvians, Chilenos, were not maritime peoples but essentially landsmen, who, but for the stepping stones of the Aleutan chain, never would have found their way to this continent.

All the American tribes of Turanian origin came originally, therefore, from the north in successive waves, which gradually overflowed the northern continent and poured their tide into the south. They came in at least two different forms or types of national character; the civilized Japanese, represented by the Muyscas and Peruvians, and in a minor degree, if these were not the Peruvians in progress southward, by the mound-builders, the miners of Lake Superior, the potters and weavers of the Ohio valley, by the Dacotah Mandans and the Natchez; and the uncivilized warriors of Koriak blood, from whom a succession of Araucanians and Cherokee-Choctaws, Iroquois and Dacotahs, have descended. And to tell the story of migration and make it plain so that all the world may understand, and the baseless fabric of an autochthonic American race may melt before it, the process still goes on across the bridge that spans the northern ocean from Kamtchatka to Alaska, over which so many generations have passed to an American home. There Aleutans and Unalashkans, Kaniagmutes and American Tchuktchis link the populations of two continents, and, with the facts that prove the advent of the intrusive Malays, who, wedge-like, entering from the west, split into many fragments the once solid Turanian phalanx, answer the oft-repeated question—"Whence came American man ?"

PRE-GLACIAL FORMATION OF THE BEDS OF THE GREAT AMERICAN LAKES.

By Prof. E. W. Claypole, B.A., B.Sc. (Lond.) of Antioch Coll., Ohio.

In a paper by the writer of these lines which appeared in the *Canadian Naturalist* in April, 1877, under the title "Pre-Glacial Geography of the Region of the Great Lakes," an attempt was made to shew that the beds of those inland seas of North America are not results of glacial erosion during the ice age, but that they antedate the ice age altogether, and are due to the action of fresh water streams which flowed in the region at an earlier time, and when the land, especially to the northward, stood at a higher level compared with the sea than at present. The beds of Lakes Huron, Erie and Ontario were attributed to the action of a pre-glacial Mohawk having its sources somewhere in the basin of the first named lake, and flowing past Detroit, where a deep channel is known to exist, into the basin of Lake Erie, thence through a similar old and lost channel somewhere near Niagara, into the Ontarian basin, and thence through a yet deeper but now filled up passage near Syracuse and Lake Onondaga into the valley of the Mohawk, and through that and the present Hudson into the Atlantic. In like manner it was maintained that the bed of Lake Michigan was a valley formed by the upper waters of a river whose later course was through a deep but buried channel running southward through Illinois, and which has been traced as far as Bloomington, where it is at least 200 feet deep. The bed of Lake Superior, it was also suggested, may be the valley formed or occupied by the head waters of a river which flowed away at some point east of Marquette, and traversed the State of Wisconsin along the lines of Lakes Winnebago and Horicon and Rock River, until it met the Mississippi near where Rock Island now stands.

Many of the facts upon which the opinions then expressed were founded were derived from the Geological Survey of Ohio, and the whole tenor of the paper was largely in accord with many passages from Dr. Newberry's pen, though in some points the writer was at issue with the distinguished director of the Ohio Survey, and in others he went beyond any conclusions reached in that work. Since the publication of the paper, Dr.

Newberry has however expressed his entire dissent from the writer's views in the following words (Geol. of Ohio, Vol, III. p. 46): "The considerations which oppose this theory" (that the beds of these lakes are only portions of the valleys of pre-glacial rivers blocked up in the ice period by beds of drift) "are so apparent and formidable that it never could have been proposed or accepted by any one who had carefully studied the problem." While yielding to none in due respect for Dr. Newberry's labours and his contributions to the geology of the Western and Midland States, without which the very materials for the paper in question would not have been attainable, the writer must maintain that his theory was not hastily put forward and that in his opinion, for reasons hereinafter given, the objections urged by Dr. Newberry are not valid, and further that Dr. Newberry's own position is not tenable. These objections are as follows:

1st. "The lakes occupy a series of boat-shaped *rock*-basins which have almost nothing in common with river-valleys. The notion that the valley of a river could be beaded in this way by the broad excavation of such portions as lay in soft rock and the formation of *canons* through hard strata, has no warrant in any facts yet observed on the earth's surface."

It may be quite correct technically to speak of the beds of the great lakes as basins, but the impression generally produced by this use of the term is far from accurate. As was pointed out in the paper referred to, if the water were drained away their beds would appear not as deep valleys nor to the eye as valleys at all, but as wide almost level plains. The bed of Lake Erie would show a slope from its north and south shores to its middle averaging about ten feet to the mile. Lake Michigan, with a depth of 900 feet and breadth of 90 miles, would become a vast plain sloping only 20 feet in the mile. Such slopes would be utterly undiscoverable by the eye, and consequently the lake-beds would appear as immense prairies rather than basins. Now such broad slightly sloping vales are precisely what large rivers form when flowing for long ages through a region of the softer rocks. If at any spot cliffs of such material are ever formed, the weather ere long destroys them and reduces all to a smooth outline. It is for this very reason that a practised eye can to a great extent read the geology of a country by observing its surface. One portion consists of smooth, rounded hills, sloping down into wide, shallow valleys; another, of different structure, shows a rugged outline of cliff and gorge, of plateau and canon. In the former case erosion is so rapid that the streams are unable to carry away the material as fast as it is broken down by the weather. The erosive agents surpass the transporting. In the second the rocks afford less material than the streams can remove, and the transporting power exceeds the eroding. Hence come the two great types of surface-contour, the rugged and the smooth, the former characteristic of resisting, the latter of yielding material. It must therefore evidently follow that a river flowing through regions composed of rocks of both kinds will produce alternately the broad open vale and the deep narrow chasm.

But apart from theory, Elisée Réclus (The Earth, p. 132) says: "Some valleys present a succession of rounded basins separated from each other by narrow passes. In the Pyrenees, the Jura and the calcareous regions of the Alps, valleys of this kind are very numerous." "The variations in the shape of valleys may be explained by the different natures of the rocks which the waters have had to hollow out. Wherever the materials operated upon—gravel, sandstone, granites, schists or lavas—are of analogous composition, and thus everywhere present an equal resistance to the action of the water, the latter is able to pursue its normal movement and adopts a meandering course. On the contrary, where the rocks consist of strata of unequal hardness, or are traversed by obstructing walls, the water is necessarily compelled to spread out into a lake-like accumulation, in the meantime eating away the banks in a lateral direction, until the barrier being at length penetrated, the sheet of water is poured down to some lower level. In this way there has been formed during a course of ages *a series of basins* one above another, some of which are still partially filled with water, others entirely empty, all being linked together by *narrow defiles* through which pours the mountain torrent."

In years past the writer resided on the banks of the Avon in England. This river affords a remarkable illustration of the same phenomenon. In its upper course it flows over the Oxford clay in a wide open vale or plain, but before reaching the city of Bath it comes upon the harder beds of the great oölite through which its course lies in a deep valley bordered by high hills of that formation, to which the city owes much of its attractiveness and beauty. Emerging from the great oölite, the Avon wanders at will over a wide plain or open valley of the Keuper marls and alluvium until it reaches a spur of hard Carboniferous and Devonian rocks through which it has cut the romantic gorge of Clifton more than two miles long and in some places 300 feet deep between almost vertical walls. With its suspension bridge of 800 feet span, no more exact counterpart of the Niagara rift as seen from the Canadian namesake of the English "Clifton" can well be found, except that in the latter case the work of erosion is still in progress, while in the former it is complete and the cataract has disappeared.

But coming nearer home, our own rivers in Ohio supply many similar instances. The Little Miami in its upper course flows through a wide shallow valley of glacial drift of depth unknown. But on reaching the village of Clifton (Greene Co.) it comes upon a ledge of the hard Niagara limestone through which it has long been and is still engaged in cutting a deep narrow chasm, in some places about 60 feet in depth and less than 20 feet from side to side with overhanging walls. Lower down the stream where the gorge is older, it is more than 100 feet deep and 200 feet from bank to bank. After leaving the Niagara formation, the river comes upon the soft shales and thin stone beds of the blue limestone of the Cincinnati group, where the valley again widens out until its sides are more than a mile apart with smooth and gentle slopes.

Numerous other examples might be quoted to show that this "beaded" appearance of the channel of a river flowing for long ages over rocks of various powers of resistance is not by any means an uncommon phenomenon on the earth's surface. Not only should it occur in theory but it does frequently occur in reality. There is therefore no improbability in the supposition that this pre-glacial Mohawk cut for itself such a channel.

2nd. Dr. Newberry says: "The great and unequal depth of the lake-basins renders it impossible that they can have been excavated by a continuous flowing stream." "Lake Huron is 800 feet in depth, while the buried channel which connects it with Lake Erie is not more than 200 feet deep." "Lake Erie is generally very shallow, and while its bed is no doubt traversed by an old river channel which is very much deeper than most parts of the lake itself, it is incomprehensible that it should not have been cut as deeply by the old river as Lake Huron was, since the rocks to be removed were the same."

In this connection it must be borne in mind that the theory which Dr. Newberry is here criticising is founded on the fact, generally admitted by geologists, that before the glacial era and at the time when this old river existed, the relative levels of land and sea were not the same as now, but that the land was higher, especially to the northward. Of this it is scarcely necessary to adduce proof (see Dana's Manual, 1874, p. 540). Prof. Newberry himself says (Geol. of Ohio, Vol. I, p. 44): "The rocky bottoms of these gorges," in N. E. Ohio, "are deeply buried, and the erosion which produced them began before the ice period and was mostly accomplished during an interval of *continental elevation*." Again (p. 172): "This excavation was anterior to the drift period, when the *continent was raised several hundred feet higher than now*." Again (p. 433): "It is easy to see that the erosion" of Mill Creek valley in Hamilton Co. "could not have been effected under existing conditions. It can only be explained by a higher altitude of the continent." Again (Vol. II, p. 6): "At the commencement of the ice period this continent must have stood several hundred feet higher than now."

Facts gathered from North American and European geology show that the elevation was not uniform but increased towards the north, and the only assumption in the paper already alluded to was that this northward elevation was at the rate of three feet per mile. Now if this estimate be applied to Lake Huron and the buried channel at Detroit, we have the following results:—The central part of Lake Huron then lay about 540 feet higher than now, or 260 feet below the present surface. The buried channel at Detroit has been explored to the depth of 200 feet, but its bottom has never been reached. Dr. N. says (Vol. II, p. 13): "Its greatest depth is unknown." This places the bed of Lake Huron at the time in question only 60 feet below the bottom of the deepest known boring (not the real bottom) in the Detroit channel, and removes all serious difficulty from this part of the subject.

A similar argument will meet the objection urged in the case of Lake Erie and quoted above. Lake Erie lying to the south of Lake Huron, has been relatively less depressed since that time and may actually have then been more deeply eroded than the latter.

3rd. "Lake Ontario is again a deep basin, being 450 feet deep, with a surface level of only 234 feet above the ocean. Every-thing indicates that the basin of Lake Ontario is connected by a buried channel with the Hudson, but we have no proof that this pre-glacial channel is cut as low as the rock-bottom of the basin."

The buried channel at Onondaga, to which allusion is here made, has not, it is true, been proved as deep as the bottom of Lake Ontario at present. But it has been explored to the depth below the lake level of "414 feet, and we are not certain that rock was reached in this boring." (Vol. II, p. 16.) Nor, it may be added, can we be sure that this bore was made in the deepest part of the channel. The buried channel at Onondaga has therefore been explored almost to the level of the bottom of Lake Ontario at present in its deepest part. But on the estimate mentioned above of the elevation of northern land, the bed of Lake Ontario at the time in question was relatively to the buried channel 100 feet higher than now, and in that case the channel was many feet below the lake bed, and the flow of the pre-glacial Mohawk from the Ontarian vale to the Hudson river was both possible and easy.

4th. "The bottoms of some of the great lakes are now several hundred feet below the ocean level," and "their rock bottoms may be covered with a great depth of mud." "They could not have been drained into the ocean when it stood at its present level. It is true that the continent was 500 or 600 feet higher than now at the time the old buried channels were cut, but even this does not afford sufficient fall for a stream which should wear the rock-basins of Lakes Michigan and Huron to their bottoms. They are undoubtedly" (?) "1000 to 1200 feet below the water surface, and reach nearly to the old ocean level, a relative depth far too great for rivers to excavate rock a thousand miles from their mouths."

The very basis of this objection is a supposition of which no proof is given, that the beds of Lakes Michigan and Huron are covered with 200 to 300 feet of deposit. In this way they are brought down nearly to the level of the pre-glacial Atlantic. But with any more moderate estimate they lay considerably higher, and if this deposit is disregarded, were more than 300 feet above that level. If we halve Dr. Newberry's figures and allow 150 feet of deposit in the beds of Lakes Huron and Michigan, the former was between 300 and 400, the latter between 200 and 300 feet above the ocean. These heights would give ample fall for the old Mohawk river in its course of 1000 miles, and it need scarcely be added that where there is fall enough for a river to flow, there erosion will take place. It mnst moreover be remembered that even allowing Dr. Newberry's supposition to its full extent, the objection has no force, for it can only apply to the lowest points of the lake beds and the latest days of our pre-glacial rivers. The geological destiny of every river is to cut its bed down to the ocean-level, and time enough being given every river will fulfil its destiny. The greater part of the lake-beds, even on Dr. Newberry's supposition, must have been so far above the old ocean as to give an ample fall, and in all but its latest years the old river must have been equally high. It is not surprising that a stream which, so far as we can judge, flowed through that region for many ages, should ere its day of extinction came, have so far fulfilled its destiny as to leave what we may call its death-bed but little elevated above the contemporary ocean. It would be more surprising were the result otherwise. On either view therefore little force lies in the objection.

Similar arguments apply to Lake Michigan. Though the lake is 900 feet deep, and the greatest *known* depth of the buried channel, *whose bottom has never been reached*, is only 200 feet, yet the latter is about 240 miles south of the middle of the lake, and in the time of pre-glacial elevation the depth of the lake was diminished by 720 feet, and its outflow along the line previously indicated through the State of Illinois not only possible but probable.

The above arguments seem fully to meet the objections urged in the third volume of the Ohio Survey. Let us advance a little further. Dr. Newberry agrees with the writer in admitting the existence of the pre-glacial river to which allusion has been so often made. He says (Geol. of Ohio, Vol. II, p. 77): "Previous to the glacial period the elevation of this portion of our continent was considerably greater than now, and it was drained by a river system which flowed at a much lower level than at present. At that time our chain of lakes—Ontario, Erie and Huron—apparently formed portions of the valley of a river which subsequently became the St. Lawrence, but which then flowed between the Adirondacks and Appalachians, in the line of the deeply buried channel of the Mohawk, passing through the trough of the Hudson and emptying into the ocean 80 miles south-east of New York. Lake Michigan was apparently then a part of a river course which drained Lake Superior and emptied into the Mississippi."

But while asserting the existence of the old and lost river along the whole course indicated, Dr. Newberry does not allow that the excavation of the lake beds is due to its action. He inclines to the view that though a small and shallow or narrow channel existed previously, yet the formation of these broad hollows in which our great lakes lie was the work of another and later agent. He says (Vol. I, p. 49): "The basin of Lake Erie in all its length and breadth—as well as the smaller but deeper one of Lake Ontario, and the broader and far deeper ones of Lake Michigan and Lake Huron—has been excavated by mechanical force from the solid rock. The agents were the same that have produced all the great monuments of erosion seen elsewhere—*water* and *ice*, and of the two that which was by far the more potent, and that which alone could excavate broad boat-shaped basins such as these, was *ice*."

To this view there are many formidable objections, some of which are very evident. Allusion was made to one of them in the former paper, which may however be repeated here. Speaking of the glacial markings in the basin of Lake Erie, Dr. Newberry says (Geol. of Ohio, Vol. VII, p. 10): "The glacier which moved from the east westward in the lake basin, following the continental glacier, was a local glacier of later date, and the one by which the excavati n of the lake basin was principally effected." But on the same page we read: "In this portion (N.W.) of the State, a series of glacial marks which have a nearly north and south bearing are obliterated (nearly ?) by the stronger, fresher, and more numerous grooves, of which the bearing is nearly east and west."

As was before remarked, it seems utterly impossible to attribute the excavation of the bed of Lake Erie, which means the removal of about 1000 feet of rock, to a glacier which was evidently unable to remove pre-existing grooves upon the surface over which it flowed.

Again (Vol. III, p. 47) Dr. Newberry quotes from a paper published by Mr. G. J. Hinde, in which that writer mentions having traced glacial furrows at the eastern end of Lake Ontario from one hundred feet above the lake to the water's edge in a southwesterly direction, and also having found similar striæ at the south-western end of the lake running the same course. "This striking instance of glacial action seems to me," he adds, "to furnish strong proof of the basin of this lake at least having been excavated by *ice*."

The evidence here given completely fails to support the conclusion drawn. Instead of inferring from the presence of glacial grooves in the bed of Lake Ontario that that lake-bed had been entirely formed by the action of ice, the only logical inference is that it was occupied by ice long enough to allow time for the production of these marks. It would be as correct to argue from the presence of the scratches made by sandpaper upon an ornamental moulding that the whole of it had been worked out by the carpenter by that means.

This reply may be carried a step farther. Admitting just for the sake of argument that the beds of Lakes Erie and Ontario were filled for a longer or shorter time towards the end of the great ice age by a local glacier, we may fairly ask, "What caused these local glaciers to exist there and move from east to west? A narrow gorge such as that at Niagara would not deflect a glacier. It would be filled with glacial drift, and the ice would then pass over it as if it did not exist. This has happened in numerous instances both in east and west and in north and south gorges. To deflect a glacier the depression must be wide enough to allow the ice to sweep or scrape its bottom clear of deposit. We need in fact a wide open valley not a deep ravine for this purpose, and if such deflection of the margin of the continental glacier really occurred, the valleys of Erie and Ontario must have been valleys of this kind, in fact nearly what they are at present. It would have been more logical to assume the existence of these valleys as the cause of the diversion of the local glacier, otherwise the fact of this diversion remains without apparent cause. The excavation, to whatever cause due, was earlier than the glacier which filled it. To suppose otherwise is to make the glacier produce its own cause. But further: "Is it possible to admit the existence of these local glaciers in the beds of Lakes Ontario, Erie, Huron and Michigan?" Without the pre-existence of the lake beds this question may be answered promptly and decidedly in the negative. That the edge of the great continental ice-sheet was not regular we may consider certain. That it stretched farther southward on low ground than on high ground, may be assumed, it being quite in accord with the phenomena of recent glaciers. But that it was capable of throwing out long narrow tongues of ice where scarcely any depression of surface existed, is incredible. It is contrary to what we know of the physics of ice to believe in the existence of an ice tongue 200 miles long and 40 miles wide occupying for ages the place of Lake Ontario and only connected with the ice sheet at its eastern end. The same is true of the glacier supposed to have excavated the bed of Lake Erie. Yet more incredible is the theory that would require us to accept the existence of a glacier tongue 350 miles long by 80 miles wide occupying the site of Lake Michigan and employed in scooping out that lake-bed. For be it remembered these are not Alpine glaciers lying in deep narrow valleys hemmed in by rocky walls which prevent all escape and bar all progress except downward. These glaciers must have lain upon the level or nearly level surface of the continent, and towered above it for hundreds of feet in order to possess the weight necessary to grind or scoop out the lake-beds as the theory of Dr. Newberry requires. Such a phenomenon, so far as the writer knows, is without parallel on earth, and moreover its existence is opposed to what we know of the physics of ice. Such a mass must move either by its own weight or by a propelling force behind it. The former is excluded, because a glacier tongue thus extended would lie not in the zone of accumulation but in the zone of waste, and must be maintained by supplies of ice from behind it. But ice thus supplied from behind would find much less resistance at the sides of the mass and would consequently spread out laterally instead of urging forward the ice in front, and would thus form a wide semicircular sheet rather than a long and narrow tongue. To suppose such a glacier occupying the site of Lake Michigan for so long a time as to scoop it out to the depth of 900 feet is therefore contrary to the principle of dynamics, which maintains that when a glacier moves it moves in the line of least resistance.

If however we admit the existence of the lake beds to nearly their present depth and width before the ice age, we may without difficulty admit that as the continental glacier was retreating, a short projecting tongue would be found occupying each of them in part and extending a small distance southward or westward from the main body of the ice. This would not necessitate the persistence of such glaciers long enough to fill the whole valleys at once or to scoop them out to their present depth, but only long enough to produce those superficial east-west scratches which Dr. Newberry admits have not always effaced the earlier north-south grooves made by the great continental ice sheet. On this view we have a reason for the deflection of the ice, ample depth to retain a glacier of sufficient mass to produce such markings, and moreover we are not driven to violate any law of glacial physics in trying to explain the phenomena.

The argument, however, is not yet quite complete. Supposing we admit all the premises which Dr. Newberry lays down—that the continental glacier during its retreat was capable of extending tongues of ice several hundred miles long and only 40 to 80 miles wide, and that these tongues of ice lying on a nearly level surface and rising above it to a height of several hundred feet without side walls to confine them, persisted in pushing forward their ends where the resistance was greatest instead of spreading laterally where it was less—let us enquire next whether these tongues could possibly accomplish the task assigned to them.

In a lecture on New York Island and Harbour, published in the Popular Science Monthly for October, 1878, Dr. Newberry estimates the mass of material worn off the surface of that part of the State during the ice age and by the action of the ice as not improbably "one hundred feet." This estimate seems rather high, especially as that region consists of the hard primitive rocks. We have no reason to believe that so large an amount was removed from the surface of northern Ohio by the same agent. Probably the ice age in Ohio did not last quite so long as in New York, New England, and Lower Canada. We have fortunately, however, a gauge, though at present a somewhat rough one, of the amount eroded in this region. Deposition is the true measure of erosion, and if we can form an estimate with tolerable accuracy of the mass of the drift clays, &c., that cover our own and neighbouring States, we shall then have to that extent a key to the amount of degradation they suffered at the hands of the northern ice. Observation shows that as a rule the material was not transported very far, but that what was eroded from one locality was pushed on to another a little south or south-east of it. The deposit on one spot may therefore be used to a great extent to measure the denudation a few miles to the northward. Now it is on the whole very rare to find the drift much exceeding 100 feet in thickness in this or adjoining States. Such districts are never very extensive. The bulk of the transported material was not carried on the top of the ice but shoved along underneath it, constituting a ground moraine. There can have been few spots to the northward from which superficial moraine-matter could be obtained during the greatest extension of the glacier. Accordingly we find the greater part of the drift in any county consists of material brought from the counties to the northward, mixed with a smaller quantity from a greater distance, and some metamorphic boulders or pebbles from Canada. It becomes thinner as we go southward, probably because the propelling power of the ice became less with decreasing thickness. By noting the depth of the glacial drift in the northern part of the State, therefore we take it at its maximum, and we deal with material brought for the most part from the region of the great lakes. We can thus obtain approximately the amount of erosion which that region suffered during the glacial era. The following figures from the Geological Survey of Ohio show us the thickness of the drift through the three northern tiers of counties.

Table shewing the thickness of the drift in Northern Ohio:

Williams	127	Vol. I,	page	546
Fulton	85–146	" I,	"	546
Lucas	65–89	" "	"	"
Ottawa	50	" II,	"	233
Lucas (Toledo)	100			
Erie	thin	" II,	"	185
Lorain	not given	" II,	"	209
Cuyahoga	238 *	" I,	"	175
Lake	110	" I,	"	517
Cuyahoga	12	" I.	"	197
Ashtabula	90	" I,	"	489
Defiance	7–118	" II,	"	435
Henry	8–72	" II,	"	421
Wood	75	" II,	"	383
Sandusky	100	" I.	"	606
Huron	42+	" III,	"	298
Ashland	12 ?	" III,	"	525
Medina	?	" III,	"	362
Summit	60	" I,	"	204
Portage	10–100	" III,	"	137
Summit	220 *	" I,	"	205
Trumbull	?	" I,	"	493
Paulding	45	" II,	"	345
Putnam	22–94	" II,	"	395
Hancock	30–80	" II,	"	366
Seneca	60+	" I,	"	623
Richland	10+	" III,	"	321
Wayne	18	" III,	"	531
Stark	10–100	" III,	"	155
Mahoning	45	" III,	"	799

* This thickness is measured in the deeply excavated and buried channel of the Cuayhoga, and is therefore far above the average.

These figures shew plainly that we have no grounds for making any enormous estimates of the erosion of our State and the lake district by the continental glacier. Omitting the two measurements in Summit and Cuyahoga counties, which as shown above in the note are altogether exceptional and accidental, and taking the mean depth wherever two extreme limits are given, we find that the average thickness of the drift over all these northern counties of Ohio scarcely exceeds 50 feet. The thinning out to the southward of the clays and sands of which it is composed is moreover easily noted even in the list above quoted, the upper names being those of counties near the lake and the lower of those more distant.

From the facts and figures now given we may draw the inference that as the mass of deposited glacial matter in northern Ohio does not exceed fifty feet in average thickness, and as this matter was mainly derived from the region lying immediately north of Ohio, therefore the average thickness of surface-erosion accomplished by the great ice-sheet during its whole duration did not overpass this limit.

It may be urged that some of this material has since been removed by streams. This amount, however, except in the stream-valleys is not large. On the uplands and plateaux this factor in the problem may safely be disregarded, and these are not the places in general where the greatest depth is found. Moreover an allowance in the opposite direction must be made for that portion of the drift which was brought from land yet farther north in Canada. Though not very large in comparison with the whole it is large enough to form an important offset to the portion removed by the action of fresh water.

Returning now to the line of argument followed above, we may conclude if the great continental glacier prevailing over the lake region and Ohio for so many ages, possessing a thickness of many hundred feet (which can scarcely be doubted) and probably moving at a rate (for a glacier) exceedingly rapid, could only remove from the surface a layer of earth and rock (surface soil included), not exceeding fifty feet in thickness, that the local glaciers in the lake-beds, thinner and smaller by far, shorter-lived and probably less rapid in movement, must have been utterly powerless to scoop out those beds to their present depth. Is it rational to believe that one of these puny ice-tongues lying on the site of Lake Ontario, could excavate in a short time to the depth of 450 feet, those rocks from which its gigantic ancestor of longer duration could only scrape off at most some fifty feet?

And with yet stronger reason we may ask, "Is it possible that similar ice-tongues—a mere fringe of the great Canadian ice-sheet—could cut out the valleys of Michigan and Huron 800 and 900 feet below their present water surface and more than 1500 feet below much of the surrounding land, and thus perform from sixteen to thirty times as much work as the massive grinding continental ice-sheets have performed?" Surely this is varying the effect inversely with its cause.

Summing up the results thus obtained we find:—

1st. That the objection founded on the beaded nature of the old Mohawk valley is overruled by high authority in Physical Geography and by the phenomena of existing rivers.

2nd. That the objection drawn from the great and unequal depth of the lake-beds is answered by appealing to the elevation of the northern part of the continent at the time referred to.

3rd. The same reply meets the objection drawn from the want of sufficient fall for the old river in question.

4th. That Dr. Newberry's own theory of the origin of these lake-beds is open to the following very serious objections, if not indeed altogether untenable.

a. The evidence afforded by glacial striae in the bed of Lake Erie is not sufficient to prove the excavation ot the whole of that valley by the action of ice.

b. The same is true of similar markings in the bed of Lake Ontario.

c. Instead of attributing to the action of local glaciers the excavation of the deep vales of Michigan, Erie, Huron and Ontario, we are compelled to assume the pre-existence of these valleys as the only possible cause of the local glaciers; for the existence of such local glaciers without the lake-beds, *and perhaps with them*, is incompatible with the laws of the motion of ice.

d. We cannot assume the erosion of the great continental ice-sheet at more than 50 feet over the lake district.

e. Granting for the sake of argument the existence of these local glaciers it is utterly impossible to suppose them capable of eroding broad valleys 500 to 1000 feet deep, for this would be to suppose them capable of accomplishing many times as much work as their more massive continental predecessor had performed.

APPENDIX.

As any contribution however small to the Preglacial Geography of the lake region and the course of the old Mohawk must possess some value I add the following:

During the summer of 1877 when on the St. Lawrence I met one of the inspectors on the new Welland Cannal. In the course of conversation he mentioned that some difficulty had been found in choosing a site for Lock No. 1, Port Dalhousie. Visiting the spot soon afterwards he explained to me that where it was at first intended to construct this lock no rock could be found by probing the soil except at the southern end. It was consequently determined to remove the site back from the lake about the length of the lock in order to place it on a solid foundation. Lock No. 1, therefore now stands upon the very edge of a buried cliff, its north-western corner projecting beyond the line and being supported on piles. The same gentleman also informed me that at the distance of a few feet from the lock-sill towards the lake a rod was sunk to the depth of forty feet through soft oozé or peat without finding anything solid.

It may be that we have here another small link in the chain of evidence which will some day map out for us the Preglacial Mohawk. This buried cliff it should be remembered is below the water level of Lake Ontario and consequently more than 300 feet below the surface and about 100 feet below the bottom of Lake Erie, and of the buried channel of Detroit. It would therefore appear as if there may have been a swift current or possibly rapids between these valleys in Preglacial times as there is now.

NOTE ON RECENT CONTROVERSIES RESPECTING *EOZOON CANADENSE.*

By Principal Dawson, LL.D., F.R.S., &c.

In a recent article, published in the *American Journal of Science*, I have remarked that

"*Eozoon Canadense* has, since the first announcement of its discovery by Logan in 1859, attracted much attention, and has been very thoroughly investigated and discussed, and at present its organic character is generally admitted. Still its claims are ever and anon disputed, and as fast as one opponent is disposed of, another appears. This is in great part due to the fact that so few scientific men are in a position fully to appreciate the evidence respecting it. Geologists and mineralogists look upon it with suspicion, partly on account of the great age and crystalline structure of the rocks in which it occurs, partly because it is associated with the protean and disputed mineral Serpentine, which some regard as eruptive, some as metamorphic, some as pseudomorphic, while few have had enough experience to enable them to understand the difference between those serpentines which occur in limestones, and in such relations as to prove their contemporaneous deposition, and those which may have resulted from the hydration of olivine or similar changes. Only a few also have learned that *Eozoon* is only sometimes associated with serpentine, but that it occurs also mineralized with loganite, pyroxene, dolomite. or even earthy limestone, though the serpentinous specimens have attracted the most attention, owing to their beauty and abundance in certain localities. The biologists on the other hand, even those who are somewhat familiar with foraminiferal organisms, are little acquainted with the appearance of these when mineralized with silicates, traversed with minute mineral veins, faulted, crushed and partly defaced, as is the case with most specimens of *Eozoon*. Nor are they willing to admit the possibility that these ancient organisms may have presented a more generalized and less definite structure than their modern successors. Worse, perhaps, than all these, is the circumstance that dealers and injudicious amateurs have intervened, and have circulated specimens of *Eozoon*, in which the structure is too imperfectly preserved to admit of its recognition, or even mere fragments of serpentinous limestone, without any structure whatever. I have seen in the collections of dealers and even in public museums, specimens labelled "*Eozoon Canadense*," which have as little claim to that designation as a chip of limestone has to be called a coral or a crinoid." *

These statements were called forth by the appearance of a learned and well illustrated paper, disputing the animal nature of *Eozoon*, by Prof. Karl Moebius of Kiel, and in which, on the evidence of several specimens given to him by Dr. Carpenter and myself, he assumes that he has "investigated more closely and described more minutely" than any other naturalist, its forms and structures, and that by his labours *Eozoon* has been "successfully eliminated from the domain of organic bodies."

Since the appearance of this memoir, and of my criticism upon it, Moebius has published in the same Journal a reply, which has appended to it a note by the principal editor, closing the controversy in so far as that Journal is concerned, by stating that the editor had pledged himself that no rejoinder would be permitted. This, of course. excludes the advocates of the animal nature of *Eozoon* from any farther argument, in so far as the principal organ of scientific opinion in the United States is concerned; and it is partly for this reason that I appear at present in the attitude of a defender of *Eozoon* on its own soil, instead of, as heretofore, carrying the war into the enemy's country.

Still later than this reply of Moebius, are two additional papers of still more remarkable character. For, while Moebius is content to take up a purely negative position, these undertake to account for the structures of *Eozoon* by other causes than that of animal growth, and by causes altogether inconsistent with one another. The first of these is an abstract of a memoir "On the origin of the mineral, structural and chemical characters of Ophites and related rocks," presented to the Royal Society of London by Professors King and Rowney. The second is a quarto pamphlet of 96 pages with 30 plates, by Dr. Otto Hahn, entitled "Die Urzelle,,' the "Primordial cell."

I confess I do not regard either of these papers as of any scientific value, in so far as *Eozoon* is concerned, but as they are at least bold and confident in their tone, and emanate from quarters which may be supposed to give them some little influ-

* Amer. Jour. of Science. March, 1879.

ence, I think it well to notice them along with the reply of Prof. Moebius.

Moebius has thought proper to take advantage of the security guaranteed to him by the Editor of the American Journal, to reply to my courteous and somewhat forbearing criticism, in a manner which relieves me from any obligation to be reticent as to his errors and omissions. I shall, however, confine myself to those points in his rejoinder which seem most important in the interest of scientific truth.

1. With reference to the geological and mineral relations of *Eozoon*, I cannot acquit Moebius of a certain amount of inexcusable ignorance. More especially, he treats the structures as if they consisted merely of serpentine and calcite, and neglects to consider those specimens which, if more rare, are not less important, in which the fossil has been mineralised by Loganite, Pyroxene and Dolomite. If he had not specimens of these, he should have procured them before publishing on the subject. He neglects also to consider the broken fragments of *Eozoon* scattered through the limestones, and the multitudes of *Archæospherinæ* lying in the layers of deposit. Nor can I find that he has any clear idea how the structures of *Eozoon* could have been produced otherwise than by living organisms. Still farther, he makes requirements as to the state of preservation of the proper wall and canal system which would be unfair even in the case of Tertiary or Cretaceous *Foraminifera* injected with Glauconite, how much more in the case of a very ancient fossil contained in rocks which have been subjected to great mechanical and chemical alteration.

2. In his reply he reiterates the statement that *Eozoon* is so different from existing *Foraminifera*, that, if this is a fossil, we must divide all organic bodies into "1. Organic bodies with protoplasmic nature (all plants and animals); and 2. Organic bodies of Eozoonic nature (*Eozoon*, Dawson)." Without referring to the somewhat offensive way in which this is stated, I need only say that Dr. Carpenter has well replied that the structures of *Eozoon* are in no respect more different from those of modern *Foraminifera* than those of many other old fossils are from their modern representatives. All palæontologists know, for example, that while we cannot doubt that *Receptaculites*, *Archæocyathus*, and *Stromatopora* are organic, and probably Protozoan, it has proved most difficult to correlate their structures with those of modern animals.

3. I took occasion to mention certain errors of Prof. Moebius, due to his limited information on the subject of which he treats. He admits two of these, which were particularly pointed out, but taunts me with not producing others. This, however, would not have been difficult had I been disposed to enter in detail into a task so ungracious. Another example may be taken from his plate XXXV, in which he represents together, and obviously for comparison, portions of the pores or tubuli of the modern *Polytrema*, and an imperfect fragment of the proper wall of *Eozoon*, and this more especially, as appears in the text, to show the comparative fineness of the latter. But the specimen of *Eozoon* is magnified only 75 diameters, while that of *Polytrema* is magnified 200 diameters, or in the proportion of 5625 to 40,000. Again he has affirmed and repeats in his reply that the casts of the canal systems of *Eozoon* do not present cylindrical forms but are "*flat* and *irregular* branched stalk-like bodies." If they appeared so to him, he must have possessed most exceptional specimens. Some canals, especially the larger, no doubt have flattened forms, particularly at their points of bifurcation; but this is comparatively rare, more especially in the vastly numerous minute canals which are more frequently filled with dolomite than with serpentine. I have indeed been able to detect only a few out of very numerous specimens in which the majority of the casts of canals are not approximately round in cross section, even in the case of the larger canals. It is a question also if some flattening may not be due to pressure; and there are flat stolon-like tubes which can scarcely be called canals.*

It occurs to me here to remark that Moebius seems to have overlooked the extremely fine canals injected with Dolomite that fill the upper and thinner calcite walls of the better preserved specimens, and which in the thinner walls are nearly as fine as the tubuli of the proper wall, into which in many cases they almost insensibly pass where these last are themselves filled with dolomite. Possibly these structures have not been present in his specimens, or may have been destroyed or rendered invisible by his methods of preparation, and if so this would account for

* The forms of the canals are perhaps best seen in decalcified specimens; but Mr. Weston, who has done so much toward this investigation, has managed to cut slices so accurately at right angles to the general course of groups of canals, as to show their round cross sections with great distinctness.

some of his conclusions. These fine canals are best seen in well-preserved serpentinous specimens free from chrysotile veins, and etched with very dilute nitric acid. They have scarcely been done justice to in any of the published figures either of Dr. Carpenter or myself, and do not appear in those of Prof. Moebius.

4. In reply to my objection that he has confounded the proper wall of *Eozoon* with veins of chrysotile, and that both are represented in his figures, he challenges me to point out which of the latter are chrysotile and which proper wall. Of course doing so will be of little importance to the argument, but I may indicate his figs. 18, 43, 44 and 48 as in my opinion taken from portions of proper wall, and fig. 45 seems to show the proper wall along with chrysotile. I may farther now point out to him that even Profs. King and Rowney in their recent paper admit that the proper wall is not continuous chrysotile, but consists of "aciculæ separated by calcareous interpolations," though they try to account for this structure by complicated changes supposed to have occurred in veins of chrysotile subsequently to their deposition.

In truth, the chrysotile veins cross all the structures of *Eozoon*, and those specimens are best preserved which have suffered least from this subsequent infiltration of chrysotile into cracks formed apparently by mechanical means. This has been amply shewn in figures which I have already published, but I have now still more characteristic specimens which I hope may yet be engraved.

5. Prof. Moebius sneers at my statement that when the proper wall of *Eozoon* is merely calcareous and not infiltrated, its structures are invisible, and that in many cases it has become opaque, while in thick slices its structure is always indistinct; but he should know that this is the case with all fine organic tubuli or pores in fossils penetrated with mineral matter, and eminently so with fossil Nummulites, as the researches of Carpenter have long ago demonstrated, and as any one possessing slices of these fossils can see for himself. I may add that in some decalcified specimens in my possession, where the proper wall has been wholly of calcite, it is indicated merely by an *empty band* intervening between the serpentine cast and the supplemental skeleton filled with casts of canals.

6. Lastly, he seems to think that no offence should be taken at his insinuation that the figures printed by Dr. Carpenter and myself are idealized or untruthful representations, and he repeats the accusation in the following terms: "The individual peculi-

arities of diagrams should not exceed the limits of the known variability of the real specimens, but in the *Eozoon* diagrams of Carpenter and Dawson these limits are exceeded." There could not, I think, be a more plain charge of wilful falsification, and this is made by a naturalist who discusses *Eozoon* without having taken the pains either to study it *in situ*, or to avail himself of the large collections of specimens which exist in England and in Canada. I can only reply that while I have been unable to figure all the peculiarities of the canal systems of this complicated and often badly preserved fossil, I have endeavoured to select the most characteristic specimens; and that my representations are principally, nature-prints, photographs, and camera tracings, some of the latter by artists in no way interested in *Eozoon*. Dr. Carpenter's representations appear to me to be equally truthful. Neither of us have taken the trouble to represent badly preserved or imperfect specimens, any more than we should do so in the case of any other fossil, when better examples were procurable.

In connection with this, Moebius seems to think that in my criticism I should have gone into all the details into which he enters. This was unnecessary, except to expose his principal errors or mis-statements. It could not have been done without publishing a treatise as long and as expensively illustrated as his own; and this I should prefer to do in some other form than as a mere reply to him; and with reference to much larger and more varied collections than those at his command. It is to be hoped that his expectations will be satisfied in this respect by a monograph which Dr. Carpenter proposes to undertake.

He is good enough to add that if I will send him more and better specimens, he will willingly "forgive" me for "disappointing" him and other naturalists. I must say that I cannot purchase forgiveness on such terms, but if he will take the trouble to visit Canada and inspect my collections, he shall have every opportunity to do so.

I think it is only due to the interests of palæontological science to add here, that I attach more blame to the editors of the German publication "Palæontographica," in which his memoir appears, than to Prof. Moebius himself. We have been in the habit of regarding this publication as one in which the matured results of original observers and discoverers are given, and when it devotes 40 costly plates to the labours of a naturalist who is not of this character, in so far as *Eozoon* is concerned, and who has not even studied the principal collections on which other naturalists equally competent have based their conclusions, they incur a responsibility much more grave than if they were merely the conductors of a popular scientific journal, open to cursory discussions of controverted points. They cannot relieve themselves from this responsibility till they shall have published a really exhaustive description of *Eozoon* by some one of the original workers on the subject. This is the more necessary, since if *Eozoon* is really a fossil, its discovery is one of the most important in modern palæontology, and since its claims cannot be settled except by the most full investigation and illustration.

The second paper referred to above contains little that is new, being a re-habilitation of that hypothesis of "Methylosis," or chemical transmutation, which the authors have already fully explained in the Transactions of the Irish Academy and elsewhere. Its bearing on *Eozoon* is simply this:—that if any one acquainted with geological and chemical possibilities can be induced to believe that the Laurentian limestones of Canada are "Methylosed products," which originally "existed as gneisses, hornblende schists, and other mineralised silacid metamorphics," he may be induced also to believe that *Eozoon* is a product of merely mineral metamorphism.

When we consider that these great limestones have been so fully traced and mapped by Sir William Logan and his successors on the Geological Survey; that some of them are several hundreds of feet in thickness and traceable for great distances, that they are quite conformable with the containing beds, and themselves exhibit alternating layers of limestone and dolomite, with layers characterized by the presence of graphite, serpentine, and other minerals, and subordinate thin bands of gneiss and pyroxene rock, the idea that they can be products of a sort of pseudomorphism of gneisses and similar rocks, becomes stupendously absurd, and can only be accounted for by want of acquaintance with the facts on the part of the authors.

To explain the structures of *Eozoon*, however, even this is not altogether sufficient, but we must suppose a peculiar and complex arrangement of laminae, canals. and microscopic tubuli or fibres simulating them, to be produced in some parts of the limestones and not in others; and this by the agency of several different kinds of minerals.

In other words we have to suppose a conversion on a gigantic scale of gneiss into dolomite, limestone, graphite, serpentine, and other minerals, consisting for the most part even of different elements, and this at the same time or by still more mysterious subsequent changes, producing imitations of the most delicate organic forms. The mere statement of this hypothesis is, I think, sufficient to show that it cannot be accepted either by chemists or palæontologists, and it only serves to illustrate the difficulties which *Eozoon* presents to those who will not accept the theory of its organic origin.

Dr. Otto Hahn regards the matter from an entirely different point of view. He has himself visited Canada, has collected specimens of *Eozoon*, and now proposes to effect an entire revolution in our ideas of the palæontology of the Eozoic rocks.

In a former paper he had maintained that *Eozoon* is altogether of mineral origin, that its serpentine is hydrated olivine, and the canal system merely cracks in calcite injected by the expansion of this mineral. This hypothesis he now finds untenable, and he regards *Eozoon* as a vegetable production, or rather as a series of such productions. He regards the laminæ as petrified fronds of a sea-weed, and the canal systems as finer algæ of several genera and species. Not content with this, he describes as plants other forms found in granite, gneiss, basalt, and even meteoric iron, and others found included in the substance of crystals of Arragonite, Corundum and Beryl. All these are supposed to be algæ of new species, and science is enriched by great numbers of generic and specific names to designate them, while they are illustrated by thirty plates representing the quaint and grotesque forms of these objects, many of which are obviously such as we have been in the habit of regarding as mere dendritic crystallisations, cavities, or impurities included in crystals.

Among other curious discoveries the author refers to a plant which he honours me by naming *Photophoba Dawsoni*, and which he discovered in certain "amoeba-like" nodules of flint found in the Silurian of Montreal, and used to adorn the grounds of McGill College. I was puzzled for some time by this, until it occurred to me that at the time of the Doctor's visit some English gravel had been laid on our College terrace, and that several heaps of large irregular flints from this gravel had been gathered in front of the buildings. These had apparently afforded the new plant in question. Some other plants stated to be found in hornblende from Montreal mountain, and in limestone said to be called "fancy stone," are more difficult to account for.

All this plant theory, advanced with the utmost confidence, has no evidence whatever except the assertion of the author and his belief as to the imperfect character of the observations of his predecessors. The following extracts, kindly translated by our colleague Dr. Sommer, will serve to show his mode of treatment:—

"I was convinced of the inorganic nature of Eozoon, or at least of the fact that it could not be an animal. But the fine "canal systems" as Dr. Carpenter had named them, were the source of much anxious thought on my part, and this was necessarily augmented by the following consideration, of which I could not rid myself. "Gneiss is formed by water and therefore a sedimentary rock. Its layers of limestone must contain the first organic enclosures; for, life cannot begin with the silurian rocks." This is a hypothesis, but, like many others that are true, one of which I have not yet rid myself."

"It happened, then, that I had to go to Canada, in consequence of an invitation from the Canadian Government.* I visited Dr. Dawson and thence went to Côte St. Pierre, Petit Nation, there I saw the stratified layers and obtained a great number of pieces of Eozoonic Limestone and of Eozoonic specimens. On my return I examined the material. The result of my examinations I publish here: *the Limestone of the Laurentian Gneiss of Canada, the oldest sedimentary strata of our earth, contains a plant organization belonging to the family of the Algæ.*"

"Till now there have been but few new species established different from the modern; but, I am persuaded, that by continual researches, the number will soon be increased. All these plants, I found enclosed in the *true* "Eozoic Rock," which I shall henceforth call *Eophyllic Limestone*. I shall draw attention to the words that my honorable friend Dr. Dawson also used: "all is not Eozoon!" †

Then follows a description, condensed from Canadian reports, of the Laurentian formation, after which occur the following statements:—

"It is incomprehensible that on looking upon this form, a plant did not occur to the mind, at once. It can only be explained thus: that, at first, when such pieces were not yet discovered, they were so prepossessed by the idea of Foraminifera, that it pervaded all their investigations; while the opponents, (myself included) arrived at once at the obvious conclusion: namely that not being animal it was therefore mineral."

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* Dr. Hahn seems to have been employed on some mission connected with emigration from Germany.

† This, I suppose, refers to the fact that I warned Dr. H. that he would find the greater part of the Laurentian limestone to be destitute of distinguishable Eozoon.

"I found the species which I first called *Eophyllum* in a piece of *Eozoon*, in the first white band of limestone overlying a layer of serpentine: in other words between two layers of serpentine. Then first this question occurred to me: Are not the whole lumps of Eozoon plants? I was forced to yield to the inference after I had exposed, by applying Hydrochloric acid to the limestone, some larger lamellæ which were in connection with serpentinic layers: indeed, the forms are so permanent and so constantly reappearing that they cannot be explained otherwise. Of course with this there was gained the best argument against the animal theory; for, hitherto the discovered species of Algæ have never been found in either stones or shells. This plant belongs to the family of the Algæ. They either rest immediately upon dolomite and gneiss, or, are found in the proper Eophyllous limestone, i.e. in the layers of serpentine limestone, between the large strata of dolomite and serpentine. They are, however, not only to be found in the limestone, but also in the serpentine of the strata. No plants or but few, are found in the thick layers of serpentins which enclose the Eophyllous limestone: certainly none in the lowest. Some of them may be seen with the naked eye, while with the microscope, we come to the smallest conceivable forms. Being replaced by silicates, they may be exposed by the application of acid to the limestone. This done, the plants make their appearance as shining white stems, calyxes, and leaves. In thinly ground plates, they appear a yellowish brown. This, probably, is the reason that Mobius describes their color as being a light brown. In reality, it is the refraction of the light in the opaque masses." *

"There was scarcely ever a more difficult task given to natural science, than the determination of the nature of "*Eozoon*." When I made my first announcement of *Eophyllum* in the "Ausland" I little thought that the large ribbons of serpentine were also plants. I had already half-finished this work after my original plan, when I came across a defective specimen of rock, in which, in consequence of its defectiveness, the serpentine parts were very clearly distinguishable.

"I looked at it over and over again, till it struck me that the sarcode-chambers were nothing but cells of plants. Thus the fate of the microscopist is decided. What others can see with the naked eye he does not see at all. Then came the more difficult part: the examination of the case. Now, I had no more doubt. And in this manner only facts become clear. The ribbons of serpentine which constitute that which is called *Eozoon*, belong to an alga with broad leaves—if the expression is permitted—which radiating from one point arranges itself in regular forms. The basal-cell rests upon serpentine or dolomite. Roots I found only in one case, of which, however, I am not sure. The limestone is the replacing-material. The germ-cells

* Thus far, the author refers principally to the serpentine casts of the canal system.

are still visible in it, for in ground pieces for the microscope they still shine through. This may be proved by dissolving the limestone by means of acid. Here the leaves are perfectly covered with germ-cells, the "warzenansätze" of Gümbel. This is still clearer wherever the plant has been altered into dolomite. The brood-cells are then visible without the aid of the microscope. There appear, also, calyx-like cells, clear as water, which have weathered out upon the dolomite.

"But by far the most beautiful are the limestones in which the plants are changed, partly into serpentine, and partly into mica. The same cells are observed in a spar, changed into copper and malachite, visible to the naked eye. The canal-systems, therefore, of the "intermediate skeleton" are the microscopical plants which, partly, are simply of a limestone nature or have grown firmly upon large algæ, or are deposited there, dead. As I remarked in the beginning, a key to this new creation is, at all events, necessary. I say new, for it is entirely new to our imagination. The microscopical forms constitute this key. Now from these safe premises we may easily come to a conclusion; but I must here caution against the exclusive use of ground microscopical plates.* It is only by mere accident that, by this means, a view is gained; hundreds of them may be made, but only a very trained eye can decipher them."

It seems scarcely necessary to criticise the above statements, as it is probable that very few naturalists will be disposed to accept the supposed plants described by Dr. Hahn as veritable species. It may be observed, however, that in regarding the thick plates of serpentine, interrupted, attached to each other at intervals, penetrated by pillars of calcite, and becoming acervuline upward, as fossil algæ, he disregards all vegetable analogies; while in supposing that the calcite is a filling, and that the delicate fillings of canals contained in it are fine thread-like algæ, he equally asserts what is improbable. Farther, no vegetable structure or remains of carbonaceous matter have been discovered in the serpentine. Had he discovered these supposed vegetable forms in the graphite of the Laurentian, this would have been far more credible.

Hahn's paper, however, suggests one or two points of interest respecting *Eozoon*, which have perhaps not been sufficiently insisted on. One of these is the occurrence of rounded "chamberlets" in the calcareous walls. These are his "germ-cells,"

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* If this is intended to apply to Canadian and English students of *Eozoon*, it is quite inaccurate, as they have always employed decalcified specimens as well.

and they sometimes present the curious character that they are hollow vesicles of serpentine filled with calcite, and when these have been cut across in making a section, and the calcite has been dissolved out with an acid, they present very singular appearances. They may in some cases have been germs of *Eozoon*, or smaller foraminifera of the type of *Archæospherinæ*, overgrown by the calcareous walls. It is farther to be observed, as I have also elsewhere remarked, that the serpentine filling the larger spaces between the calcareous laminæ sometimes shows indications of deposit as a lining of the cells, and in some specimens this lining has not filled the original space but has left a drusy cavity afterwards filled with calcite.

Again, in parts of the canal system, especially when filled with dolomite, there occur little disc-like bodies or trumpet-shaped terminations of canals. These, I fancy, are the calyx-like objects figured by Hahn. Their precise significance is not known, further than that they may represent the expanded ends of canals. Another appearance deserving of notice is the occurrence of portions of specimens of *Eozoon* in which little or no serpentine occupies the chambers. In this case the laminæ have either been pressed close together, or the chambers have been filled with calcite not distinguishable from the walls, in which, however, the casts of groups of canals often occur, and might then be more readily mistaken for algæ than when they occur between laminæ of serpentine.

Lastly, I have recently found in a specimen of *Eozoon*, structures which may possibly indicate contemporaneous plants. I have previously remarked the occurrence of deep pits or cylindrical cavities in some specimens of *Eozoon*, and have supposed that they might be of the nature of oscula. Those now referred to are, however, more definite than any previously observed. They are cylindrical perforations penetrating the whole thickness of the mass, and filled with calcite. One of them is simple, another seems to bifurcate. They are about an eighth of an inch in diameter, and present indications of alternate swellings and contractions. In approaching them the plates of serpentine split into two, and then unite, forming a continuous close wall of sarcode. This proves that these tubes are not perforations of any boring animals. They must be either definite canals penetrating the mass while living, or must represent cylindrical stems of algæ or other perishable organisms, around which the *Eozoon* has grown. As they are only exceptionally seen, the latter supposition is perhaps the more probable. Peculiarities of this kind, to which perhaps heretofore too little attention has been given, are of some importance with reference to the controversies respecting *Eozoon*.

It may be said, in connection with the attacks in question, that if *Eozoon* is an object of which so many and strange explanations can be given, it is probable that no certainty whatever can be attained as to its real nature. On the other hand it is fair to argue that, if the opponents of its animal nature are driven to misrepresentation and to wild and incoherent theories, there is the more reason to repose confidence in the sober view of its origin, consistent with its geological relations and microscopic characters, which has commended itself to Carpenter, Gumbel, Rupert Jones, Sterry Hunt, and a host of other competent naturalists and geologists. For my own part the arguments adduced by opponents, and the re-examination of specimens which they have suggested, have served to make my original opinion as to its nature seem better supported and more probable; though of course I would be far from being dogmatic on such a subject, or claiming any stronger conclusion than that of a reasonable probability, which may be increased as new facts develop themselves, but cannot amount to absolute certainty until the discovery of Laurentian rocks in an unaltered state shall enable us to compare their fossils more easily with those of later formations.

In point of fact, the evidence for the organic nature of a fossil such as that in question, is necessarily cumulative, and depends on its mode of occurrence and state of mineralisation, as well as on its general form and microscopic structure; and it is perhaps hopeless to expect that any considerable number of naturalists will be induced to undertake the investigations necessary to form an independent opinion on the subject. It may be hoped, however, that they will fairly weigh the evidence presented, and will also take into consideration the difficulty of accounting for such forms and structures except on the hypothesis of an organic origin.

PROCEEDINGS OF THE NATURAL HISTORY SOCIETY OF MONTREAL.

The first regular meeting for the Session 1879-80, was held in the Society's Rooms on Monday evening, Oct. 27th. The minutes of the last meeting were read and confirmed. An eagle presented to the Society by J. J. Gibb, Esq. of Como, and mounted by Mr. Passmore, was exhibited and carefully examined.

There being a very small attendance, owing to some misunderstanding as to night of meeting, a general discussion of the affairs of the Society was held, after which the meeting adjourned.

The second meeting was held on the evening of December 1st, the President, A. R. C. Selwyn, Esq., F.R.S., in the chair. The minutes of last meeting being read and approved, the following gentlemen were elected members of the Society:—Dr. Angus MacDonnell and Messrs. Wm. Crowther, L. Bamburgher, and W. J. Morris.

Principal Dawson then read a paper entitled "Recent Controversies respecting *Eozoon*." In this paper the Principal discussed the memoir of Prof. Karl Moebius, of Kiel, published in the "Palæontographica," and a reply by Moebius to a previous criticism; also an abstract of a memoir presented to the Royal Society of London by Professors King and Rowney, of the Queen's University of Ireland, and a memoir lately published by Dr. Otto Hahn in Germany. He referred to the points in which the several writers in question had misapprehended the structures and relations of *Eozoon*, and illustrated these by specimens and drawings.

At the close of the paper, Dr. T. Sterry Hunt stated that inasmuch as Principal Dawson had mentioned his name in connection with the subject of *Eozoon*, he might be permitted to say that he thought quite too much notice had been taken in the paper of the views of Hahn and others, whose statements with regard to *Eozoon* were really too absurd to be worthy of consideration. On the occasion of his recent visit to Europe (in 1878) he had carried with him a collection of specimens of *Eozoon*, placed in his hands by Principal Dawson. The collection had been studied by Zirkel and Renard, and both these most distinguished observers in the field of microscopic petrography had expressed their belief in the organic character of *Eozoon Canadense.*

(Principal Dawson's paper appears in full in this number of the *Naturalist.*)

There was also exhibited during the evening a collection of rocks forwarded by Albert J. Hill, Esq., C.E. These are an extensive series of rock specimens representing the cuttings on the Canada Pacific Railway between Kaministiquia and the English River, a distance of ninety-three miles. They consist of a variety of gneisses, hornblende schists, and other highly crystalline rocks, with clay slates, quartzites, chlorite slates and serpentine, and belong to the Huronian and Laurentian series of that region.

NOTES ON A FEW CANADIAN ROCKS AND MINERALS.

By B. J. Harrington, B.A., Ph. D.*

I.—On some of the diorites of Montreal.

There are probably few regions of such limited extent that furnish a greater variety of interesting eruptive rocks than Montreal and its vicinity. This fact long ago attracted the attention of Dr. Hunt, and though many of the rocks were ably described by him, there still remains a wide field for investigation, both as regards the character of the rocks and their relative ages. Numerous facts bearing upon these points have recently been accumulated, but many additional details are required before the subject can be fully discussed.

In the *Geology of Canada* the intrusive rocks of Montreal are described as dolerites, trachytes and phonolites, the first af these constituting the main mass of Mount Royal as well as numerous dykes, while the others occur only in dykes, which are stated to cut the dolerites in some instances. No mention is, however, made of the numerous dykes of diorite which occur, and which,

* From the Report of the Geological Survey of Canada for 1877-78.

in some cases, have also been observed to cut the dolerite of the mountain. These diorites vary considerably in their characters, ranging in colour from light to dark grey, and in specific gravity from 2·75 to over 3.* They are usually medium to fine grained in texture, and often porphyritic with crystals of hornblende. Sometimes, too, they are amygdaloidal, the cavities containing calcite, zeolitic minerals, and rarely epidote. They all appear to contain carbonates, the quantity of which, however, varies in different cases. Their principal constituents are hornblende, a triclinic feldspar, and titanic iron; but they commonly contain other minerals, the most important of which is, perhaps, mica. Augite is also sometimes present. The mica is occasionally so abundant that the rock becomes the mica-diorite of some lithologists.

A dyke occurring in the reservoir extension consists of what may probably be regarded as a typical variety of the diorites referred to above. It is dark grey in colour, rather fine grained, but still showing, without the lens, quantities of acicular prisms of a black mineral which proves to be hornblende. The dyke was about two feet thick and very homogeneous, showing neither porphyritic nor amygdaloidal texture. Specimens sliced and examined with the microscope are seen to consist essentially of hornblende, a triclinic feldspar, and numerous opaque grains of titanic iron. Mica, apatite, calcite, and a little of a green chloritic mineral, are also commonly present. The hornblende appears mostly fresh, though in places slightly altered to the chloritic mineral just mentioned. It is of a rich brown colour and strongly dichroic. In cross sections the cleavage of the prisms is often beautifully displayed. The feldspar is in part altered, but in places fresh. It is triclinic, and judging from the unusually basic character of the diorite, must be a feldspar low in silica. The black mineral occurs mostly in irregular grains, but here and there in curious fantastic forms after the manner of titanic iron ore. That it consists mainly of this mineral, and not of magnetite, is evident from the considerable proportion of titanium dioxide shown by the analysis, and also from the fact

* The following are the specific gravities of a number of specimens:

2·749	2·94	2·923	3·005
2·889	2·97	4·947	....
2·805	3·07	2·927	....

that when the rock is pulverised the magnet removes almost nothing. The specific gravity of different fragments of the rock varied from 2·927 to 3·005. An analysis was made some time ago, and, as the composition appeared unusual, search was made for descriptions of similar rocks from other localities, but none could be found. Since then, however, Mr. G. W. Hawes has described rocks of wonderful similarity from Campton, in the State of New Hampshire.* An analysis, by Mr. Hawes, of one of these diorites is given under II. for comparison with I., which is an analysis of the diorite from Montreal just described :—

	I.	II.
Silica	40·95	41·94
Alumina	16·45	15·36
Ferric oxide †	13·47	3·27
Ferrous oxide	....	9·89
Manganous oxide	0.33‡	0.25
Titanium dioxide	3.39	4.15
Lime	10.53	9.47
Magnesia	6.10	5.01
Potash	1.28	0.19
Soda	4.00	5.15
Phosphoric Acid	0.29	...
Carbon dioxide	...	2.47
Loss on ignition	3.84	3.29§
	100.63	100.44

On boiling I. with hydrochloric acid for several hours, and filtering, the insoluble residue after ignition amounted to only 51.80 per cent. Although the amount of carbon dioxide was not determined, it must constitute a large proportion of the loss which the rock sustains on ignition; for acetic acid dissolves 4.02 per cent. of lime and 0.67 of ferrous oxide, and these bases, if calculated as carbonates, would require 3.57 per cent. of carbon dioxide. The basic character of the rock, and the extent to which it is dissolved by hydrochloric acid, seem to indicate a feldspar of the nature of anorthite. In that case a considerable proportion of the alkalies must belong to the hornblende; but

* *Geology of New Hampshire*, Part IV, p. 160. *American Journal of Science*, 1879, p. 148.

† All the iron is calculated as ferric oxide, the ferrous oxide not having been determined.

‡ With a little cobalt. § Water.

this is not improbable, as some varieties of hornblende are known to contain several per cent. of alkalies.

Another dyke, occurring within a few yards of that just described, is also of much interest. It is dark grey in colour, and, like the last, shows numerous acicular prisms of hornblende penetrating the mass in all directions. Here and there macroscopic scales of dark brown mica are seen, and the rock is dotted with numerous spots—occasionally as much as a quarter of an inch across—of a glassy, colourless to white mineral, which, on analysis, proves to be analcite. The specific gravity of the analcite is 2.255, and its composition as follows:—

Silica	53.29
Alumina	23.33
Ferric oxide	trace.
Lime	0.64
Magnesia	trace.
Soda	14.54
Water	8.47
	100.27

The mineral was examined for potash, but none found. Before the blow-pipe it fuses easily to a colourless glass. When thin sections of the rock are examined with the microscope the analcite appears very transparent and shows but few inclusions. It is traversed by numerous reticulating cracks, but displays no characteristic cleavage. The feldspar is mostly dull, but here and there is sufficiently transparent to show its triclinic character with polarized light. The hornblende and titanic iron appear exactly similar to what occurs in the ordinary diorites of the locality. No augite has been observed, but one slide shows numerous green crystals, which are evidently pseudomorphs of serpentine after olivine.

In so far as its constituents are concerned, this rock appears to be somewhat similar to that which Tschermak, many years ago, called *teschenite*, after Teschen in Austria. Tschermak regarded the analcite as one of the normal constituents of the rock, and this it may possibly be in the present instance. On the other hand, the general similarity of the other constituents of the rock to those of the ordinary diorites of the vicinity would lead one to infer that the analcite is a secondary mineral, and that the rock is simply an altered diorite.

The diorites described above traverse not only the Lower

Silurian limestones. but also the dolerite of Mount Royal. Rounded masses of the diorite of precisely similar character occur in the Lower Helderberg conglomerate or breccia of St. Helen's Island. Those, therefore, who would classify eruptive rocks according to age, would say that Mount Royal is a diabase and not a dolerite. Admitting such to be the case, how is it, the question may be asked, that dykes of *phonolite* are abruptly cut off by the diabase, when phonolite, according to the chronological theory, ought to be of Tertiary or more recent age? It may be that future investigations will solve the difficulty, but, in the meantime, the eruptive rocks of Montreal do not seem to fall into their proper place in a classification based upon age.

II. PYROXENE AND URALITE.

Of all the mineral associates of apatite in the Ottawa region, pyroxene is the most constant and the most abundant. In one form or another it is probably present in all the apatite deposits, excepting, perhaps, some of the calcareous veins with imbedded apatite crystals. The most common variety appears to be an aluminous sahlite or lime-magnesia-iron pyroxene, but a light-coloured variety, probably diopside or malacolite, is also common. Less frequently a beautiful black kind may be observed, excellent examples of which have been obtained from the thirteenth lot of the eleventh range of Templeton. It is here associated with green apatite, white orthoclase, scapolite, graphite and small grains of titanite. The pyroxene crystals often contain little round or irregular mases of the orthoclase as well as scales of graphite, and their surfaces are sometimes coated by broad plates of the last-named mineral. The crystals differ from those of the more ordinarily occurring sahlite not only in colour, but also, to a certain extent, in chemical composition and form. having the faces of the inclined rhombic prism usually much more fully developed than the clinopinacoid, and presenting rather different pyramidal terminations. The observed planes are those of the inclined rhombic and rectangular prisms ∞ P. ∞ P∞ . [∞ P∞], combined with the pyramidal faces P. 2 P.–P. and the clinodome [2 P ∞]. The faces of the rhombic prism are often developed almost to the exclusion of the ortho- and clinopinacoid. In some crystals the pyramidal planes are pretty equally developed, but in others much distorted. In the specimens examined the basal plane oP. is absent, but there is a very distinct basal cleavage.

The fracture varies from uneven to conchoidal. The colour is mostly black, but in some specimens blackish-green. On the edges or in thin splinters the mineral is translucent, and by transmitted light appears deep bottle-green. The lustre is vitreous, and sometimes almost splendent. The hardness is about six, and a crystal, of which the following is an analysis, was found to have a specific gravity of 3·385 :

Silica	51·275
Alumina	2·821
Ferric oxide	1·317
Ferrous oxide	9·164
Maganous oxide	0·329
Lime	23·334
Magnesia	11·612
Loss on ignition	0·174
	100·026

The analysis shows that this is an aluminous lime-magnesia-iron pyroxene, and its composition and other characters seem to connect it with the variety sometimes called fassaite.

Examples of other varieties of pyroxene may be met with at almost any of the apatite mines. They vary much in colour, usually being of some shade of green or grey, but sometimes white or brown. Lower down the Ottawa, in the augmentation of Grenville, a beautiful lilac pyroxene occurs, the crystals of which are sometimes imbedded in a pale lemon-yellow scapolite.

Now and then crystals of large dimensions are obtained. One, for example, from the township of Templeton is eleven and a half inches in circumference, nine inches long, and weighs eight and one-third pounds. Large crystals have also been found on the sixth lot of the first range of Portland township, and a portion of one now in the museum of the Geological Survey weighs about twelve pounds. Some of them, though dull outwardly are glassy within, and of a pale bottle-green colour.

The simplest forms observed are crystals of sahlite showing the following combination : $\infty P \infty$. ∞P. [$\infty P \infty$]. $P\infty$. P. Other planes are, however, frequently present, and among them 2 P. 3 P.–P. and oP. Sometimes the crystals of sahlite are striated longitudinally, and they are often much flattened in the direction of the orthodiagonal. One, for example, having a width of an inch and eight-tenths, measured only seven-tenths of an inch in thickness ; another, an inch and a half wide, was five-eighths of an inch thick, while a third measured two and a quarter inches by eight-tenths of an inch—giving an average width of over two and a half times that of the thickness.

In the township of Templeton well crystallised pyroxene is often found in veins unaccompanied by apatite, for which mineral, however, it has frequently been mistaken. As affording a good example of this, a vein occurring on the twenty-fourth lot of the ninth range may be mentioned. Good crystals of more or less glassy, subtranslucent green pyroxene are here imbedded in a pale flesh coloured calcite. They vary in length from a couple of inches downwards, and are often well terminated at both ends. They are almost invariably flattened in the direction of the clino diagonial, and show the following planes: ∞ P. [∞ P∞]. ∞ P ∞ . P∞ . P. 2 P.-P. oP., and sometimes [2 P∞]. The specific gravity of a crystal was found to be 3·232. Scales of mica sometimes coat the crystals, or are enclosed in them.

On lot thirteen in the eighth range of Templeton a white to greyish-white or greenish-white pyroxene occurs, small quantities of which were at one time mined under the supposition that the mineral was apatite. The crystals exhibit the same planes as those just described, but are less frequently flattened in the direction of the clinopinacoid.

The enclosure of mica in pyroxene crystals, which has already been alluded to, may frequently be observed, and in some instances the scales or crystals of mica may be seen to be more or less symmetrically arranged with reference to the planes of the pyroxene. On the seventeenth lot of the ninth range of Templeton large crystals were observed, showing a central portion of dark green pyroxene surrounded by a zone of minute scales of mica, while the outer portion of the crystal was pale green pyroxene. Other inclusions also are common, and among them calcite, apatite and orthoclase. Not infrequently also pyroxene crystals are rounded as if by the action of some solvent, but this is much less common than in the case of apatite. Sometimes they have been cracked or broken in two, and the spaces between the pieces filled up with calcite, apatite, or some other mineral. In one case, a crystal four inches in diameter was observed which had been fractured and re-cemented with apatite.

The most interesting peculiarity observed, however, is the tendency which the pyroxene in some localities exhibits to become altered into a kind of uralite. This name was long ago given by Gustav Rose to crystals possessing the form of pyroxene but cleavage and other characters of hornblende, and first observed by him in certain rocks from the Urals, which he termed uralite porphyries. The larger crystals were found to frequently contain a kernel of pyroxene, which in the smaller ones had entirely disappeared. In the case of pyroxene from Arendal in Norway also, Rose observed a perfect transition from lustrous crystals showing no apparent trace of hornblende within to others with drusy surfaces, in which no trace of augite could be detected.*

Crystals of pyroxene from Traversella afford another example of a change of this kind. The unaltered crystals are described as transparent and glassy, but on being altered become opaque, and often assume a silky lustre. In this opaque portion fine fibres running parallel to the principal axis begin to be developed, and, as the change advances, distinctly recognizable individuals of hornblende are formed, also parallel to the principal axis and looking like actinolite.†

Of late years, by the aid of the microscope, it has been demonstrated that the development of uralite has taken place in many crystalline rocks, not only in Europe but on this side of the Atlantic. In the case of diabase, the change of this kind has been described by Rosenbusch as follows: ‡—"The alteration processes to which the augite of diabase is subject is one of most varied character. Ordinarily, they begin with the formation of a vertical fibrous structure. At the same time the fibres often take the form of well-defined uralite, and in this case the process commonly begins from the entire periphery of the augite, and proceeds thence towards the centre, in general more rapidly in the direction of the vertical axis than at right angles to it. So long, then, as the process is not wholly completed, there remain in the interior portions of augite with irregular outline. Less frequently, or rather only in exceptional cases, the formation of uralite does not begin along the whole circumference, but attacks only single narrow strips in a vertical direction, so that thin columns of augite and uralite, parallel to the vertical axis, alternate with one another. The uralite itself passes, on still fur-

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* Bischof, *Lehrbuch der Geologie*. 1864. pp. 623, 624.

† *Lehrbuch der Geologie*, Bischoff, 1851. p. 539.

‡ *Mikroskop. Physiogr. d. massigen Gesteine*. 1877. p. 330.

ther alteration of the rock into chlorite, and this finally into a mixture of brown iron ore, quartz and carbonates.*"

The above facts have been cited because of interest in connection with what now follows concerning the alteration of certain pyroxenes in the apatite region of Quebec. The best examples were observed at the mines of Mr. Breckon, on the twenty-third lot of the thirteenth range of Templeton, where crystals have been obtained showing perfectly the transition from pyroxene to what may be called uralite. The crystals are mostly flattened in the direction of the orthodiagonal, and while some of them are apparently quite unaltered, others have been converted into hornblende for a greater or less depth from the surface; others, again, are entirely changed to hornblende, and show no trace of pyroxene even when sliced and examined microscopically. In the first stage of alteration the pyroxene, which in its original condition is glassy and of a grey color, becomes more or less dull and greenish or greyish-white, still, however, retaining the cleavage of pyroxene. In this pale portion acicular prisms of green hornblende begin to be developed, gradually increasing until in some cases, all trace of pyroxene is obliterated. The change appears to have always begun at the surface of the crystals, extending inwards more rapidly in some parts of the crystals than in others, but although the hornblende prisms at the surface appear to be mostly parallel with the principal axis, within they are seen to run in every direction, or in some cases to be arranged in radiating groups. Intermingled with the hornblende prisms a little calcite occurs in places.

Even when the crystals have been entirely changed to hornblende the pyroxene angles remain perfectly distinct, and one crystal with terminal planes shows the following combination: ∞ P ∞. ∞ P. [∞ P ∞]. P ∞ . – P. 2 P. The crystal is an inch and seven-eighths wide and a little over half an inch thick. The remaining portion of another crystal, which has lost its terminal planes, is three inches wide and an inch thick, and apparently wholly uralite. The crystal which supplied the material for the following analyses was about an inch and three-quarters wide and an inch thick. The centre consisted of glassy grey pyroxene, surrounded, however, by the dull and pale material described

* For other interesting details concerning uralite see Zirkel. *Mik. Beschaff. d. Min. u. Gest.* p. 178. Also Rosenbusch, *Mik. Physiog. d. Min.*, p. 316.

above, and this was surrounded in turn by an aggregation of hornblende prisms. These three portions may be called respectively A., B. and C. A. resembled in appearance much of the ordinary pyroxene of the region, from which also it probably does not differ much in composition. The specific gravity was found to be 3·181, and it gave on analysis the following results:

A.

Silica	50·868
Alumina	4·568
Ferric oxide	0·970
Ferrous oxide	1·963
Manganous oxide	0·148
Lime	24·438
Magnesia	15·372
Potash	0·497
Soda	0·218
Loss on ignition	1·439
	100·481

This is the composition of an aluminous diopside or malacolite, and, except in the larger proportion of iron, resembles that of pyroxene from Grenville and Bathurst.* The following analysis of B., the white portion of the crystal, shows that, chemically, no great amount of change had taken place. The specific gravity (3·205) was also about the same as that of A:—

B.

Silica	50·898
Alumina	4·825
Ferric oxide	1·741
Ferrous oxide	1·358
Manganous oxide	0·152
Lime	24·392
Magnesia	15·268
Potash	0·150
Soda	0·076
Loss on ignition	1·200
	100·060

It will be observed that although the total amount of iron in A. and B. is almost identical, more of it exists as ferric oxide in B. than in A. The quantity of alkalies is also only about one-third of the amount found in A.

* See analysis, Report of Progress, 1874-75, p. 302, and Geology of Canada, 1863, p. 467.

If now we pass to C., the uralitic portion of the crystal, the changes are much more striking, as will be seen from the following analysis:

C.

Silica	52·823
Alumina	3·215
Ferric oxide	2·067
Ferrous oxide	2·709
Manganous oxide	0·276
Lime	15·389
Magnesia	19·042
Potash	0·686
Soda	0·898
Loss on ignition	2·403
	99·508

The specific gravity in this case was only 3.003. Comparing C. with A. and B. we find that the lime is diminished by about nine per cent., while there is a gain of about four and a-half per cent. of magnesia. The ratio of loss and gain, however, is not that of the molecular weights of lime and magnesia; that is to say, for a molecule of lime lost a molecule of magnesia has not been gained. A portion of lime has been lost without its place being taken by magnesia. At the same time there is a slight increase of silica relatively to the other constituents, and, as would be expected, a decrease in density.

It is well known that pyroxene commonly contains more lime and less magnesia than hornblende, and in the present case loss of lime and gain of magnesia would appear to be the principal cause determining the change to hornblende. The larger proportion of alkalies in the uraltic or hornblendic proportion of the crystal is also worthy of note, because hornblende is commonly richer in alkalies than pyroxene. On the other hand, it is interesting to observe that there is less alumina in the hornblendic product than in the original pyroxene, for, as a rule, hornblende is apt to contain more alumina than pyroxene. This subject has recently been discussed by Mr. G. W. Hawes in his valuable report on the mineralogy and lithology of New Hampshire. He there gives some interesting analyses to illustrate the differences in the composition of pyroxene and hornblende, and seems to regard preponderance of alumina as the principal cause determining the formation of the latter species. At the same time, however, he does not lose sight of the fact that pyroxene usually contains more lime and less alkalies than hornblende.

III. ON THE OCCURRENCE OF OLIVINE IN CANADA.

The occurrence of olivine in the eruptive rocks of Rougemont, Montarville and Mount Royal, as well as in a doleritic dyke cutting the Hudson River formation at St. Hyacinth, and in the dolomitic conglomerate or breccia of St. Helen's Island, near Montreal, was described by Dr. Hunt many years ago. and an analysis of that from Montarville given. Recently it has been found in a number of other localities, and a few facts concerning its occurrence at some of these are of sufficient interest to be given here.

Owing to the difficulty of navigating the Ottawa River below the railway bridge at Ste. Anne's during the time of low water, communication with a deeper channel than the one ordinarily followed was deemed necessary, and was finally effected by cutting across a ridge of rock in the bed of the river. Coffer-dams were built enclosing the required area, and when the water was pumped out an excellent opportunity was afforded of seeing the bottom of the river. The rocks exposed were sandstones and conglomerates of the Potsdam formation, striking nearly east and west and dipping to the south $\angle 3\frac{1}{2}^{\circ}-4^{\circ}$. Traversing these beds with a course of N. 20° W., a vertical dyke about three feet thick was found. It consisted of a rather fine grained ground mass holding large plates of mica sometimes an inch or more across, irregular masses and occasionally large crystals of black augite, and angular masses of olivine occasionally more than an inch in diameter. The last-named mineral gives the rock a very striking appearance, as much of it is of a bright red colour. An analysis of this red olivine gives the following results:—

Silica	38·560
Magnesia	44·369
Ferric oxide	1·361
Ferrous oxide	12·649
Manganous oxide*	0·112
Water (ign.)	2·914
	99·965

It is, therefore, a variety with much less iron than that from Montarville, which, according to Dr. Hunt's analysis, contains—Silica 39·17, ferrous oxide 22.54, magnesia 39·68 = 99·39.

When thin sections of the olivine from Ste. Anne's are examined with the microscope, the usual fissured or cracked appear-

* With a little oxide of cobalt.

ance is seen. Along some of the cracks an alteration to serpentine has taken place, while along others a little red oxide of iron is visible. Although the amount of this peroxide is small as shown both by the microscope and by analysis, it is nevertheless, evidently the cause of the general red colour which the mineral has assumed.

Another locality in which olivine has recently been found is a short distance to the south-east of Mount Albert, just south of the south second fork of the Ste. Anne River, Quebec. The explorations of Mr. Richardson during the past season have shown that it there forms important rock-masses close to the serpentines of Mount Albert, which have evidently been produced by the alteration of the olivine. A specimen of the rock collected by Mr. Richardson is fine-granular, slightly friable, and pale yellowish to greyish-green in colour. It shows a few minute black grains, probably of chromite, and rarely a little of a fibrous mineral which resembles enstatite. Altogether, the rock looks remarkably like one variety of that from North Carolina, which was many years ago described by Genth, and regarded by him as the source of the serpentine and talc of the same region.*

. . . .

The origin of such olivine rocks as those of Carolina and Mount Albert is a difficult and disputed question, but one which still remains, whether we believe that the serpentines which accompany them where derived from them or not. In opposition to the view that they owe their origin to chemical precipitation, Clarence King suggests that they may represent accumulations of olivine sands like those now occuring on the shores of the Hawaiian Islands.† Whether such accumulations did take place in the earlier geological formations we do not know, but there is certainly nothing unreasonable or unlikely in the view that magnesian precepitates may then, as in later times, have been formed and subsequently altered to olivine.

A thin section of the olivine rock or dunite from near Mount Albert, when examined with the microscope, presents the appearance shown in Fig. 1 *a*. It is seen to consist almost entirely of granular olivine, with occasional black grains of chromic iron. Owing to an alternation of layers with finer and coarser texture,

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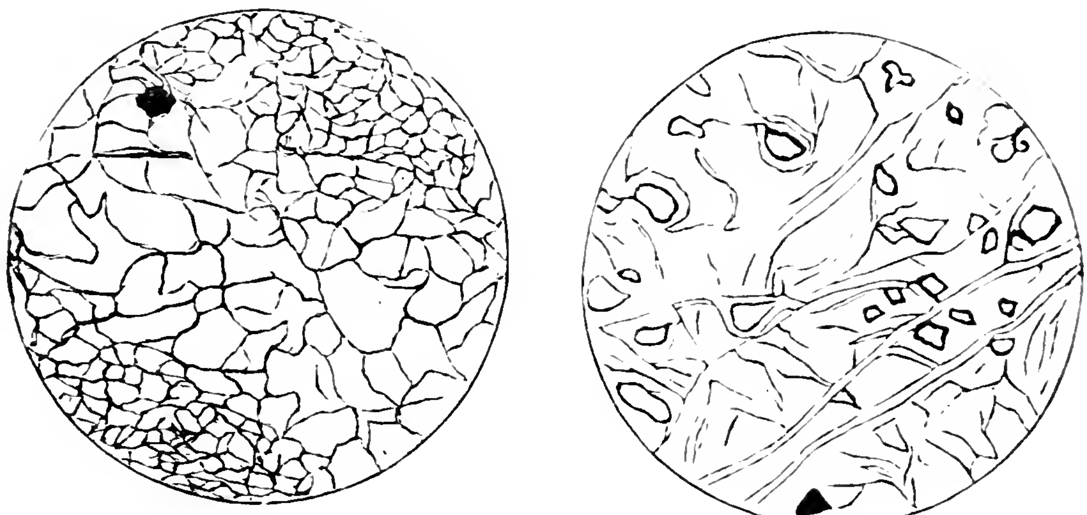
* *American Journal of Science*, Vol. XXXIII.; 1862. p. 199.

† United States Geological Exploration of the Fortieth Parallel. Vol. I., p. 117.

it shows a more or less banded structure. As observed above, an enstatite-like mineral may occasionally be seen in the hand specimen, but none of it happened to occur in the portion sliced.

Fig. 1.



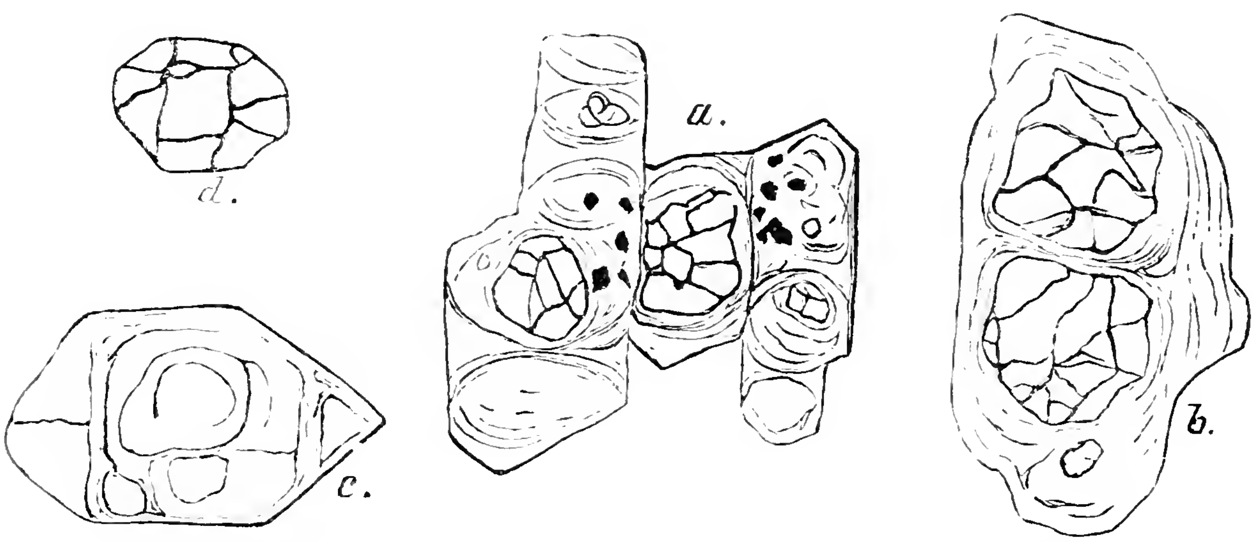
a b

Fig. 1 *b* is drawn from a section of one of the so-called serpentines occurring near the dunite. Its relation to the latter is evident, for it still contains numerous grains of unaltered olivine. In some specimens the change has not advanced so far as here, but in other cases the olivine has almost, if not entirely, disappeared. The chromite, however, always remains.

Another example of the occurrence of olivine is to be found in the case of a dark grey dolerite occurring near South Lake, in Antigonish County, Nova Scotia. When a section of the rock is examined with the microscope, it is seen to consist of a beautifully banded triclinic feldspar, brownish augite, magnetite, and very numerous irregular grains, or occasionally rude crystals, of olivine. The olivine resembles that sometimes seen in gabbro. It is traversed by the usual cracks or rifts, which in this case appear very broad and black, and also contains great quantities of black and opaque microlites, which are probably magnetite, and which are sometimes so abundant as to render the mineral almost opaque. Some of them are arranged in parallel rod-like shapes, while others occasionally assume star-like or other more or less symmetrical forms.

Olivine has also been detected in several of the eruptive rocks of British Columbia. One of these, of Tertiary age, from Kamloops, affords most beautiful examples of the alteration of olivine to serpentine. It is massive, rather fine-grained, and of a very dark olive-green colour. The examination of a slide with the microscope shows that originally the rock must have consisted of crystals and grains of olivine, augite (mostly in crystals) and a small proportion of plagioclase feldspar and magnetite. But while the augite mostly remains fresh, a large part of the olivine, which appears to be the most abundant constituent of the rock, has been altered to serpentine. Most of the olivine crystals and grains retain a nucleus of the unaltered mineral, showing the characteristic rifts, and the outlines of many crystals which are partly or entirely converted into serpentine are still perfectly sharp. In the accompanying figure (Fig. 2) *a* represents a group of crystals which are mainly composed of serpentine, but show nuclei of olivine and a few opaque grains probably of magnetite; *b* is an irregular mass also partly changed to serpentine; *c* represents a crystal which has been entirely converted into serpentine; while *d* is an almost perfectly fresh crystal of olivine.

Fig. 2.



On further alteration such a rock might be almost entirely converted into serpentine. Such a change has been observed elsewhere, as, for example, in the case of many of the Wurtemberg basalts, which are said to be "little more than serpentine rocks containing some magnetite, since the olivine and augite which composed the basalt are changed into serpentine."

In this country we have other examples than those already given of the production of serpentines by the alteration of other rocks. That such is the origin of many of the serpentines of the Eastern Townships there can be little doubt. The fact of their being commonly chromiferous suggests that at least they may have been derived from such peridotic rocks as lherzolite, dunite, olivine-gabbro, &c.

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THE HISTORY OF SOME PRE-CAMBRIAN ROCKS IN AMERICA AND EUROPE.

BY T. STERRY HUNT, LL.D., F.R.S.

(Read before the American Association for the Advancement of Science, at Saratoga, September 1, 1879.)

I. INTRODUCTION.

One of the earliest distinctions in modern geology was that between the crystalline or so-called Primary strata, and those which are found in many cases to have been deposited upon them, and being in part made up of sediments derived from the disintegration of these, were designated Transition and Secondary rocks. While the past forty years have seen great progress in our knowledge of these younger rocks, and while their stratigraphy, the conditions of their deposition, and their geographical distribution and variations have been carefully investigated, the study of the older rocks has been comparatively neglected. This has been due in part to the inherent difficulties of the subject, arising from the general absence of organic remains, and from the highly disturbed condition of the older strata, but in a greater measure, perhaps, to certain theoretical views respecting the stratified crystalline rocks. In fact, the unlike teachings of two different and opposed schools lead to the common conclusion that the geognostical study of these rocks is unprofitable.

The first of these schools maintains that the rocks in question are, in great part at least, not subordinated to the same structural laws as the uncrystalline formations, but are portions of the original crust of the earth, and that their architecture is due not to aqueous deposition and subsequent mechanical movements, but rather to agencies at work in a cooling igneous mass. The igneous origin of gneisses, petrosilex-porphyries, diorites, serpentines, and even of magnetic and specular iron-ores was held and taught almost universally by our geologists a generation since, and has still its avowed partizans; some maintaining that these various crystalline rocks are portions of the first-formed crust of the planet, while others imagine them to be volcanic matters extravasated at more recent date; in either case however, more or less modified by supposed metasomatic processes. By the term metasomatosis are conveniently designated those changes which are not simply internal (diagenesis), but are effected from without,—as a result of which the chemical elements of the original rock are supposed to be either wholly or in part replaced by others from external sources (epigenesis).

The other school, to which allusion has been made, and which, not less than the preceding, has helped to discourage, in the writer's opinion, the intelligent geognostical study of the crystalline stratiform rocks, is that which believes them to be, in great part at least, the result of chemical changes, often metasomatic in their nature, which have been effected in paleozoic and more recent sedimentary beds, obliterating their organic remains, and transforming them into crystalline strata. According to this view, feldspathic, hornblendic, and micaceous stratiform crystalline rocks having similar mineralogical and lithological characters, may belong to widely separated geological periods,—while the same geological series may, in one part of its distribution, consist of uncrystalline silicious, calcareous, and argillaceous fossiliferous sediments, and in another locality, not far remote, be found, as the result of subsequent changes effected in these strata, transformed into gneiss, hornblende-schist or mica-shist, by what is vaguely designated as metamorphism.

The recent history of geology abounds in striking illustrations of the fact that in a great number of cases these views have been based on misconceptions in stratigraphy, and without entering into the discussion of the question, it may be said that, in the writer's opinion, careful stratigraphical study will, in all cases, suffice to show the error, both of the plutonic and the metamorphic hypotheses of the origin of crystalline rocks. The former is supported chiefly by the lithological resemblances between certain stratified and unstratified rocks, and by the appearances of stratification occasionally found in these; while the latter is sustained by the analogies offered in cases of local hydro-thermal action on sediments, and by the resemblances which recomposed materials frequently offer to their parent crystalline rocks. It is here maintained that the great formations of stratiform crystalline feldspathic, hornblendic and micaceous rocks, which, in various parts of the world, have been alternately described as plutonic masses, and as metamorphosed paleozoic, mesozoic or cenozoic strata are, in all cases, neptunean rocks, pre-Cambrian or pre-Silurian in age, and that we know of no uncrystalline sediments which are their stratigraphical equivalents.

We have then before us two schools, the one maintaining the secondary origin of a great, and, by them, undefined portion of the crystalline stratiform rocks, while assigning to certain older (pre-Cambrian) crystalline rocks (of which they admit the existence), either a neptunean or a plutonic origin. The other, or plutonist school, while asserting the plutonic derivation of the greater part of the crystalline formations, accepts, to some extent also, the notion of secondary and neptunean metamorphic schists. It is believed that the above concise statements cover the ground held by the hitherto prevailing neptunean and plutonist schools, neither of which, it is maintained, expresses correctly the present state of our knowledge. In opposition to both of these are the views taught for the last twenty years by the writer, and now accepted by many geologists, which may be thus defined:—

1*st*. All gneisses, petrosilexes, hornblendic and micaceous schists,* olivines, serpentines, and in short, all silicated crystalline stratified rocks, are of neptunean origin, and are not primarily due to metamorphosis or to metasomatosis either of ordinary aqueous sediments or of volcanic materials.

2*d*. The chemical and mechanical conditions under which these rocks were deposited and crystallized, whether in shallow waters, or in abyssal depths (where pressure greatly influences chemical

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* It is a question how far the origin of such crystalline aluminous silicates as muscovite, margarodite, damourite, pyrophyllite, kyanite, fibrolite and andalusite is to be sought in a process of diagenesis in ordinary aqueous sediments holding the ruins of more or less completely decayed feldspars. Other aluminous rock-forming silicates, such as chlorites and magnesian micas, are however connected, through aluminiferous amphiboles, with the non-aluminous magnesian silicates, and to all of these various magnesian minerals a very different origin must be ascribed.

affinities) have not been reproduced to any great extent since the beginning of paleozoic time.

3*d*. The eruptive rocks, or at least a large part of them, are softened and displaced portions of these ancient neptunean rocks, of which they retain many of the mineralogical and lithological characters.

II. The History of pre-Cambrian Rocks in America.

Coming now to the history of our knowledge of American crystalline rocks, we find that the lithological characters of the Primary gneissic formation of northern New York were known to Maclure in 1817, and were clearly defined in 1832 by Eaton, who, under the name of the Macomb Mountains, described what have since been called the Adirondacks, and moreover distinguished them from the Primary rocks of New England. Emmons, in 1842, added much to our lithological knowledge of the crystalline rocks of northern New York, but regarded the gneisses, with their associated limestones, serpentines and iron-ores as all of plutonic origin. Nuttall, who had previously studied the similar rocks in the Highlands of southern New York and New Jersey, had however maintained, as early as 1822, that these had resulted from an alteration of the adjacent paleozoic graywackes and limestones, into which he supposed them to graduate. This view was, at the time, opposed by Vanuxem and Keating, but was again set forth in 1843, by Mather, who while admitting the existence of an older or Primary series of crystalline rocks, conceived a great part of these rocks in southern New York to be altered paleozoic, and distinguished them as Metamorphic rocks. To this latter class he referred all the crystalline stratified rocks of New England, and ended by doubting whether a great part of what he had described as Primary was not to be included in his Metamorphic class. The subsequent labors of Kitchell and of Cooke have however clearly established the views of Vanuxem and Keating as to the Primary age alike of the gneisses and the crystalline limestones of the Highlands.

The similar gneissic series in Canada, which was known to Bigsby and to Eaton as an extension of that of northern New York, was noticed by Murray in 1843, and by Logan in 1847, as pre-paleozoic, though apparently of sedimentary origin, and hence, according to them, entitled to be called Metamorphic rather than Primary. It was described by Logan in 1847, as consisting of a lower group of hornblendic gneisses without limestones, and an upper group of similar gneisses, distinguished by interstratified crystalline limestones.

These rocks were found by Logan and by Murray to be overlaid, both on Lake Superior and in the valley of the upper Ottawa, by a series consisting of chloritic and epidotic schists, with bedded greenstones, and with conglomerates holding pebbles derived from the ancient gneiss below. The same overlying series had, as early as 1824, been described by Bigsby on Lake Superior, and by him distinguished from the Primary and classed with Transition rocks.

Labradoritic and hypersthenic rocks like those previously described by Emmons in the Primary region of northern New York, were, in 1853 and 1854, discovered and carefully studied in the Laurentide hills to the north of Montreal, when they were described as being gneissoid in structure, and as interstratified with true gneisses and with crystalline limestones. In 1854, the writer, in concert with Logan, proposed for the ancient crystalline rocks of the Laurentide Mountains, including the lower and upper gneissic groups already mentioned, and the succeeding labradoritic rocks (but excluding the chloritic and greenstone series), the name of Laurentian. In an essay by the writer, in 1855, the oldest gneisses of Scotland and Scandinavia were, on lithological and on stratigraphical grounds, referred to the Laurentian series, and at the same time the name of Huronian was proposed for the chloritic and greenstone series, which had been shown to overlie unconformably the Laurentian in Canada.

Previous to this, in 1851, Foster and Whitney had described the Laurentian and Huronian rocks of Lake Superior as constituting one Azoic system of Metamorphic rocks, with granites, porphyries and iron-ores of igneous origin ; and in 1857, Whitney attacked the two-fold division adopted by the Canadian geological survey, maintaining that the stratified crystalline rocks of the region belong to a single series, with a granitic nucleus. The observations of Kimball in 1865, and the later studies of Credner, of Brooks and Pumpelly, and of Irving, have, however, all confirmed the views of the Canadian survey as to the relations of the Laurentian and Huronian in this region.

The primary age of the Highlands of southern New York, and their extension in what is called the South Mountain, as far as the Schuylkill, was now unquestioned, but the crystalline rocks to the east of this range, while regarded by Eaton and by Emmons, as also forming a part of the Primary, were, by Mather, as we have already seen, supposed to be altered paleozoic strata. These rocks in New England, with the exception of the quartzites and limestones of the Taconic range, were by him assigned to a horizon above the Trenton limestone of the New York system, and portions of them were conjectured by other geologists, who adopted and extended the views of Mather, to be of Devonian age.

The characteristic crystalline schists of New England and southeastern New York, passing beneath the Mesozoic of New Jersey, re-appear in southeastern Pennsylvania, where they were studied and finally described by H. D. Rogers in 1858. According to him, these crystalline schists, while resting unconformably upon an ancient (Hypozoic) gneissic system, were themselves more ancient than the Scolithus-sandstone, which he regarded as the equivalent of the Potsdam. While he supposed these newer crystalline schists, called by him Azoic, to be connected stratigraphically with the base of the Paleozoic series, he nevertheless assigned them to a position below the base of the New York system; thus recognizing in Pennsylvania, beneath this horizon, two unconformable groups of crystalline rocks, corresponding stratigraphically as well as lithologically, with the Laurentian and the Huronian of the Lake Superior region.

The existence among these newer crystalline schists of Pennsylvania, of a series distinct from the Huronian, and representing the White Mountain or Montalban rocks (the Philadelphia and Manhattan gneissic group), had not been then recognized. Rogers at this time taught the igneous origin of the magnetic iron ores, the quartz-veins, the serpentines and their associated greenstones in this region. The belief entertained by Rogers of an intimate connection between his upper or Azoic series and the Paleozoic, had its origin, apparently. in the fact of the existence in this region of still another and a newer crystalline series, the Lower Taconic of Emmons, or the Itacolumite group of Lieber, which I have designated Taconian, and propose to consider in detail in a future paper. In it are included the iron-ores of Reading, Cornwall and Dillsburg, in Pennsylvania.

The views of H. D. Rogers with regard to the crystalline schists of the Atlantic belt were thus, in effect, if not in terms, a return to those held by Eaton and by Emmons, but were in direct opposition to that maintained by Mather, which had been adopted by Logan, and by the present writer. The belt of micaceous, chloritic, talcose and epidotic schists, with greenstones and serpentines, the extension of a part of the Azoic of Rogers, which, through western New England, is traced into Canada, (where it has been known as the Green Mountain range), was previous to 1862 called by the geological survey of Canada, Altered Hudson-River group. It was subsequently referred to the Upper Taconic of Emmons, to which Logan, at that date, gave the name of the Quebec group, assigning it, as had long before been done by Emmons (in 1846) to a horizon between the Potsdam and the Trenton of the New York system.

In 1862 and 1863 appeared, independently, two important papers bearing on the question before us as to the age of these rocks. The first of these was by Thomas Macfarlane, who, after a personal examination of the three regions, compared the Huronian of Lake Huron and the Green Mountain range of Canada, with portions of the Urschiefer or Primitive schists which, in Norway, intervene between the ancient gneisses and the oldest Paleozoic (Lower Cambrian) strata. The second paper was by Bigsby, who was, as we have seen, the earliest student of the Huronian in the northwest, pointing out that these rocks could not in any sense be called Cambrian, but were the equivalents of the Norwegian Urschiefer. The conclusions of Macfarlane were noticed in connection with the views of Keilhau on these rocks of Norway in "The Geology of Canada" in 1863, with farther comparisons between the New England crystalline schists and the Huronian, but official reasons then, and for some years after, prevented the writer from expressing any dissent from the views of the director of the geological survey of Canada.

Meanwhile, the existence of an equivalent series of crystalline schists was being made known in southern New Brunswick, where they were described by G. F. Matthews in 1863, under the name Coldbrook group, which included a lower and an upper division. In a joint report of Matthews and Bailey in 1865, these rocks were declared to be overlaid unconformably by the slates in which Hartt had made known a Lower Cambrian (Menevian) fauna, and were compared with the Huronian of Canada. The lower division of the Coldbrook was then described as including a large amount of pink feldspathic quartzite and of bluish and reddish porphyritic slates. In the same report was described, under the name of the Bloomsbury group, a series lithologically similar to the Coldbrook, but apparently resting on the Menevian, and overlaid by fossiliferous Upper Devonian beds, into which it was supposed to graduate. The Bloomsbury group was therefore regarded as altered Upper Devonian, and its similarity to the pre-Cambrian Coldbrook was explained by supposing both groups to consist in large part of volcanic rocks.

In 1869 and 1870, however, the writer, in company with the gentlemen just named, devoted many weeks to a careful study of these rocks in southern New Brunswick, when it was made apparent that the Bloomsbury group was but a repetition of the Coldbrook on the opposite side of a closely folded synclinal holding Menevian sediments. These two areas of pre-Cambrian rocks were accordingly described by Messrs. Matthews and Bailey in their report to the geological survey of Canada in 1871, as Huronian, in which were also included the similar crystalline rocks belonging to two other areas, which had been previously described by the same observers under the names of the Kingston and Coastal groups, and by them regarded as respectively altered Silurian and Devonian.

After studying the Huronian rocks in southern New Brunswick, and their continuation along the eastern coast of New England, especially in Massachusetts (where, also, they are overlaid by Menevian sediments). the writer in 1870, announced his conclusion that the crystalline schists of these regions are lithologically and stratigraphically equivalent to those of the Green Mountain range of western New England and eastern Canada. These, he further declared, in 1871, to be a prolongation of the newer crystalline or Azoic schists of Rogers in Pennsylvania, and the equivalents of the Huronian of the northwest. The pre-Cambrian age of these crystalline schists in eastern Canada has now been clearly proved by the presence of their fragments in the fossiliferous Cambrian strata in many localities along the northwestern border of the Green Mountain belt, and farther by the recent stratigraphical studies of Selwyn, as announced by him in 1878.

In close association with these Huronian strata in eastern Massachusetts is found a great development of petrosilex rocks, generally either jaspery or porphyritic in character, and sometimes fissile, which, by Edward Hitchcock were regarded as igneous. These were found to be identical with the rocks designated by Matthews and Bailey, feldspathic quartzites and siliceous and porphyritic slates, which form the chief part of the Lower Coldbrook or inferior division of the Huronian series in New Brunswick. The petrosilexes of Massachusetts were, after careful examination by the writer, described by him in 1870, and in 1871, as indigenous stratified rocks forming a part of the Huronian series. He subsequently, in 1871, studied the similar rocks in south-eastern Missouri, and, in 1872, on the north shore of Lake Superior, but was unable to find them in the Green Mountain belt, or in its southward continuation, until, in 1875, he detected them occupying a considerable area in the South Mountain range in southern Pennsylvania. The stratified petrosilex rocks of all these regions were described in a communication to this Association, in 1876, as apparently corresponding to the *hälleflinta* rocks of Sweden, and, having in view their stratigraphical position both in that country and in New Brunswick, they were then "provisionally referred" "to a position near the base of the Huronian series." Their absence in the Huronian belt in western New England, and in the province of Quebec, as well as at several observed points of contact between Laurentian and the well-defined Huronian in the nothwest, led to the suspicion that these hälleflintas might belong to an intermediate series.

C. H. Hitchcock has pointed out that the characteristic Huronian rocks do not form the higher parts of the Green Mountain range in Vermont, which he conceives to belong to an older gneissic series, a conclusion which the writer regards as premature. Hitchcock, however, in his final report on the geology of New Hampshire, in 1877, adopts the name of Huronian for the crystalline rocks of the Altered Quebec group of Logan, which makes up the chief part of the Green Mountain range in Quebec, is largely developed along it in Vermont, and appears in a parallel range farther east, which extends southward into New Hampshire. In his tabular view of the geognostical groups in this State, Hitchcock assigns to these rocks a thickness of over 12,000 feet, with the name of Upper Huronian; while he designates as Lower Huronian the petrosilex series of eastern Massachusetts, already noticed, where these rocks are of great, though undetermined, thickness. The similar petrosilex or hälleflinta rocks in Wisconsin, where they have lately been described by Irving as Huronian, have according to this observer, a thickness, in a single section, of 3,200 feet. They here sometimes become schistose, and are interbedded with unctuous schists, and rest in apparent conformity upon a great mass of quartzite. The general high inclination both of this series and of the typical Huronian, renders the determination of their thickness difficult. The maximum thickness of the Huronian (excluding the petro-silex series) to the south of Lake Superior, may, according to Major Brooks, exceed 12,000 feet, while the estimates of Credner and Murray, respectively, for this region, and for the north shore of Lake Huron, are 20,000 and 18,000 feet.

As regards the Laurentian, there exists a certain confusion of nomenclature which requires explanation. As originally described, it includes, as already said, a basal granitoid gneiss, without limestones, which the writer has elsewhere designated the Ottawa gneiss, and of which the thickness is necessarily uncertain. Succeeding this is the Grenville series of Logan, having for its base a great mass of crystalline limestone, and consisting in addition to this of gneisses, generally hornblendic, and quartzites, interstratified with similar limestones. To this series, as displayed north of the Ottawa, Logan assigned an aggregate thickness of over 17,000 feet, though the later measurements of Vennor, in the region south of the Ottawa, give to it a much greater volume. The geographical distribution of this limestone-bearing Grenville series gives probability to the suggestion of Vennor that it rests uncomformably upon the basal Ottawa gneiss.

Thes two divisions constitute what was designated by Logan, in his Geological Atlas, in 1865, the Lower Laurentian,—the name of Upper Laurentian or Labradorian being then, for the first time given by him to a series supposed to overlie unconformably the former, of which it had hitherto been regarded as constituting a part. This third division has already been referred to as characterized by the predominance of great bodies of gneissoid or granitoid rocks, composed chiefly of labradorite or related anorthic feldspars, and apparently identical with the norites of Scandinavia. With these basic rocks are interstratified crystalline limestones, quartzites and gneisses, all of which resemble those of the Grenville series. This upper group, for which the writer in 1871 proposed the name of Norian, was supposed by Logan to be not less than 10,000 feet thick.

For farther details of the history of these various groups of pre-Cambrian rocks, and their distribution in North America, the reader is referred to a volume published in 1878 by the Second Geological Survey of Pennsylvania, being Part I of the writer's report on Azoic Rocks, intended as an historical introduction to the subject.

III.—The History of Pre-Cambrian Rocks in Great Britain.

In an address before this Association in 1871, in which the writer maintained the Huronian age of a portion of the crystalline schists of New England and Quebec, he further expressed the opinion, based in part upon his examinations at Holyhead in 1867, and in part upon the study of collections in London, that certain crystalline schists in North Wales would be found to belong to the Huronian series. The rocks in question were by Sedgwick, in 1838, separated from the base of the Cambrian, as belonging to an older series, but were subsequently, by Delabeche, Murchison and Ramsay, described and mapped as altered Cambrian strata, with associated intrusive syenites and feldspar-porphyries.

In South Wales, at St. David's in Pembrokeshire, is another area of crystalline rocks, which the geological survey of Great Britain had mapped as intrusive syenite, granite and felstone (petrosilex-porphyry) having Cambrian strata converted into crystalline schists on one side, and unaltered fossiliferous Cambrian beds on the other. So long ago as 1864, Messrs. Hicks and Salter were led to regard these granitoid and porphyritic rocks as pre-Cambrian, and in 1866 concluded that they were not eruptive but stratified crystalline or metamorphic rocks. After farther study, Hicks, in connection with Harkness, published in 1867, additional proofs of the bedded character of these ancient crystalline rocks, and in 1877 the first named observer announced the conclusion that they belong to two distinct and unconformable series. Of these, the older consisted of the granitoid and porphyritic felstone rocks, and the younger of greenish crystalline schists, the so-called Altered Cambrian of the official geologists; both of these being overlaid by the undoubted Lower Cambrian (Harlech and Menevian) of the region, which holds their ruins in its conglomerates. To the lower of these pre-Cambrian groups, Hicks gave the name of Dimetian, and to the upper that of Pebidian. The last, with a measured thickness of 8000 feet, he supposed to be the equivalent of the

Huronian, and compared the Dimetian with the Upper Laurentian of Logan.

The similar crystalline rocks of North Wales, already noticed, were now studied by Professor T. McKenny Hughes of Cambridge, who described them in 1878. These include in Carnarvonshire and Anglesey the greenish crystalline schists which the writer in 1871 referred to the Huronian (pre-Cambrian of Sedgwick, and Altered Cambrian of the geological survey), certain granitoid rocks formerly described as intrusive syenite, and also a reddish feldspar-porphyry which forms two great ridges in Carnarvonshire. This latter was by Professor Sedgwick regarded as intrusive, and is moreover mapped as such by the geological survey, though described in Ramsay's memoir on the geology of North Wales as probably the result of an extreme metamorphism of the lower beds of the Cambrian. The pre-Cambrian age of all these rocks was clearly shown by Hughes, who however considered that the whole might belong to one great stratified series; while Hicks, from an examination of the same region, regarded them as identical with the Dimetian and Pebidian of South Wales.

Dr. Hicks continued his studies in both of these regions in 1878,—being at times accompanied by Dr. Torell of Sweden, Professor Hughes and Mr. Tawney of Cambridge, and the writer—and was led to conclude that beside the chloritic schists and greenstones (diorites) of the Pebidian, and the older granitoid and gneissic rocks, there exists, both in North and South Wales, a third independent and intermediate series, to which belong the stratified petrosilex or quartziferous porphyries already noticed. These are sometimes wanting at the base of the Pebidian, and at other times form masses some thousands of feet in thickness. At one locality, near St. David's, a great body of breccia or conglomerate, consisting of fragments of the petrosilex united by a crystalline dioritic cement, forms the base of the Pebidian. For this intermediate series, which constitutes the quartziferous-porphyry ridges of Carnarvonshire, Dr. Hicks and his friends proposed the name of Arvonia, from Arvonia the Roman name of the region.

This important conclusion was announed by Dr. Hicks at the meeting of the British Association for the Advancement of Science at Dublin, in August, 1878. The writer, previous to attending this meeting, had the good fortune to examine these various pre-Cambrian rocks in parts of Carnarvonshire and Anglesey with Messrs. Hicks, Torell and Tawney. He subsequently, in company with Dr. Hicks, visited the region in South Wales where these older rocks had been studied, and was enabled to satisfy himself of the correctness both of the observations and conclusions of Dr. Hicks, and of the complete parallelism in stratigraphy and in mineral composition between these pre-Cambrian rocks on the two sides of the Atlantic. It may here be mentioned that Dr. Torell, who, during his visit to America in 1876, had an opportunity of studying, with the writer, the petrosilexes of New England and Pennsylvania, which he regarded as identical with the hälleflinta of Sweden, at once recognized them in the Arvonian series of North Wales.

Of the many areas of these various pre-Cambrian rocks which the writer was enabled to examine in company with Dr. Hicks, may be mentioned the granitoid mass of Twt Hill in the town of Carnarvon, and the succeeding Arvonian to Port Dinorwic, followed, across the Menai strait, by the Pebidian on the island of Anglesey, near the Menai bridge. Farther on, the Pebidian was again met with near the railway station of Ty Croes, in the southwest part of the island, succeeded by a large body of Arvonian petrosilex, and a ridge of granitoid gneiss, fragments of which make up a breccia at the base of the Arvonian series. The Pebidian is again well displayed at Holyhead.

In South Wales, the similar rocks were examined by him at St. David's, where three small bands of an impure coarsely crystalline limestone are included in the Dimetian granitoid rock, which is here often exceedingly quartzose. It may be remarked that the Dimetian, as originally defined at this, its first recognized locality, included a great mass of Arvonian petrosilex, the two forming a ridge which extends for some miles in a northeast direction, flanked by Pebidian rocks, which are sometimes in contact with the one and sometimes with the other series. At Clegyr bridge was seen the base of the Pebidian, already mentioned as consisting of a conglomerate of Arvonian fragments. Another belt of the same crystalline rocks was also visited, a few miles to the eastward of the last, and not far from Haverfordwest, forming, according to Hicks, a ridge several miles in length and about a mile wide. Where seen, at Roch Castle, it was found to consist of Arvonian petrosilex, with some granitoid rock near by. The ridge is flanked on the northwest side by Pebidian and Cambrian, and on the southeast by Silurian strata, let down by a fault.

On the shore of Llyn Padarn, near the foot of Snowdon in North Wales, the porphyritic petrosilex of the Arvonian is again well displayed, while in contact with it, and at the base of the Llanberris (Lower Cambrian) slates, is a conglomerate made up almost wholly of the petrosilex. This locality was supposed by Prof. Ramsay and others to show that the petrosilex is the result of a metamorphosis of the lower portion of the Cambrian, the conglomerates being regarded as beds of passage. The writer, after a careful examination of the locality, agrees with Messrs. Hicks, Hughes and Bonney that there is no ground for such an opinion, but that the conglomerate marks the base of the Cambrian, which here reposes on Arvonian rocks, and is chiefly made up of their ruins. In like manner, according to Prof. Hughes, the Cambrian in other parts of this region includes beds made of the *débris* of adjacent granitoid rocks.

These petrosilex-conglomerates of Llyn Padarn are indistinguishable from those found at Marblehead and other localities near Boston, Massachusetts, which have been in like manner interpreted as evidences of the secondary origin of the adjacent petrosilex beds, into which they have been supposed to graduate. The writer has, however, always held, in opposition to this view, that these conglomerates are really newer rocks made up of the ruins of the ancient petrosilex. He has found similar petrosilex-conglomerates at various points on the Atlantic coast of New Brunswick, of Lower Cambrian, Silurian and Lower Carboniferous ages, all of which have, in their turn, been by others regarded as formed by the alteration of strata of these geological periods. The evidence now furnished in South Wales of still older (Huronian) beds of petrosilex-conglomerate should be noted by students of North-American geology. From observations near Boston, made by one of my former students, I have for some time suspected the existence of petrosilex conglomerates of Pre-Cambrian age.

To the eastward of the localities already mentioned in Wales, are some other small areas of crystalline rocks, including those of the Malverns, and the Wrekin and other hills in Shropshire, all of which appear as islands among Cambrian strata; also those of Charnwood Forest, in Leicestershire, which rise in like manner among Triassic rocks. The Wrekin, regarded by Murchison as a post-Cambrian intrusion, has been shown by Callaway to be unconformably overlaid by Lower Cambrian strata, and consists in part of bedded greenstones, and in part of banded reddish petrosilex-porphyries, closely resembling the Arvonian of North Wales and the corresponding rocks of North America. The geology of Charnwood has within the past two years been carefully studied by Messrs. Hill and Bonney. The ancient rocks of this region are in part crystalline schists (embracing in the opinion of Dr. Hicks and of the writer—who have seen collections of them—representatives both of the Pebidian and the Arvonian of Wales) and in part eruptive masses, including the granitic rocks of Mount Sorrel.

There is not, so far as known, in the British localities already mentioned, any representative either of the Taconian or Itacolumite group, or of the white micaceous gneisses with micaceous and hornblendic schists, which I have designated the Montalban series. I have, however, found the latter well displayed in Ireland, in the Dublin and Wicklow Hills. The probable presence both of this series and of the Huronian in the northwest of Ireland was pointed out by me in 1871. I have there lately seen the Huronian on Lough Foyle, and also in Scotland in various parts of Argyleshire and Perthshire, as along the Crinan Canal and in the vicinity of Loch Etive and Loch Awe. From collections sent me by Mr. James Thomson of Glasgow, it appears that both Huronian and Laurentian rocks occur in the island of Islay.

The crystalline schists of Charnwood offer, as was pointed out by Messrs. Hill and Bonney, many resemblances with parts of the Ardennian series of Dumont in France and Belgium. These, which have been in turn regarded as altered Devonian, Silurian and Lower Cambrian, were, as shown by Gosselet, islands of crystalline rock in the Devonian sea, and in one part include argillites with impressions of *Oldhamia* and an undetermined graptolite. These rocks have lately been described in detail in the admirable memoir of de la Vallée Poussin and Renard. The writer had the good fortune, in 1878, to visit this region, and in company with Gosselet and Renard to examine the section along the valley of the Meuse. The crystalline rocks here displayed greatly resemble those of the American Huronian, in which may be found most of the types described by the authors of the memoir just mentioned. It would be easy to extend farther this review of late advances made in the study of the ancient crystalline rocks, but the writer has preferred to confine himself to those regions which he has lately examined.

Conclusions.

1. The Pebidian of Hicks has both the lithological characters and the stratigraphical position of the Huronian of North America, to which he has already referred it.

2. The Arvonian is, in like manner, identical with the Hälleflinta group of Sweden and with the Petrosilex group of North America, which the writer had provisionally included in the lower part of the Huronian, and which Hitchcock subsequently called Lower Huronian. The fact that there is in Wales a stratigraphical break between it and the overlying Huronian, will help to explain the frequent absence of the Arvonian at the base of Huronian in many of its American localities.

3. The Dimetian, including the granitoid and gneissic rocks with limestone bands, so far as can be seen in the limited outcrops, is indistinguishable from parts of the Laurentian of North America. It was from a misconception that Dr. Hicks in 1878 provisionally referred the Dimetian to the Upper Laurentian—a name at one time used by the geological survey of Canada to designate the Norian series, which in some parts of North America overlies unconformably the Laurentian. Hicks at the same time designated as Lower Laurentian the gneiss of the Hebrides (Lewisian of Murchison), which he believed to be distinct from and older than the Dimetian. These two apparently correspond to the Ottawa and Grenville divisions of the proper Laurentian in Canada, and perhaps to the Bojian and Hercynian gneisses of Gümbel, in Bavaria.

[The following is a partial list of publications relating to the rocks noticed in part III. of this paper :

In the Quar. Jour. Geol. Soc. of London are the following papers on these rocks in Wales : Hicks, May, 1877, p. 230 ; Hicks & Davies, Feb. 1878, p. 147, and May 1878, p. 153 ; Hughes & Bonney, Feb. 1878, p. 137 ; Hicks & Davies, May 1879, p. 285 ; Hicks & Bonney, ibid, p. 295 ; Bonney, ibid, p. 309 ; Bonney & Houghton, ibid, p. 321 ; Hughes, Nov. 1879, p. 682 ; Maw, Aug. 1878, p. 764 ; also Hicks, rocks of Ross-shire, Nov. 1878, p. 811. Tawney, Older Rocks of St. Davids : Proc. Bristol Naturalists' Society, vol. II, part 2, p. 110.

On these rocks in Shropshire, in the same Journal, Allport, Aug. 1877, p. 449 ; Callaway, Nov. 1877, p. 653, and Aug. 1878, p. 754 ; Callaway & Bonney, Nov. 1879, p. 643.

On these rocks in Charnwood Forest, in the same Journal, Hill & Bonney, Nov. 1887, p. 753, and May, 1878, p. 199.

See farther, Hunt, Chemical and Geological Essays, pp. 34, 269, 270, 272, 278, 383; also his Azoic Rocks, part I (Second Geol. Survey of Penn., 1878), pp. 187, 188.

For the rocks of the Ardennes see Memoir sur les Roches dites Plutoniques, etc. (4to, pp. 264), by de la Vallée Poussin and Renard, from Memoires de l'Acad. Royale de la Belgique for 1876; Memoire sur la Comp. Minéralogique du Coticule, by Renard, from the same for 1877; and The Mineralogical and Microscopical Characters of the Belgian Whetstones, by Renard, Monthly Microscopical Journal for 1877, Vol. xvii. p. 269. Also Gosselet and Malaise, Terrain Silurian des Ardennes, Bull. Acad. Roy. de la Belgique (2) No. 7, 1868; Dewalque, Terrain Cambrien des Ardennes, Ann. Soc. Géol. de la Belgique, tom. I, p. 63; and farther, Hunt, Chem. and Geol. Essays, p. 270.]

Appendix.

Since the above paper was read the author has received (November, 1879) a private communication from Prof. L. W. Bailey, giving his latest results as to the pre-Cambrian rocks of southern New Brunswick, which confirm what has already been said about that region. Bailey separates the Huronian into a lower division, for which he reserves the name of Coldbrook, consisting chiefly of petrosilex rocks, and an upper division, the typical Huronian, called by him the Coastal group. He adds that there is between the two a marked physical break, which is indicated by a stratigraphical discordance, and by the presence in the lower part of the Coastal group of coarse conglomerates made up from the ruins of the Coldbrook or underlying division. This corresponds to the break between the similar Arvonian and Huronian in South Wales.

At the meeting of the British Association for the Advancement of Science at Sheffield in August, 1879, Dr. Hicks read a paper on the Classification of the British Pre-Cambrian Rocks, which is published in the Geological Magazine for October, 1879. He concludes that the Pebidian is "a group of enormous thickness, which is largely distributed over Great Britain, where it has a prevailing strike of N.N.E. and S.S.W., or from this to N.E. and S.W." In addition to the localities which we have already mentioned in Great Britain, he notes its occurrence in Shropshire and in Charnwood Forest, and also in the northwest of Scotland, where, as elsewhere, it enters largely into the Lower Cambrian conglomerates. The group is concisely described by him as consisting "for the most part of chloritic, talcose, feldspathic and micaceous schistose rocks, alternating with slaty and massive greenstones, dolomitic limestones, serpentines, lava-flows, porcellanites, breccias and conglomerates. It is also traversed frequently by dykes of granite, dolerite, etc."

The conglomerates at the base of the Huronian in Wales are largely make up of the masses derived from the Arvonian, with which "it is undoubtedly, at most of the points examined, unconformable." This Arvonian series, Hicks regards as identical with the great Hälleflinta group of the Swedish geologists and with the Petrosilex series which the writer has made known in America. In addition to the localities already mentioned of it in the British Isles, Hicks notes its occurrence in the Harlech Mountains and the Orkneys, and probably also in the Western Islands, and in the Grampians of Scotland. Its strike in the regions examined by him is generally about N. and S.

As regards the gneissic Dimetian group, the strike of which is N.W. and S.E., or from this to N. and S., Hicks adds to the localities in Wales, already noticed, its occurrence in the Malvern chain, especially in the Worcester Beacon, and cites Dr. Callaway as authority for its existence in Shropshire. Hicks further notes its presence in several points in the northwest Highlands of Scotland. From this series of light colored gneisses, often very quartzose, with limestone bands, he separates, as we have seen, under the name of Lewisian, proposed by Murchison for the ancient gneisses of Lewis and others of the Hebrides Isles, these, and similar reddish and dark-colored hornblendic gneisses which are found in parts of the Malvern chain, in the northwest of Ireland, and possibly also in Anglesey. This series, according to Hicks, is unconformably overlaid by the Dimetian, brecciated beds in which hold fragments of the older Lewisian gneiss. The strike in these older gneisses "is usually E. and W., or some point between that and N.W. and S.E."

Dr. Hicks concludes the above paper by remarking that the chief part of these ancient rocks in Great Britain "were until recently supposed to be either intrusive masses, or altered sediments belonging to tolerably recent times," and adds, "it is becoming more and more an acknowledged fact that the metamorphism of great groups of rocks does not take place so readily as was formerly supposed, but that some special conditions, such as do not appear to have prevailed over this area since pre-Cambrian times, were necessary to produce so great a result."

The reader in this connection is referred to the abstract of a memoir communicated by the writer to the British Association at Dublin in August, 1878, on The Origin and the Succession of the Crystalline Rocks of North America, which will be found in the Geological Magazine for that year (page 466), as well as in Nature, vol. xviii, page 443.

Montreal, February, 1880.

HITTITES IN AMERICA.

By John Campbell, M. A.

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Perhaps the most startling and important discovery ever made in comparative philology is that announced some time ago by Dr. Hyde Clarke in his "Khita and Khita-Peruvian Epoch." The Khita of the Egyptian and Assyrian inscriptions, whose records in Carchemish and in Asia Minor have recently been discovered by the Rev. Professor Sayce, are the Hittites of Bible Story, a large and powerful confederacy that ruled for a time the whole of Palestine, invaded and occupied for many years the Lower Egyptian Kingdom, and afterwards measured their strength with the Assyrian monarchs, as lords of Mesopotamia and Syria. As late as the reign of Jehoram, son of Ahab, they are mentioned in the book of Kings as a great and warlike people, and the Assyrian records furnish still later accounts of their hostilities. Then they disappear from the page of authentic history, and find mention in the legendary stories of the Mohammedan writers of Persia and neighboring countries, as inhabitants of Touran and allies of the Tartars and Chinese. Sadik Isfahani, the geographer, places Khita in the northern part of China; and Katai or Cathay, the name by which the Celestial Empire was known to Marco Polo, and to Europeans in general for a long period, is but a survival of the same ancient national designation. In the time of Strabo, the Cathaei of Cathaia were still in the vicinity of the Punjaub, from whence a portion of them may have passed to farther India, for Dr. Hyde Clarke says: "Kitaya too, or Indo-China may be only another form of Khita." There seems to be good evidence for believing that many of the Khita or Hittites of Mesopotamia and Syria, not being maritime peoples and unable therefore to maintain their independence by setting the sea between them and their Assyrian enemies, took refuge among the mountains of Armenia and the Caucasus. Thence, moving along the southern shore of the Caspian, they became the enemies of the Aryans, at first Persian, afterwards Indian, until, passing into the region of the Himalayas, they found a brief respite in Thibet. There they became the neighbors of the Chin or Chinese, with whom they are constantly associated in Persian legendary history. From this point the Khita divided and spread in two directions, the one southward to Khitaya or Indo-China, the other north-east towards the waters of the Amoor or Saghalien, in the Kathai of Mediæval times.

With these Khita Dr. Hyde Clarke has connected the Peruvians, making the Indo-Chinese peoples, the Burmese, Siamese, Peguans, Cambodians, Annamese and Kariens, the connecting link. He supposes, therefore, a passage of the Khita from the Indo-Chinese area by the Malay Archipelago and the Polynesian Islands to Peru, where he thinks settlement may have taken place so far back as from three to five thousand years ago. It may naturally be asked, however: "What do we know of the language, appearance, arts, etc., of the Khita?" and the answer is: "Very little." Of their language we have only a few proper names, like Khita-sar, Mara-sar, Kirep-sar, from which, as has been shown by the Rev. Professor Sayce, we may learn that the Khita were Turanian, inasmuch as the word *sar*, an Accadian term denoting king or chief in the nominative case, follows its genitive according to Turanian order. In regard to religion or mythology, we know also that their great divinity was Sheth or Ashtar. It is supposed that the Hamathite inscriptions are Hittite, with those in Carchemish and in Asia Minor; but, inasmuch as these are not yet deciphered, nothing is added to our knowledge from that source. In regard to the appearance of the Khita, authorities differ so widely that we are left in doubt as to whether they were bearded men, dressed in the Assyrian fashion, Tartars with pig-tails and mustaches, as they are depicted at Abusimbel, or beardless savages with breech clouts and scalp-locks. The solution of the problem may be that the Hittite confederacy embraced within it all these different features. From what source then has Dr. Hyde Clarke obtained materials for a comparison of the Khita with the Peruvian? That source is the Accad, or ancient language of the primitive inhabitants of Chaldea, vocabularies of which are preserved in Assyrian tablets, together with bilingual records and treatises. The Accadians were undoubtedly a Turanian people, the predecessors of the Semitic occupants of the Tigro-Euphrates basin, and their language bears a well defined Turanian stamp. Assyriologists generally refer it to the Ugrian family as kindred to the Lapp, Finn, Magyar, etc. Still the Accad differs from the other members of this family in its constructions. Like them, it employs postpositions and postpositional pronouns, and places the verb after its regimen. But, unlike these languages, it places the nominative before the genitive and the adjective after the noun, as do the Celtic dialects. In the postposition of the genitive, it also differs from the Khita language as indicated by its few remains. But the Khita *sar* is a thoroughly Accad word, and Ashtar, the god of the Khita, can be no other than Hasisadra of the Accadian mythology. Instead, therefore, of employing the term Accad, Dr. Hyde Clarke takes the word Khita as more comprehensive, being convinced of the essential unity of the Accadian and Hittite populations.

It is worthy of note, however, that the ancient rulers of Chaldea termed themselves "Kings of Sumer and Accad," and reference is constantly made to this double constitution of the monarchy, as important apparently as the later distinction between the Medes and Persians, as elements in one nationality. True there survives no Sumerian grammar or dictionary as distinguished from the Accadian, so that full license has been afforded to philologists to denote the language by either name, or to suppose that one of them, Sumer or Accad, was a Semitic dialect and the parent of the later Chaldean. From the double character of Accadian grammar, as partly Turanian and partly Semitic or Celtic, from the presence of a large number of purely Celtic words in the language alongside of others as purely Turanian, and from the very name Sumer itself as related to Kymri, with other facts which will come out in the sequel, I am compelled to the conclusion that Accad, as we possess it, is a compound language, in which Khita or Accad proper exists in union with Celtic or Sumerian, both as regards grammatical and verbal forms. As the Celtic connections of the Accad find illustration in America and elsewhere along the line of Khita migration, I subjoin a brief comparison of words in the two languages.

Accad (Sumerian).		Celtic (Cymric).		
		Erse.	*Gaelic.*	*Welsh.*
all	kak.	gac.	....	....
below	cit.	....	....	isod.
body	urus.	....	urra.	....
black	mi, amas.	....	....	much.
	dir.	....	dorch.	....
break	dub.	....	....	dofi.
build	duk.	....	tog.	....
burn	luga.	....	....	llosgi.
city	uru, eri.	(ker....*Armorican*)	....	caer.
	murub.	....	....	mamdref.
copper	zabar.	....	....	copr.
	urud.	....	....	elydn.
country	cur.	....	....	goror.
	lat.	....	....	gwlad.
cover	dak.	teigh.	....	....
cut	tar.	....	....	tori.
	khal.	....	....	cyllellu.
dawn	khur.	....	....	gwawr.
day	ud, utu.	....	....	dydd.
die, death	be, bat.	....	bas.	....
	durgu.	droch.	....	....
demon	telal.	....	....	ellyll.
descend	turi.	....	teirinn.	....
desire	sem.	caemh	....	....
dream	biru.	....	bruadar.	breudwydd.
eye	limta.	...	....	lhyyad.
	ud.	aedh.	....	....
end	dun.	....	dunadh.	....
father	ad.	....	....	tad.
family	tsil.	....	....	tylwyth.
	seslam.	....	....	cystlynan.
famine	sagar.	....	siocras.	....
fear	tum.	tim.	....	....
foundation	pin.	....	bun.	bonad.
ghost	gibil.	....	....	gwyll.
glory	impar.	...	....	ymfawrygu.
go	du.	....	....	dos.
hand	id.	....	....	adaf.
	gap.	cib.	....	....
have	tuk.	tog.	....	....
head	pir.	bar.	....	....
heaven	enum.	....	neamh.	....
hero	gudhu.	....	....	cadgun.
high	tal.	....	....	tal.
	annab.	....	inbhe	....
house	duku.	....	tigh.	....
image	lani.	....	....	llun.
insect	sadugucunu.	....	....	ednogyn.
kill	bat.	bath.	....	....
kindness	gam.	....	....	cymwynas.
king	ara.	aireach.	....	....
lift	aganateti.	....	....	cynydo.

Accad (Sumerian).		Celtic (Cymric).		
		Erse.	*Gaelic.*	*Welsh.*
long	puda.	....	fada.	....
man	khairu, karra.	....	cearn.	gur.
messenger, news	succal.	....	sgeul.	....
moon	acu, es.	....	esga.	....
	lid.	....	....	lleuad.
mountain	tal.	tula.	....	....
mouth	ca, gu.	....	....	ceg
multitude	caradin.	....	....	gwradd o ddynion.
	dugu.	dese	....	. ..
	khig.	....	....	haig.
nail	ebin.	....	....	ewin.
old	sakus.	saigheas.	....	....
perish	busus.	....	basaich.	....
point	gir.	....	....	cor.
	rum.	....	....	rim.
proclaim	gude.	....	....	cyhoeddi.
property	cuda.	....	cuid.	....
red	gusci.	....	....	coch.
repeat	ili.	....	....	ailadrodd.
rest	cus.	....	...	cws.
road	cas.	casan.	....	....
run	riati.	....	ruith.	rhedeg.
sea	ab.	....	aibheis.	....
seed	kul.	....	seol	hil
seize	tab.	....	....	(take) tybio.
servant	eri.	ara	....	....
sheep	ua.	oi	....	....
sick	tura.	....	....	drwg.
	pad.	....	bochd.	....
side	usur.	....	....	ochr.
soldier	erim.	....	....	arwron.
	mas.	amas.	....	....
sun	zal.	....	...	hual.
tribute	gun.	....	cain.	....
warrior	gurus.	....	curaidh.	...
water	a.	....	....	aw.
white	ukmu, sigunu.	....	....	can, gwyn.
	bar.	....	....	pur.
woman	dam.	....	....	dynes.
	rak, khiratu.	....	....	gwraig.

Traces of the Celtic as distinct as those which survive in the Accad vocabulary meet us again in a region that must have been largely subjected to Khita-Sumerian influences. When the Hittite invaders of Egypt were driven out by the powerful Pharaohs of the eighteenth dynasty, they did not all return to Palestine. Some seem to have passed far to the south, there becoming Nubians or Barabra; and a large body gradually spread from the Libyan border along the whole southern shore of the Mediterranean, where they were known as Libyans or Berbers. These extended as far as the Canary Islands, where they called themselves Guanches. Many writers have insisted upon the Celtic relationship of the Berbers and Guanches, and, in particular, M. E. Pégot Ogier in the book translated by Frances Locock under the name of "The Fortunate Isles." It must be confessed, however, that this writer, while asserting "that the Guanches may be put down as exclusively of Celtic origin," does not proceed to the proof of the statement, except by comparing a Guanche temple with similar Celtic remains at Carnac in Brittany. Megalithic structures of the same character have been found throughout the Berber area, such as that at Bless in Tunis, described by Frederick Catherwood in the Transactions of the American Ethnological Society. Jackson, in his account of travels in Barbary, gives special prominence to the Berber tribes who call themselves Zimuhr and Amor, whom he regards as descendants of Canaanitic Zemarites and Amorites. Of the former he says: "They are a fine race of men, well grown and good figures; they have a noble presence and their physiognomy resembles the Roman." Writing of the Amor, whom, on account of their bravery, the Sultan Muhamed called the English of Barbary, he says: "When the Sultan Muhamed began a campaign, he never entered the field without the warlike Ait Amor, who marched in the rear of the army; these people received no pay, but were satisfied with what plunder they could get after a battle; and accordingly, this principle stimulating them, they were always foremost in any contest, dispute or battle." The names Zimuhr and Amor, together with Gomera, that of one of the Canary Islands, tell strongly in favour of a Sumerian or Cymric connection of the Berbers. Sir Henry Rawlinson, in his Essay on the Alarodians of Herodotus, gives the name Burbur to the Accadians (? Sumerians), and, although the correctness of this is disputed by Professor Sayce, I am disposed to think that the veteran Assyriologist is right. It is at least a remarkable coincidence that links Sumerian Burbur and Zimuhr Berbers by a double nomenclature and without any intention on the part of Sir Henry Rawlinson so to unite the widely separated peoples. The grammar of the Berber has been studied by Mr. Newman and others, and has been denominated sub-Semitic, but anyone acquainted with the Celtic tongues knows that they also might be called sub-Semitic in character. The marking of inflexion by internal vowel changes, the paucity of tenses in the verb, and the postposition to the verb of the personal pronoun, are Semitic and not Indo-European. Now the two tenses of the Berber verb, the deriva tion of verbal forms from the imperative, the formation of the plural in nouns by changing the medial vowels or suffixing *n*, the use of *n* as a mark of the genitive and *ghi*, *ze*, *zigh* of the dative, with many other points of structure, are purely Celtic. Finally, when we turn to the Berber vocabulary, forms that find hardly any analogies outside of the Celtic tongues come to confirm the evidence for a Sumerian and Cymric origin. The following are a few of these:

	BERBER.	CELTIC.
bad	duny, *Shelluh.*	dona, *Gaelic.*
	dirith. *Berber.*	drwg, *Welsh*, droch, *Gaelic.*
	isan, *Shelluh.*	asan, *Erse.*
barley	ahoren, *Guanche.*	eorna, *G.*
basket	carianas, "	crannog, *E.*
boy	guanch, "	oganach, *G.*
	ayel, *S.*	gille, "
bread	aghroum, *B.*	aran, "
call	kerar, "	goirim, *E.*
come	adude, eddon, *B.*	thig, *G.*, dynesu, *W.*
cow	tafunest, "	fionn, *E.*
cup	bukul, "	pacol, *W.*, bachla, *E.*
dart	banot, *G.*	bansach, *E.*
drink	soo, iswa, *B.*	sugh, *G.*
	jowah, *Showiah.*	yv, *W.*
eat	itch, *B. Sho.*	ith, *G.*
eye	elu, *S.*	suil, "
	teeat, *Tuarik.*	aedh, *E.*
face	odom, *B.*, woodmis, *Sho.*	aodann, *G.*
father	dada, *S.*	tad, *W.*
fire	aphougo, *S.*, tefoukt, *B.*	bacht, *E.*
	timis, *B.*, temsa, *Siwah.*	tan, *W.*, teine, *G.*
foot	thareet, *Sho.*, adar, *B.*	troed, *W.*, troidh, *E.*
fowl	eizid, *B.*	ehediad, *W.*
girl	wilt, *S.*	llodes, "
give	ross, "	rhoi, rhoddi, *W.*
god	acoran, *G.*, mkoorn, *B.*	crom, *E.*
good	elali, *B.*	llesol, *W.*
go	maat, *T.*	imich, *G.*
head	eagph, *S.*, ikhf, *B.*	copa, *W.*, cab, *E.*
heaven	igna, *B.*	eon, *Armorican.*
horse	ayeese, *S.*, yeese, *Sho.*	each, *G.*, ech, *E.*
hog	tamacen, *G.*	mochyn, *W.*
	amuran, *S.*	maharan, *W.* (ram.)
king, chief	quehebi, *G.*	ceap, *E.*
lamb	ana, "	oen, *W.*, uan, *E.*
leg	ighas, *B.*	coes, *W.*
man	oggue, *Si.*	cia, *G.*
	meddan, *B.*	modh, *G.*
	coran, *G.*	cearn, *G.*, gur, *W.*
milk	aho, *G.*, acho, *B.*, achi, *Si.*	as, *G.*, ceo, *E.*
mother	mamma, *B.*	mam, *W.*
mountain	aya, "	ais, *G.*
	iddra, *S.*, athraar, *B.*	torr, "
neck	arguh, *B.*	arusg, *E.*
nets	tararach, "	dorga, "

	Beeber.	Celtic.
night	id, *B.*	oidche, *G.*
	ciar, *Sho.*	ciar, *E.* (dark.)
nose	chunfur, *S.*	comar, *E.*, ffri, *W.*
pitcher	ganigo, *G.*	cunnog, *W.*
priest	faycayg, "	faigh, *E.*
property	ajda. *B.*	eiddo, *W.*
	agla, "	cail, *G.*
report	issawal, *B.*	adchwedl, *W.*
road	abreede, "	fford, *W.*
servant, slave.	issemg, *S.*	ciomach, *G.*
sheep	ikerri, *B.*	caora, "
	thikhsi, *B.*, tibaxan, *G.*	othaisg, *G. E.*
small	imeek, *S.*	cumhach, *E.*
speak	guelaine, *Si.*	agallaim, "
stand	bidfillah, *Sho.*	sefyll, *W.*
star	eran, *T.*	seren, "
sun	kylah, *Sho.*	haul. "
valley	douwaman, *B.*	domhain, *E.*
warrior	althayas, *G.*	lath, *E.*, lluyddur, *W.*
water	aman, *T. Si*, eman *B.*	amhain, *G. E.* (river.)
wealth	agela, *B.*	aelaw, *W.*
white	guarn, *G.*	guen, *A.*
woman	tamergart, *B.*	merch, *W.*
wood	ikshuden, "	coeden, "
	asroen, *S.*	crann, *G.*

The ancient British traditions, preserved by Nennius, Geoffrey of Monmouth, and others, agree in bringing the Celtic population of the British Islands into Europe by way of Northern Africa, and this, whatever the value of these traditions, was in all probability the route by which the Sumerians journeyed westward. But, together with these, or perhaps at an earlier period, there passed into Western Europe that strangely isolated people, the Basques. Their language, which contains many Celtic words, is nevertheless not Celtic. The declension of its nouns is virtually a use of postpositions; its pronouns are postpositional; the verb follows its regimen, and the adjective follows the noun; in all of which it agrees with the Accad. But it differs from that language in placing the genitive before the nominative, in which it agrees with the Khita proper and the general order of Turanian grammar. There is virtually no such thing as a Basque verb, if we except the forms *niz*, I am, *dut*, I have, with the remaining persons, which may be regarded as pronominal affixes with verbal powers to transformed nouns or participles. This is a development peculiar to the Basque as the most isolated of Turanian languages. Yet the want of any true distinction between the verb and the noun is both Turanian and American, and, taken together with the polysynthetic character of the Basque, has led many writers to compare that language with the forms of speech on this continent. The Rev. Professor Sayce once held a connection or relationship of the Accad with the Basque, but informs me that he has since changed his opinion. Now the Basque I hold to represent the Khita as distinguished from the Sumerian, just as Berber and Celtic represent the Sumerian as distinguished from the Khita. The Accad contains both these elements in combination, so that it would be vain to look for perfect agreement between it on the one hand and any purely Sumerian or Khita language on the other. There are many Accad words in Basque, but the vocabulary as a whole is far less Celtic or Sumerian than that of the Accad.

My grounds for asserting that the Basques are Khita are based on facts in mythological and tribal nomenclature. The great god of the pagan Basques was Haitor, and this name, taken in connection with the geographical and tribal terms Astura and Astures, recalls Ashtar, the god of the Khita. From the annals of Shalmanezer and other Assyrian monarchs we learn of the existence of a state or states called Khupuskai or Hupuscia situated in the country of the later Nairi, who are generally supposed to be Hittites. While one of these is said to have been in the neighbourhood of Armenia, the other, as adjoining Gozan or Gauzanitis, must have been the region of which Thapsacus was the centre. Indeed Thapsacus, the root of which is Pasach or Psach, is of the same origin etymologically as Khupuskai, and the two forms were probably used indifferently to denote the same place, the Th of the one and the Kh of the other being mere locative prefixes. That Hupuscia had Accad relations is manifest from the appearance of a god Hubisega who occupied an important place in the Accad pantheon, being, according to Professor Sayce, the analogue of the Assyrian Bel. Now one of the Basque provinces is Guipuzcoa, a name suspiciously like Khupuskai, and Pasach, the name of the tribe who dwelt in Khu-Pasach or Tha-Pasach, the abode or town of the Pasach, is identical with the word Basque. The Basques also call themselves Euskara, a form that will meet us again in tracing the migrations of the Hittite stock. Some of the Armenian Khupuskai seem to have taken refuge in the Caucasus, for there, among the Circassians proper, we find the Schapsuch and Abasech, the ancient Abasci of Iscouria or Dioscurias, and the worshippers of Achaicarus and Pkhah. While Abasech and Pkhah are forms of Pasach and Basque, and Schapsuch or Chapsouke of Khupuskai and Guipuzcoa, Iscouria and Achaicarus help to explain the name Euskara. Yet, though many Accad and Basque words are found in Circassian, the grammar of that language is neither Accad nor Basque. While in some respects resembling them, it is in all its main features the same as the Japanese and that of the American languages which in my second paper I connected with the Peninsular family.

I have prefaced the inquiry into the question of a Khita or Hittite migration to America with these detailed remarks because my views on the subject differ somewhat from those of the learned author of the "Khita-Peruvian Epoch." Dr. Hyde Clarke makes the terms Khita Peruvian and Sumero-Peruvian interchangeable, and refers to the peoples classified under these names as builders of stone structures. Now I distinguish between Khita and Sumerian, making the former Turanian and mound-builders, or if builders at all in the true sense, founders of cities, while the latter are Celtic and the erecters of megalithic monuments. The latter I propose to recognize by their possession in some form of the Sumerian name, as Zimuhr, Amor, Cymri; the former, by the occurrence in their geographical, tribal or mythological nomenclature of such forms as Ashtar, Hasisadra, Haitor, Astura, Hubisega, Khupuskai, Thapsacus, Basque, Guipuzcoa, Schapsuch, Abasech, Pkhah, Euskara, Iscouria, Achaicarus, etc. In so doing I necessarily run the risk of passing over many Hittite families, for the Khupuskai can have been but one, and perhaps not the most important, of these. Still it is the only one for which we have data, and fortunately it is sufficient to illustrate the Khita-Sumerian occupation of Peru.

In Peru we find two main stocks, the Aymaras, supposed to be its oldest inhabitants, and the Quichuas, or so called Incas. Their grammatical forms are almost identical, and there is much resemblance in their vocabularies. In its main features the difference between Peruvian and Accad grammar is virtually that which separates the Accad from the Ugrian languages, with which it has been classed. In the use of postpositions, the postposition of the nominative to the genitive, of the noun to its adjective and of the verb to its accusative, as well as in its order of verbal root, temporal index and pronominal suffix, Peruvian grammar is essentially Turanian. Dr. Hyde Clarke finds in the name Aymara evidence of Sumerian connection, and this evidence finds confirmation in many facts concerning the Aymaras. The chief seat of this people was about Lake Titicaca, and a short distance from its shores stand the ruins of Tihuanaco, consisting of a large group of immense stones, each from six to seven yards high, placed in lines at regular intervals. It has been fitly termed "a Peruvian stonehenge," and a tradition prevails concerning it identical with that which ancient chroniclers preserve regarding the famous English structure, namely, that it was erected in a single night by an invisible hand. Turning again to the Berber region of Africa, where the Amor live and megalithic structures akin to that at Tihuanaco are found, we discover fuller confirmation. Messrs. Rivero and Von Tschudi in their work on Peruvian Antiquities, speaking of the peculiarity of the contour of the arch of the Aymara cranium, say: "It is proper here to remark that there is a very striking conformity between the configuration of this race and that of the Guanches, or inhabitants of the Canaries, who used also the same mode of preserving the bodies of their dead." The latter allusion is to the practice of mummification, which the Khita-Sumerians must have learned during their occupancy of Lower Egypt, and which

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* Further evidence for an American connection of the Berber family to which the Guanches belonged is found in the statements of Dr. Le Plongeon and other explorers of Central America, quoted in the admirable work of my colleague, Professor Short, of Columbus, Ohio, "The North Americans of antiquity." Referring to the statue of Chaac-Mol at Chichen-Itza in Yucatan, Professor Short says: "he is adorned with a head-dress, with bracelets, garters of feathers and sandals similar to those found upon the mummies of the ancient Guanches of the Canary Islands." And again: "Dr. Le Plongeon observed that the sandals upon the feet of the statue of Chaac-Mol, discovered at Chichen-Itza, and of the statue of a priestess found at the island of Mugeres, are exact representations of those found on the feet of the Guanches, the early inhabitants of the Canary Islands, whose mummies are occasionally met with in the caves of Teneriffe and the other isles of the group."

Now the language of the Mayas of Yucatan and their mythology are purely Malay-Polynesian, and cannot be associated with those of the Berbers. We must, therefore, regard such remains, differing as they do from the general character of their surroundings, as indicating a temporary occupation of Yucatan at some ancient period by the race which afterwards colonized New Granada and Peru.

appears along the eastern line of Khita migration among the Ainos of Saghalien. "The oven of the Guanches was a hole under ground like that of the Peruvians," says Pégot Ogier; and the same writer informs us that they wore their hair plaited like the Chinese, while Forbes gives the same item of information regarding the Aymaras. The two peoples, Berbers and Aymaras, also agreed in the worship of the sun, and in the performance of sacred rites by virgin priestesses. The following list presents some of the analogies between the Aymara and Berber (Amor, Zimurh, etc.,) vocabularies:

	Aymara.	Berber.
bad	hucha, *Quichua.*	usa, *Berber.*
bed	uyu.	usa, "
boy	jocca.	achicuca, *Guanche.*
cistern	huirca, *Quichua.*	hierro, "
clothes	isi, (*acsu Atacama.*)	ahico, "
cloud	cquenayu.	esighna, *B.*
club	tujru.	tesseres, *G.*
descend	lattorana.	itar, *B.*
dog	anokara.	abaikour, "
drink	açua, *Quichua.*	iswa, "
ear	hinchu.	amzough, "
earth	lacca.	elkaa, *Showiah.*
father	tata.	dada, *Shelluh.*
girl	tahuaco.	thagshishth, *B.*
give	chu.	oushe, *Sho.*
go	humi.	maat, *Tuarik.*
good	alli. *Quichua.*	elali, *B.*
head	ppekei.	fouse, *Sho.*
	echuja, *Sapibocono,*	agaio, *B.*
king. chief	capac.	quehebi, *G.*
lamb	una.	ana, "
man	chacha, hake.	oggue, *Siwah.*
	kkari.	coran, *G.*
moon	irare, *Cayubaba.*	aiur, *B.*
mother	mama.	mamma, "
name	sima, *Quichua.*	ysma, "
net	attaraya, "	tararach, "
night	tuta, "	id, "
nose	cenca, "	enchar, "
	ibarioho, *Cayubaba.*	chunfur, *S.*
pot	paylu, ppucu.	bukul, *B.*
priest	pachacuc, *Quichua.*	fayeayg, *G,*
raise	hucaro, "	ikkar, *B.* (rise.)
sheep	ccaura.	ikerri, *B.*
sit	utjana.	akeime, *Sho.*
small	iscca, (*huchhuy Quichua.*)	aacouguee, *Si.*
star	huarahuara.	eirie, *Sho.*
water	huma.	ahemon, *G.*
woman	marmi.	tamraut, *S.*

What is wanting in the Berber vocabulary is abundantly supplied by the Celtic, as in the following comparison:

	Aymara.		Celtic.		
			Erse.	*Gaelic.*	*Welsh.*
above	araja.		....	....	goruch.
after	ucata.		....	....	gwedi.
all	taque.		gac.	....	....
arm	hicami.		....	....	cainc.
belly	puraca.		...	bru, bolg.	....
bitter	haru.		....	....	chwerw.
black	chamaka.		....	....	much.
	chiara.		....	ciar.	....
blood	huila.		....	fuil.	....
body	hanchi.		....	neach.	....
butterfly	pilpinto.		....	....	balafen.
cloak	iscallo.		....	....	casul.
die, death	hinata.		...	....	ymado.
deep	ccorahua.		....	...	craff.
dew	sullu.		....	....	gwlith.
end	ccorpa.		....	....	gorphyn.
enter	mantana.		....	....	myned.
equal	cusca.		....	....	cystal.
face	akanu.		cainsi.	....	....
faggot	picho.		...	....	ffasg.
father	tata.		...	....	tad.
flesh	aicha.	hig *Armorican.*	....	....	....
foot	kayu.		....	cas.	....
friend	cachomasi.		....	....	cydymaith.
girl	imilla, ppucha.	plah, *A.*	....	....	....
go	humi.		....	imich.	....
goat	paca.		....	boc.	....
he	hupa.		....	....	efe.
head	ppekei.		....	....	pen.
heal	callana.		....	....	gwellau.
house	uta, ata.		....	....	ty.
king, chief	capac.		ceap.	....	....
know	yatina.		....	....	adwaen.
lake	ccota.		....	....	coch.
lamb	una.		uan.	....	oen.
learn	yaticha.		....	....	dysgu.
leg	chara.		cara.	....	....
louse	lappa.		...	....	lleuen.
man	chacha.		....	cia.	....
	kkari.		....	....	gur.
mother	mama.		....	....	mam.
much	alloja.		....	....	lliaws.
night	haipu.		be.	....	....
no	hani.		....	chan.	....
plants	liga.		....	....	llys.
pot	payla.		....	....	paeol.
priest	pachacuc.		faigh.	....	....
rain	hallu.		....	....	gwlaw.
red	pako.		basc.	....	....
reed	curcura.		....	....	corsen.
rest	sama.		....	....	seib.
see	ulla.		....	seall.	....
serpent	katari.		....	nathair.	....
servant	yana.		....	....	gweini (to serve.)
sew	chucuna.		....	....	gwnio.
shadow	chitua.		....	....	cysgod.
sheep	ccaura,		....	caora.	....
shoe	usuta, ojota, isca.		....	....	esgid.
sleep	iquina.	hun, *A.*	....	....	....

			Erse	*Gaelic.*	*Welsh.*
speak	sana.		....	....	cynanu.
	arusina.		....	....	areithio.
stone	ccala.		....	gall.	....
sun	villca.		....	....	hual.
tie	chinuna.		....	....	cynghlymu.
water	yaku.		....	uisge.	gwy.
a well	pucyo.		....	....	pydew.
white	hanco.	guen, *A.*	....	....	can.
will	muna.		....	....	myn.
	chicatha.		....	....	gogwydd.
woman	marmi.		....	....	merch.
word	aru.		....	....	gair.
youth	huaina.		....	....	ieuaint.

In the preceding lists the following pair of related words exhibits the most striking resemblance:

	Aymara.	Celtic.	Berber.
sheep	ccaura.	caora.	ikerri.
lamb	una.	uan.	ana.

Dr. Hyde Clarke finds the connecting link between Sumerian and Aymara among the Cambodians, who call themselves Kammer or Khmer; but in this I am not able to follow him. The Cambodian vocabulary in my possession shews no relationship to Aymara, Berber or Celtic. This may be the fault of the vocabulary, which certainly is far from extensive. But, on the other hand, with a much smaller vocabulary, I find a remarkable collection of Sumerian words in the language of the Ainos, who, whether they relate to the Humeri whom the older geographers place in this region, and who are said to have Mantchu relationships, or not, may fitly connect with Amor and Aymara by their seat, the river Amoor. The Berber analogies are very striking.

	Aino.	Sumerian.
beard	creak.	curcais, *Erse* (hair).
black	kouni.	can, *Accad.*
boat	timma.	tenawine, *Berber.*
book	shomotza.	sumuk, *Accad.*
child	vassasso.	wagshish. *Berber.*
chin	olongyse.	elgeth. *Welsh.*
day	tókaf.	thafath, *Berber* (light).
dog	enoo.	anu, *Aymora.*
drink	horopsee.	srub. *Gaelic.*
earth	toui.	tudd. *Welsh.*
	sirikata.	urakke. *Aymara.*
finger	yewbee.	biz. *Armorican.*
fire	abe.	aphougo, *Berber*, ufel. *Welsh.*
foot	assi.	essa, *Accad*, cas, *Gaelic*, ighas, *Berber* (leg).
heaven	likita.	tigot. *Berber.*
man	okkai, oikyo.	oggue, *Berber*, ka, *Accad*, cia. *Gaelic*, hake, *Aymara.*
moon	kounetsou.	cann. *Erse.*
night	atziroo.	tiziri, *Berber* (moon).
star	noro.	eirie, *Berber.* huarahuara, *Aymara.*
sun	tofskaf.	taphoute, *Berber.*
water	wakha.	yaku, *Aymara*, uisge, *Gaelic.*
woman	meanako.	bainionnach, *Gaelic.*

As in my last article in this Journal I furnished proofs of the derivation of the Peruvians in general from the Japanese-Koriak family to which the Ainos belong, it is natural that among the members of this family one or more should be found exhibiting the Sumerian character. It is also to be remembered that the Ainos, like the Berbers and Aymaras, were sun-worshippers, and that, in common with the latter people and the Guanches, they embalmed the bodies of their dead. I therefore hold that the Amoor of the Ainos is in a better connecting link between Sumerian and Aymara than the Kammer of Cambodia. Yet I would be far from denying the Sumerian origin of the Cambodians. I can find no trace of their presence in the Malay Archipelago, and no evidence that they (the Sumerians) or the Khita were ever a maritime people. It may be objected that the Celts were maritime, but it must be remembered that the Celtic population of Wales even, the land of the Cymri, was according to Cymric traditions made up of many stocks, of which that called Cymric seems to have been least addicted to the sea.*

* Since writing this article I have discovered that the Khita consisted of two distinct families, differing widely in language, character and appearance. That family, of the relation of which to the Khita I was ignorant till lately, has all its connections with the Malay-Polynesian and Maya-Quiché peoples in point of language, culture, maritime habits, etc., and undoubtedly followed the route indicated by Dr. Hyde Clarke through Indo-China to the Malay Archipelago and thence to America. The ancient buildings of Java and of Ascension and Easter Islands belonged to their period and form connecting links between Chaldæan and Central American culture. This branch of the Khita must have originated the Central American alphabets, while there is no evidence that the nomadic landsmen of Hittite name, with whom this paper chiefly deals, ever originated the art of writing.

In the Chronicon Paschale, Heth is made the father of the Dardanians. These Dardanians have been recognized as allies of the Hittites in the Egyptian inscriptions, under the forms Khairetana, Shardana, etc.; which indicate that the initial letter of their name was Z, so that Zarthan must have been their original designation. With the Dardanians of the Egyptian monuments the Tocchari are generally associated, just as the Teucri are with the Dardanians of the Troade. The important discovery by the Rev. Professor Sayce of Hittite remains in western Asia Minor may thus be accounted for, since Teucri and Dardani once overspread that region. Should it be proved that Carchemish belonged to this branch of the Hittite family, its inscriptions may yet be deciphered by the aid of the Cen-

Having thus distinguished between Sumerian and Khita, I return to the discovery of Dr. Hyde Clarke. He found many points in common in the Accad and Peruvian grammatical systems, and proceeded to an examination of the vocabularies of the two languages, or rather of the Accad on the one hand and the Quichua and Aymara on the other. The result was such an agreement that the affinity of the Peruvian tongues to the Accad could no longer remain a doubtful question. It has thus attracted the attention of many students of ethnology, and among them of Dr. Daniel Wilson, who devoted no small portion of his address before the American Association for the Advancement of Science to Dr. Hyde Clarke's researches in this field. The following is a sample of the agreement between the Accad and Peruvian vocabularies:

	Accad.	Peruvian.
all	kak.	taque, *Aymara*.
to be	gan.	kani, *Quichua*.
beast	paz.	uausza, *Quitena*.
bind	sita.	huata, *Quichua*.
bird	pak.	piscco, "
black	kug.	coca, *Aymara*.
body	su.	uku, *Quichua*.
brick	tak.	tica, *Aymara*.
build	duk.	utachana, "
choice	lut.	ahllay, *Quichua*.
city	murub.	marca, *Aymara*.
clothes	ze.	isi, "
	sic.	sau, " acsu, *Atacamena*.
cloud	gan.	equenayu, *Aymara*.
cut	khut.	cuta, "
dark	amas.	amsa, *Quitena*.
	cus.	kata, *Quichua*.
death	khan.	huanhu, "
deer	lulim.	lluchos, "
	dara.	taruco, " taruja, *Aymara*.
descend	turi.	lattorana, *Aymara*.
determine	gagunu.	chicatha, "

tral American. The Egyptian monuments present us with admirable representations of both Dardanians and Tocchari. Messrs. Nott and Gliddon in their joint ethnological work have furnished portraits of the Tocchari, taken from these sources, and have drawn attention to their striking peculiarities in regard to features and dress. It is not a little remarkable to find these features and the peculiar head-dress of the Tocchari reproduced on the monuments at Palenque and elsewhere in Central America. It would thus seem that the old Votan tradition which represented several tribes of one family as diverging from an original seat and making their way, some by a land route, others by water, to a Central American home, may be borne out by facts.

	Accad.	Peruvian.
do, make	ru.	rura, *Quichua.*
dog	liku.	alljo, " locma, *Atacamena.*
drink	ca, cagu.	açua, "
ear	pi.	paoki, *Aymara.*
	cagu.	aike. *Atacamena.*
father	ai.	yaya, *Quichua.*
	ad.	tata, *Aymara.*
field, garden	gan.	cancha, *Quichua.*
flesh	uzu.	aicha, " *Aymara.*
fish	khan.	kanu, *Aymara.*
	kal.	challua, " *Quichua.*
fire	ne.	nina, " "
	kum.	humur, *Atacamena.*
foot	essa.	chaqui, *Quichua*, cuchi, *Atacamena.*
fortress	car.	pucara, *Quichua.*
foundation	ur.	uracque, *Aymara.*
girl	turrak.	tahuaco, "
give	se, sig.	chu, " ku, *Quichua.*
god	hubisega.	apachic, *Quichua.*
gold	guski.	chocque, *Aymara.*
good	khi, khiga.	khaya, *Atacamena.*
grass	si.	ichu, *Quichua.*
green	khir.	ccari, *Atacamena.*
hair	sic.	socco, *Quichua.*
	muz.	musa, *Atacamena.*
hand	su.	suyi, "
have	tak.	tausi, "
head	ku.	echuja, *Sapibocono.*
	pir.	abaracama, *Cayubaba.*
high	annab.	ampata, *Aymara.*
house	uru.	t'huri, *Atacamena.*
	es.	huasi, *Quichua.*
	duku.	uta, ata, *Aymara.*
increase	la.	aliyani, "
king	pak.	capac, *Quidma.*
lamb	uda.	chita, "
law	cimmu.	kamay, "
leave	gadataccuru.	cacharini, "
lift	sur.	hucaro, "
	aca.	heka, *Aymara.*
male	uru.	orko, *Quichua.*
man	khairu, karra.	kkari, " *Aymara.*
	tas.	jadsi, *Cayubaba.*
	gun.	sune, *Yuracares.*
	sa, ka.	kosa, *Quichua*, chacha, hake, *Aymara.*
middle	ib.	chaupi, *Quichua.*
morning	khur.	ccara, *Aymara.*
old	sakus.	achachi, "
to place	cicu.	uscuna, "
plant	sak.	kuka, *Quichua.*
prosperous	curu.	quaraj, "
race	ili.	ayllo, *Aymara.*
rain	muru.	para, *Quichua.*
river	aria.	hahuiri, *Aymara.*
sea	ab.	eubihure, *Sapibocono.*
serpent	tsir.	katari, *Aymara.*
servant	sun.	yana, "
sheep	dara.	taruco, *Quichua.*
sick	tura.	usuri, "

	Accad.	Peruvian.
silver	babbar.	levir, *Atacamena.*
skin	sir.	ccara, *Quichua.*
spirit	alat.	llantu, "
star	ul.	sillo, *Aymara.*
stone	tak.	kak. " *Quichua.*
strike	takh.	taka, *Quichua.*
sun	utuci.	itoco, *Cayubnba.*
	lakh.	villca, *Aymara.*
tail	cun, izkun.	hinchinca, "
take	tab.	hapi, *Quichua.*
tongue	emi.	ine, *Cayubaba.*
tree	iz. gu, gis.	khoka, *Aymara*, ichcai, *Atacamena.*
truth	zik.	cheka, "
white	uknu, sigunu.	hanco, hancona, *Aymara.*
wizard, enchanter	as.	asuac, *Quichua.*
woman	rak.	rakka, "
	ni. nin.	anu, *Sapibocono.*
	sak.	ccachu, *Aymara.*
	turrak.	itorine, *Cayubaba.*
	khiratu.	cratalorane, "
young	sepuz.	sebebonto, *Yuracares.*

In the Peruvian portion of the above vocabulary we have presented the same phenomenon that the Accad language presents, a union of Khitan and Sumerian elements. Some of the Sumerian elements have already appeared in the comparison of the Aymara with the Celtic (Cymric) and Berber (Zimuhr, Amor, Gomera). It now remains to determine the Hittite or Khita element which finds its chief representation in the Quichua, although by no means unmixed with the Sumerian. Indeed so complete and far reaching seems to have been the union between Sumerians and Hittites, that it is questionable if any pure language of either class can be found, or any indeed, of the one that has not been largely influenced or affected by the other. My reasons, however, for regarding the Quichua as Khita or Khupuskian-Khita are those on the ground of which I have already proposed to recognize the languages and peoples of this class, namely, the preservation in the Quichua or Inca nomenclature of the distinctively Khupuskian-Khita names. As analogous to the words Hubisega, Basque, Pkhah, we find, first of all, the Quichua god, Apachic or Pachacamac, the form of whose name is better illustrated in the Muysca mythology, where the same solar deity appears as Pesca or Bochica. Apachic, Pesca or Bochica is the Accadian Hubsisega and the Circassian Pkhah. In the legendary history of Montesinos and others the same name meets us as Pishua and Pachacuti, famous sovereigns of the ancient Inca line; and geographical terms recalling Biscay, Abasech and Thapsacus are Pasco, Pisco, Posco and Tapacoche, all denoting places of importance. Ashtar again and the Basque Haitor are represented in the name of another legendary monarch and hero, Ayatarco, concerning whose reign a remarkable story is told that recalls the Bible narrative of Sodom and Gomorrah. "Giants having entered Peru, they populated Huaytara and other towns, and built a sumptuous temple in Pachacamac, using instruments of iron. As they were given up to sodomy, divine wrath annihilated them with a rain of fire, although a part of them were enabled to escape by going to Cuzco. Aytarco-Cupo went out to meet them, and dispersed them about Limatambo." Finally Euskara, Iscouria and Achaicarus find their analogue in a famous Peruvian name which the present war with Chili has brought to the knowledge of every newspaper reader, as that of the best war-vessel of the Peruvians. Huascar is the name given by Montesinos to the immediate successor of Ayatarco and to subsequent occupants of the throne of the Incas, and it appears also in the annals of Garcillasso. I hold that Huascar, Ayatarco and Apachic are the Peruvian equivalents of the Circassian Achaicarus and the Basque Euskara, of the Hittite Ashtar and the Basque Haitor, of the Accad Hubisega and the Circassian Pkhah. Just as, in ancient Chaldea, Sumerians and Accad worshippers of Hubisega dwelt side by side, as, in Spain, Cymri and Basques once bordered on each other, and as, in Kitaya, Cambodian Khmer and Karien Passuko are found; so, in Peru, Aymaras and Quichua worshippers of Apachic divided the land. The Institutes of Menu make mention of this ancient Turanian family, perhaps at the time that the Karien Passuko were fighting their way southward to their Burmese home. In that old Sanscrit record they are the Pisachas, and belong to the great race of the Asuras, the Sanscrit equivalent doubtless of Euskara and Huascar.

I may now refer to my former paper, in which I demonstrated that the Peruvians, far from being an isolated American family, are of the same stock as the Muyscas of New Granada, the Cherokee-Choctaws, Iroquois and Dacotahs of this northern continent, and the Japanese, Koriaks and other Peninsular tribes of north-eastern Asia. In that paper I set forth the mythological names Pesca or Bochica of the Muyscas, Eefeekeesa of the Muskogees, a branch of the Choctaw family, and Jebisu of the Japanese, as denoting the same solar divinity, and to these I now add, with the Peruvian Apachic, the Circassian Pkhah and the Accadian Hubisega.* Among the Dacotahs, the Mandans called themselves Seepshoksh, and this is the Circassian Schapsuch, the Accad Khupuskai, and the Basque Guipuzcoa. The name Euskara also appears among the Iroquois as the Huron god Tawiscara, and the title of a well known tribe, the Tuscaroras. I do not claim all the American and Asiatic peoples thus associated with the Peruvians as Khupuskian, but would rather find in them, together with the actual bearers of the Khupuskian name, members of the same great Turanian family which Dr. Hyde Clarke calls Khita and which the ancient Indians called Asura, names that are probably co-extensive and equally applicable to the non-Sumerian representatives of the Accad stock. The following table exhibits the Khupuskian (Basque and Circassian) relations of the Peruvian languages, relations which are more plainly visible when the intermediate members of the Khita family, the Peninsular tongues of Asia and the allied languages of North and South America are taken into the comparison.

	Peruvian.	Basque.	Circassian.
above	anacpi, *Quichua.*	......	ahpsey.
air	huayra, "	airea.	
all	taque, *Aymara.*	gucia.	eezahk.
arrow	huachi, *Q.*	guezd.	
	micchi, *A.*	......	bzey.
axe	ayri, *Q.*	haizcora.	
bad	micha, *A.*	......	bzaghey.
	chata, "	gaiztoa.	
beard	socco, *Q.* (hair)	......	shagha.
beast	llama "	......	billim.
bed	uyu, *A.*	oya.	
behind	ucata, *A.*	ostean.	yeytahney.
below	mancaro. *A.*	beherra.	
	ichcu, *Atacama.*	......	ayshay.
bind	huata, *Q.*	lota.	
bird	chiroti, *A.*	choria.	
	ppisko, *Q.*	......	bzoo.
birth	qa, *Q.*	jayo.	
black	coca, *A.*	......	shoodzah.
blood	huila, "	odsla.	kleh, thleu.
bone	cchaca, "	......	kutsha.

* Pisca or Bochica of the Muyscas, Apachic of the Peruvians, and Eefeekeesa of the Muskogulges are represented as diluvian heroes or divinites. In Chaldea, Hasisadra or Xisuthrus was such. But in Evechous, whom Africanus and Eusebius make the first Chaldean king after the flood, it is easy to recognize the Hubisega of the Accadians, while the Muskogulge Eefeekeesa and Peruvian Apachic almost perfectly reproduce the Greek form of the Hittite name handed down by the two fathers.

	Peruvian.	Basque.	Circassain.
boy	sima, *At.*	seme.	
	jocca, *A.*	......	saghoo.
	churi, *Q.*	......	kaala.
break	pakiy, "	......	seebeta.
breast	haiti, *At.*	titia.	
brother	panay, *Q.*	anaya.	
burn	raura, "	erre.	
chain	huisca, *A.*	......	psoh.
child	huarma, *Q.*; churi, *Q.* (boy)	aurra.	tshahley.
clothes	acsu, *At.*; isi, *A.*	jauci, jaunci.	shooghoon.
cloud	puhuyu, *Q.*	......	washabshey.
cold	taya, *A.*	otza.	tsheeyetsha, tsheeyeh.
dark	amsa, *Quitena.*	......	mezahshe.
day	chine, *Sapibocono.*	eguna.	atschinna.
death, die	....	il.	tlagha.
dog	anokara, *A.*	chacurra.	tkari, Mizjeji.
door	....	atea.	tshey.
drink	haitama, *At.*	edan.	
	açua, *Q.*	......	yeshwey.
eagle	paca, *A.*	......	bzoo-oosh.
ear	paoki, *A.*; uyari, *Q.* (hear)	bearria.	
earth	lacca, *A.*; hoire, *At.*	lurra.	latte, Mizjeji.
	idatu, *Cayubaba.*	......	yatta.
	pacha, *Q.*	......	wahtey.
egg	runto, "	arraultzia.	
	ccanti, *At.*, cauna, *A.*	......	kanghey.
eye	nahui, *Q.*	......	neh.
face	riccay, "	aurpeguia.	
fall	urmani, "	eror.	
father	tayta, "	aita.	yati, taht.
field	vaca, *At.*	park.	bughodshee.
fight	huacta, *Q.*	guda.	
fire	cuati, *S.*	su.	zu Lesghian.
flesh	....	guelia.	glli.
forest	quenna, *A.* (tree).	oyana.	
		besoa.	pkhe (wood).
girl	ppucha, *A.*; ussussiy, *Q.*	batsaya.	psahsey.
	sapana, *A.*	......	sipshaz.
good	ccaya, *At.*; asque, *A.*	egun.	souyyey..
great	....	andia.	atto.
grief	nanay, *Q.*	mina.	
hail	chijchi, *A.*	......	skhakzee.
hair	chuccha, *Q.*	......	shatzeh.
hand	suyi, *At.*	escua.	oyg, ey.
head	ppekei, *A.*; abaracama *C.*	burua.	
	echuja, *S.*	......	shkhah.
hot	capi, *At.*	beroa.	pahbey, fahbey.
house	ata *A.*, huasi, *Q.*	etchi.	hadsheeshish.
	puncu, *A.*	......	wohuey.
heavy	....	gacha.	zaaha.
iron	quella, *A.*	......	shelitsh.
king	capac, *Q.*	jabea, nabusia.	pshee.
know	yatina, *A.*	jaquin.	zshagha, skhaner
lamb	una, *A.*	......	heene.
		umerria.	melai.
leaf	cora, *A.*	orria.	kere ,Lesghian.
learn	yachachi, *Q.*	ikasi.	ghassa.
life	....	bicia.	psagha.
lip	uirpa, *Q.*	......	oobzey, okoofaree.

	Peruvian.	Basque.	Circassian.
man	kosa, *Q.*	guizua.	kodza.
milk	nana, *Q.*	eznea.	sheyzen.
moon	coyllor, *Q.*; halar, *At.* (star)	illarguia.	
mother	mamay, *Q.*	ama.	
mountain	monono, *Yuracares.*	munoa.	
	mocco, *A.*	......	meyzee.
mouth	khaipe, *At.*	auba.	
name	simi, *Q.*	icena.	
neck	....	iduna.	eddee.
night	tuta, *G.*	......	tsheytshee.
		gau.	kayshey.
nose	evi, *S.*; sepe, *At.*	......	pey.
old	tanta, *Q.*	adinandia.	
	achachi, *A.*	......	zey.
pain	llaqui, *A.*	......	yetlerkey.
pure		chauba.	kahbzey.
rain	para, *Q.*	euria.	kare, *Mizjeji.*
red	lara, *At.*	gorria.	tleeshee.
rise	haka, *A.* (raise)	jaiki.	
river	maya, *Q.*	ibaya.	pse.
road	peter, *At.*	bidea.	
salt	cachi, *Q.*	gatsa.	zogho.
sea	icuri, *C.*	ichasoa.	shoo.
sheep	ccaura, *A.*	achurria.	tzkwari, *Georgian.*
sick	usuri, *Q.*	eria.	oozeeshel.
skin	ccati, *At.*	......	sheh.
sleep	atasei, *Y.*	......	tsheeyah.
small	huchhuy, *Q.*	chiquia, guchi.	tzick, tzook.
snow	sairi, *At.* (rain)	elurra.	azore.
speak	rima, *Q.*, arusina, *A.*	erran.	
		edas.	zeeghadshas.
star	huarahuara, *A.*	izarra.	
stone	caichi, *At.*	acha.	
sun	villca, *A.*	iluzki.	malch, *Mizjeji.*
	itoco, *C.*	iguzki.	teygha.
tail	chupa, *Q.*	opa.	
throat	etippi, *S.*	gubioa.	
	comala, *At.*	samea.	zeymer.
tongue	ine, *C.*; eana, *S.*	mia, mina.	ena, *Georgian.*
tooth	qquene, *At.*	hagin.	
	kiru, *Q.*	hortz.	kertchi, *Lesghian*
tree		arecha.	frah.
trunk	capintin, *Q.*	zepois.	
truth	checa, *A.*	eguia.	sookahded.
water	puri, *At.*; hahuiri, *A.* (river)	ur.	
	eubi, *S.*	......	psee.
white	yurac, *Q.*	churia.	
	tara, *At.*	zuria.	
wing	checca, *A.*	egoa.	
wolf	atoc, *Q.* (fox)	otsoa.	
woman	ccachu, *A.*		sus, sheez.
wood	kullu, *Q.*	egurra.	kalki, *Lesghian;* frah (tree)
year	huata, *Q.*	urte.	

NOTES ON SOME CANADIAN FERNS.

By John B. Goode, Esq.

The following new and rare species and varieties of Canadian ferns were collected by the author during the summer of 1879:

Aspidium Filix-mas, Swartz.—This common European species can now be added to the list of ferns indigenous to our own Province of Quebec. It has already been found in Ontario by Mrs. Roy, at Owen Sound; and in Cape Breton and Nova Scotia.

Whilst in Gaspé last summer I was fortunate in alighting upon a small colony of this bold fern, which was growing in a a most delightful spot, several miles back of any settlement, through close dense woods, and at the foot of a precipitous mountain, down the rough side of which a small torrent came tumbling in a series of cascades, creating an atmosphere in which the ferns and mosses appeared to luxuriate. This species was growing on a well-drained slope in rich leaf-mould, with an open exposure. My specimens were gathered on the 10th of July, the fruit-dots being then scarcely ripe.

Fronds grow in a circular clump, from an upright root-stock, attaining a maximum height of about 3 feet, broadly lanceolate in form, rather abruptly terminating in a narrow tapering apex. Stalk about a fourth of the length of the frond, densely clothed at base with chaffy brown scales, decreasing upwards.

Fronds bright green and smooth, much paler underneath, pinnate or sub-bipinnate, excepting at the top which is only pinnatifid. Pinnæ mostly alternate, rather crowded above, but more distant at the base; narrow and tapering gradually from the second pair of basal pinnules to an acute apex; pinnatifid into oblong-obtuse segments, which are connected by a narrow wing and finely serrated on the sides and apex, the basal ones being incisely-lobed and conspicuously elongated either on the anterior or posterior side or sometimes on both.

Fruit-dots nearer mid-vein than margin, medium in size and confined to the lower half or two-thirds of each fertile pinnule, the mid-veins of which are straightish, with alternate and either simple or forked lateral veins. Indusium round-kidney shaped and rather persistent.

Aspidium fragrans, Swartz.—Fine specimens were found near Hemmingford last September.

Woodsia glabella.—Fronds tufted, light green on both sides and smooth throughout, 2 to 4 inches long, ½ to ¾ inch wide, narrow linear, or linear-lanceolate pinnule. Pinnæ broadly-ovate with a somewhat wedge-shaped base, mostly alternate, cut into from 3 to 7 oblong or rounded lobes; crowded at apex, and more distant at the base where they are rounder in form and almost sessile on the rachis.

Stalks very short, one inch or less, dark-brown, and falling away at the joints.

Roots black, wiry and branching.

Fruit-dots borne on the back of the forked free veins, covering underside of lobes, and soon becoming almost hidden by the long cilia of the indusium.

This rare and pretty dwarf fern was found on the precipitous cliffs between Capes Gaspé and Rozier, at an elevation of about 1000 feet above the sea, and differs from the plant collected on Mount Mansfield, Vermont, and figured in Prof. D. C. Eaton's "Ferns of North America," in having the pinnæ more crowded, and the apices of the fronds more obtuse. As this is a northern species, it probably becomes more slender in form and less sturdy in habit as it travels southwards.

Cystopteris fragilis, var. *A. depauperata.*—Fronds 2 to 4 inches long, including the stalks (which occupy from a third to half the length), 7 to 11 lines wide, rather slender, curved, lanceolate, or oblong-lanceolate in shape; pinnate or sub-bipinnate. Pinnæ are rather crowded and erect at the apex of frond, becoming more spreading and distant from each other as they descend; upper ones attenuate-ovate in form, lower ones rather obliquely triangular-ovate.

Pinnules obtuse at apex and very irregular in outline, being oblong, wedge-shaped, ovate, or obovate, with crenate, dentate or truncate apices, those on the posterior side of the pinnæ being mostly contracted, or shorter than the anterior ones, the basal ones being connected by a very narrow wing.

Veins simple or forked.

Stalks bright-brown up to the basal pair of pinnæ, thence passing into pale green; smooth throughout, a few chaffy scales at the extreme base only.

Rhizoma dark-brown, creeping and closely beset with the stumps of old fronds; roots very wiry.

Two plants of this neat variety were gathered last July on the face of the exposed cliffs to the east of Cape Rozier, at an elevation of about 800 feet above the sea.

Cystopteris fragilis, var. "*B. Small.*"—Fronds short, erect and robust, 4 to 5 inches high, including the stalks, and from $\frac{3}{4}$ to $1\frac{1}{4}$ inches wide, firmer in texture than the common type, and rather dull in color; lanceolate or oblong-lanceolate in form, pinnate or sub-bipinnate.

Pinnæ are lanceolate or ovate-lanceolate, the lowest pair rather distant, contracted, and more erect.

Pinnules oval or ovate, with obtuse or almost truncated apices, minutely crenated or serrated on the margins, and the basal ones joined together by a very narrow wing.

Stalks stout, about $1\frac{1}{2}$ inches long, or scarcely a third of the length of the frond, reddish-brown, darkest at the base, becoming paler and passing into green above the basal-pair of pinnæ, smooth but with a few large chaffy-scales at the extreme base.

Veins forked or simple. Sori medial.

Several plants of this variety were found on a limestone ledge near Grand Grève, Gaspé.

Cystopteris fragilis, var "*B. Large.*"—Several plants were found in the same locality as the foregoing, agreeing with them generally, but having a more luxuriant growth, measuring 11 to 16 inches high, by $1\frac{1}{2}$ to 2 inches wide; these I have mounted separately.

These large plants agree closely with the description of *C. var. dentata* of Hooker.

Cystopteris bulbifera, var. *depauperata.*—A dwarf form with fronds only $2\frac{1}{4}$ to $2\frac{3}{4}$ inches long, including the stalks, one fertile frond bearing 3 bulblets, which induced me to include it, with this species, although the sori were absent.

Fronds pinnate, bipinnate towards base and pinnatifid at apex, bright green and smooth, and acutely-deltoid in shape.

Pinnæ mostly horizontal, oblong-ovate above, more triangular at the base.

Pinnules oblong, obtuse and minutely toothed.

Stalks scarcely as long as frond, or barely exceeding one inch, and light-brown in color.

Rhizoma tufted and creeping.

Veins forked.

This plant was growing at a great elevation between Capes Rozier and Gaspè, on an exposed cliff.

Asplenium viride, var. *robustum*.—This plant was found in company with the ordinary and more fragile type of this species, in the fissure of a shaded limestone ridge near Grand Grève, and being of a much more vigorous and sturdy habit, it has been deemed worthy of special mention.

Fronds 3 to 6 inches long including stalk, width about ½ inch, linear with lance-apex, rather obtuse, pinnate.

Pinnæ mostly alternate, very short petioled, somewhat rhomboid-ovate in form, the basal ones being fan-shaped, cut into rounded or irregularly-toothed lobes and rarely cleft.

Rachis is of a similar color to the pinnæ, or a bright light-green.

Length of the stalk is about one third that of the frond. It is stout and its basal-half of a dark and shining purplish-brown.

This plant has the fronds of a much thicker texture than the common type.

Asplenium Trichomanes.— A few plants of this neat and dwarf-fern were found last summer on the northerly slope of Montreal Mountain, growing in the crevices of a huge detached rock, in a very secluded and precipitous spot.

It has not, I believe, been found on the Mountain for many years past, and one reason for its disappearance, in my opinion, is that the dry and crumbling rock formation does not receive the drainage from the numerous swamps which formerly existed on the top.

Camptosorus rhizophyllus.—Splendid plants of this "Walking-Leaf" Fern, were collected last September, on some isolated rocks in a shady-pasture near Hemmingford.

Botrychium lanceolatum, Angstrœm.—A colony comprising 7 plants, was found last August, which afforded an excellent illustration of the gradation of this species, from the most minute to the largest fertile form.

Fronds varying from 2¼ to 7 inches, measured from the top of fertile part to the head of the concealed-bud at the base.

Sterile segment is short petioled, or sub-sessile in small plants, and usually attached to the common-stalk at its extreme upper part, having a form somewhat ovate-lanceolate in the smallest plants, more lanceolate in the medium, and ternate and triangular in the largest and most matured one. The smallest specimens have the sterile segment pinnatifid into from 3 to 7 rounded oblong, or obovate-obtuse lobes, which are mostly entire; the medium plants are 11-lobed, obvate or sometimes ovate and more deeply-pinnatifid, crenate or bluntly-toothed. The most matured plant has the sterile segment deltoid in form with one upper and a pair of side divisions; the latter are spreading, and narrowly lanceolate in form, with a few remote, lanceolate, or oblong, deeply cut in-curved lobes, which are represented in the top divison by small teeth.

Venation is indistinct in the smallest plants, but the medium and largest ones have a continuous midvein in the rachis of the sterile segment, from which lateral veins ascend and finally diverge and branch into the side lobes or divisions, the veins themselves being either simple or forked. Fertile segment simple in the small plants and bearing about 12 capsules, medium plants pinnate, bipinnate or forked, and in the largest plant resembling a two branched panicle.

Sterile segment thin in texture and light-green. My plants were collected in a damp deep wood, near Magog, on the 20th of August last, when they appeared to be at their prime.

Ophioglossum vulgatum, Linnæus.—This species was found near Hemmingford, rather plentifully distributed in a peaty bog. It appears to be identical with the ordinary American type described by Professor Gray.

Sterile segment ovate or elliptical-oblong, about two inches long, obtuse, narrowed at base, and sessile below the middle of the common stalk, with reticulated veins. Length 7 to 10 inches; color yellowish-green.

THE HELDERBERG ROCKS OF ST. HELEN'S ISLAND.

By J. T. Donald, B. A.,

Science Master, High School, Montreal.

The second great limestone formation in the Upper Silurian series of rocks has received the name Helderberg from its occurrence in the mountains of this name in the State of New York. It is found in several localities in eastern New York, in Gaspé, and also in various parts of New Brunswick and Nova Scotia, as well as western Ohio and Indiana.

Between these extreme limits we have but one isolated patch of genuine Helderberg rocks, and that is to be found on St. Helen's Island, in the St. Lawrence opposite Montreal. This island is almost entirely made up of a dolomitic conglomerate or volcanic breccia, in all probability poured forth from the ancient volcano of which Montreal Mountain is but the base. Associated with this breccia are certain masses of hard gray limestone, of Helderberg age. The existence of this limestone was well known for a long time before its geological age was recognised. Occupying the position it does near the Trenton of Montreal Island, it was naturally thought to belong to this formation. To Dr. Dawson is due the credit of having discovered that it was of Helderberg age. Being out, as is his custom, with a party of students, he broke off a fragment of the rock, expecting to find Trenton fossils if any. To his surprise, he was confronted with Helderberg species.

Rocks of Helderberg age must have been extensively deposited over the area reaching from Gaspé, New Brunswick and New York to Ohio and Indiana, and then in great part removed by denudation. The masses on St. Helen's Island have resisted this denuding action, being protected by the hard breccia which encloses them. This deposit of Helderberg limestone is of interest as being the only representation of this formation between the limits before indicated and, further, because it is distant nearly 200 miles from the nearest position of the group elsewhere. I have said this deposit is the only *genuine* representation of Helderberg within the limits mentioned, for, although we find elsewhere, as at Isle Bizard, Rivière-des-Prairies and Ste. Anne, rocks which are called Helderberg, they are so called on the grounds of their lithological character only, since they are "a dolomitic conglomerate so similar to that of St. Helen's Island, with the exception of the associated masses of limestone, that they are most probably of the same age." *

As to the fossils of this deposit, but little seems to have been done. Report of Geological Survey of Canada for the year 1863 says: "The fossils observed in this limestone are *Favosites Gothlandica*, *Strophomena rhomboidalis*, *S. punctulifera*. *Orthis oblata*, an undetermined species of *Rhynchonella* with *R. Wilsoni*, *Athyris bella*, *Atrypa reticularis* and two undetermined species of *Spirifera*.

The students attending the class in Geology in McGill College visit various places in the neighborhood for the purpose of studying practical Geology and collecting fossils. Among other places, St. Helen's Island is frequently visited, and, as a result, quite a collection of fossils from this deposit accumulated in the College. Having access to this collection, and possessing a small one of my own, I endeavored to determine the fossils thus obtained, the result being embodied in the following list, which comprises sixteen genera and thirty six species :

Crinoid (stems),
Favosites Gothlandica,
Favosites,
Stenopora,
Fenestella,
Ptilodictya acuta,
Orthis hipparionyx,
" discus,
" oblata,
" tubulostriata,
" eminens,
" deformis?
Orthis———
Strophomena punctulifera,
" profunda,
" rhomboidalis,
Strophodonta varistriata,
" radiata,
Spirifer concinnus,
" cyclopterus,
" allied to S. arenosus.
Rhynchonella formosa,
" æquivalvis,
" mutabilis,
" allied to R. mutabilis,
" nucleolata,
" ventricosa,
" Species undeter. and not described in Hall.
Atrypa reticularis,
Stricklandinia Gaspensis,
Pentamerus Verneuili,
" galeatus,
" pseudo-galeatus,
Avicula, perhaps allied to A. manticula, Hall.
Platyostoma depressa,
Tentaculites Helena (new species.)

* Report Geological Survey of Canada, 1863, p. 356.

With reference to the foregoing list, the following points are worthy of note:

1st. That all the species obtained (36 in number), with two or three exceptions are described in Hall's Palæontology of New York, showing the close relationship between the rocks of the Island and the typical strata in New York.

2nd. In the collection are several specimens of *Stricklandinia Gaspensis*, *Strophomena punctulifera* and *Spirifer cyclopterus* shells characteristic of the Helderberg strata of Gaspé; so that by its organic remains the limestone of St. Helen's Island is related to the Gaspé beds, as well as to the New York strata.

3rd. *Pentamerus pseudo-galeatus*, *Atrypa reticularis*, *Spirifer concinnus* are found in abundance on the Island, the latter to such an extent that it may be regarded as the shell most highly characteristic of this deposit.

4th. In the limestone of the Island are found two species which are regarded as belonging to the Oriskany sandstone, *Orthis hipparionyx* and *Spirifer* allied to *S. arenosus*.

Hall, in the Palæontology of New York, says the transition from the Oriskany to the Helderberg is very abrupt, and few species pass from the latter to the former. It is therefore remarkable that in a deposit so limited in extent we should find two species which pass from the Helderberg to the Oriskany.

5th. The tentaculites mentioned as *T. Helena* is a new species, somewhat resembling *T. annulatus* of the Lower Silurian figured by Murchison in his "Siluria." The characters are as follows:

Tube strong, somewhat rapidly enlarging from apex. Varies in length from $\frac{7}{16}$ to $\frac{7}{8}$ of an inch. Annulated by sharp elevated rings, extending to the apex, eight to nine in the eighth of an inch. Spaces between the striæ from two to three times the width of the striæ. These spaces are marked by numerous fine vertical markings. This is distinct from any other, so far as I know, by its sharp annuli with vertical markings on the intermediate spaces.

NOTES ON CHROME GARNET, PYRRHOTITE AND TITANIFEROUS IRON ORE.

By B. J. Harrington, B.A., Ph.D.*

I. Chrome Garnet.

Garnet affords us an excellent example of the wide variation in composition exhibited by many mineral species. The variation is due to what is known as isomorphous replacement, or the replacement of one or more substances in a chemical compound by analogous substances without any essential change of form resulting therefrom.

If we take $R_3\,\bar{R}_2\,Si_3\,O_{12}$ as the general formula for garnet, the numerous analyses of the mineral which have been made tell us that R may be represented by calcium, magnesium, iron (in the ferrous state), manganese, &c., while $\bar{R}$ may be aluminium, iron (in the ferric state), or chromium. With all these differences in composition, the crystals of the mineral are always closely related or identical in form; but, as might be expected, the variations in specific gravity and colour are considerable.

In a paper on "Apatite and its associated Minerals," which I had the pleasure of reading before this Society about a year and a half ago, garnet was mentioned as one of the rarer constituents of the apatite-bearing veins; and its occurrence was again noticed in a report published by the Geological Survey last year. Of the varieties which have been observed the most common is probably a lime-alumina garnet; but the most interesting is a beautiful emerald-green variety which was discovered some time ago in the township of Wakefield, Quebec, and which has proved on analysis to be chromiferous. So far as I am aware there is no instance recorded in which the element chromium has hitherto been detected in any of the Laurentian minerals of Canada, although it is well known to be a constituent of serpentines and other minerals in succeeding formations. In order to ascertain whether the Wakefield garnet resembled the original ouvarovite or chrome-garnet, from Bissersk, in the Urals, a quantative analysis has recently been made, and the results are given under

* Read before the Natural History Society May 26th, 1880.

I. Under II is given Dr. Hunt's analysis of the chrome-garnet from Orford in the Eastern Townships, while, under III, is an analysis by Erdmann of the true ouvarovite:

	I. *	II.	III.
Silica	37.50	36.65	36.93
Alumina	18.65	17.50	5.68
Ferric oxide	1.07	.....	1.96
Ferrous oxide	.....	4.97	.....
Chromium sesquioxide	4.95	6.20	21.84
Lime	36.13	33.20	31.63
Magnesia	0.52	0.81	1.54
Cupric oxide	.....	.....	trace.
Loss on ignition	0.48	0.30	.....
	99.30	99.63	99.58

On comparing these analyses we see that while in the true ouvarovite, the predominant sesquioxide obtained on analysis is that of chromium, it is alumina in the garnet of Wakefield and Orford. Strictly speaking, therefore, the two last should be classed as lime-alumina rather than lime-chrome garnets.

The hardness of the Wakefield mineral is a little above 7 and the specific gravity 3.542. Before the blow-pipe it fuses between 4 and 5. Notwithstanding that it contains less chromium, the green in the specimens which I have seen is deeper than that of the Orford mineral and quite as deep as that of ouvarovite. The crystals are rhombic dodecahedrons with the faces often striated in the direction of the longer diagonal. In my specimens the well-defined crystals are mostly one-eighth of an inch or a little more in diameter; but one—unfortunately not entire—is nearly half an inch. On weathering, the crystals lose their glassy lustre, becoming dull and paler in colour. Among the minerals associated with the garnet are a green pyroxene, which is probably chromiferous, apatite, calcite, orthoclase, tourmaline and idocrase.

I am greatly indebted to Mr. J. G. Miller of East Templeton for the specimens which have enabled me to make the above analysis.

* The Atomic and quantivalent ratios are as follows:

	Atomic.	Quantivalent.		
Si	625 × 4	2500		2500
Al	362 × 3	1086		
Fe	013 × 3	39	1320	
Cr	065 × 3	195		2636
Ca	645 × 2	1290	1316	
Mg	013 × 2	26		

II. Pyrrhotite or Magnetic Iron Pyrites.

In 1875 a vein containing considerable quantities of copper pyrites was discovered near Polson's Lake, in Antigonish County, Nova Scotia. Loose masses of the ore had long before been found scattered over the surface, and although it was evident that they had not travelled far, a number of attempts to discover their source proved failures.

Among the minerals associated with the copper pyrites are spathic iron ore, iron pyrites, pyrrhotite and more rarely native copper. Pyrrhotite, as is well known, frequently contains nickel, or both nickel and cobalt, replacing a portion of the iron, and much of the nickel of commerce has been derived from this source. On account of this fact it was deemed worth while to analyse the mineral from Polson's Lake. The specimen examined—for which I am indebted to Dr. Dawson—was paler in colour than ordinary pyrrhotite and had a very high lustre. It contained a good deal of spathic iron ore (or ankerite) which was difficult to separate completely from the pyrrhotite. An analysis gave the following results:

Iron	58.976
Copper	0.181
Manganese	traces.
Nickel	0.773
Cobalt	traces.
Sulphur	38.580
Calcium Carbonate	0.786
Magnesium Carbonate	0.216
	99.512

The carbonates must be due to a small quantity of intermixed gangue, and a little of the iron was no doubt also present as carbonate. The mineral was strongly attracted by the magnet.

It should be stated here that the late Professor Howe, of Windsor, Nova Scotia, detected nickel and cobalt several years ago in specimens of pyrrhotite from both Nova Scotia and New Brunswick.* Specimens from Cape Breton Island gave 0.50 per cent. of oxides of nickel and cobalt, the amount of metallic nickel being "at least 0.36 per cent." A specimen from Nictaux in Annapolis County, gave "nickel, with a little cobalt, 0.10 p.c.

* *Mineralogical Magazine*, April, 1877, p. 124.

while another from Geyser's Hill, Halifax County, gave a distinct reaction for nickel." Several samples of pyrrhotite from La Téte in New Brunswick were examined by Professor Howe, with the following results. "No attempt" he says "was made to separate the nickel and cobalt found, the metals were thrown down as oxides, and calculated as from protoxide of nickel."

No. 1	afforded	0.09	per cent.
" 2	"	0.36	"
" 3	"	0.80	"
" 4	"	0.40	"

Now in all the examples given, including the Polson's Lake pyrrhotite, the proportion of nickel is too small for profitable extraction, but the results of a single analysis are by no means sufficient to settle the matter. Concerning the quantity of pyrrhotite in the vein at Polson's Lake I have no information, but if an abundant constituent, then it would be wise to have a number of samples analysed. The pyrrhotite from some portions of the vein might perhaps contain a much larger proportion of nickel. It is probable also that some of the other constituents of the vein would be found on analysis to contain nickel.

I am told that some years ago a pyrrhotite containing 2.5 per cent. of nickel was profitably treated in Pennsylvania at a time when nickel was worth $1.50 per lb. Subsequently the price rose to $3.00 per lb., and in Litchfield County, Connecticut, an attempt was made to work a pyrrhotite containing, according to some authorities, about 0.75 p. c., but the results did not prove satisfactory. During the past few years the price of nickel has greatly declined, owing partly to the discovery of important deposits of nickel ores in New Caledonia. Exactly what the metal is worth in the United States at present I am not aware, but in England the price is only three shillings sterling per lb. A year ago it was four shillings to four and sixpence, while in 1874 it was eleven shillings.

The New Caledonia ores are said to be hydrated silicates of nickel, and to occur in serpentines associated with euphotides, diorites, amphibolites, &c. They are in fact found in rocks resembling the so-called metamorphic rocks of the Eastern Townships, many of which were long ago shown by Dr. Hunt to contain nickel.

That pyrrhotite is a common mineral in our Laurentian rocks is well known, and it is not unlikely that, as in Norway so here, deposits of both pyrrhotite and pyrite may yet be found, containing sufficient nickel for profitable extraction. A short time ago it was estimated that Norway annually supplied as much nickel as one-third of the yield of the whole world.*

III. Iron Ore from South Ham, P.Q.

Near the west shore of Lake Nicolet, in the first range of South Ham, there occurs a deposit of iron ore which is stated to be of considerable extent, and to occur in serpentine. A specimen recently examined was black in colour, and gave a black streak. It was readily attracted by the magnet, and had a specific gravity of 4.5. The following partial analysis shows the ore to be of interesting and unusual composition :

Metallic iron................	44.69 p. c.
Chromium sesquioxide	8.31 "
Titanium dioxide............	21.64 "

Such an ore would be of little value in the market at present, although it might be utilised by mixing with other ores. According to some authorities both chromium and titanium exert a beneficial influence upon the character of steel ; but in a number of cases steels, reported to contain one or other of these constituents have been shown to be entirely free from them.

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* *Amer. Jour. of Mining*, Oct. 18th, 1879.

PROCEEDINGS OF THE NATURAL HISTORY SOCIETY OF MONTREAL.

The third meeting for the present Session was held on the evening of Monday, January 26th. The President, A. R. C. Selwyn, Esq., F.R.S., occupied the chair.

After reading and adoption of minutes of last meeting, Mr. Frank Adams, B. A. Sc., was elected a member of the Society.

A fossil feather in an excellent state of preservation, from the post-pliocene clay of the Ottawa valley, together with a photograph of the same, was exhibited by H. E. the Governor-General through the President.

Mr. D. Hunter showed a series of specimens of molybdenite associated with various other minerals, from Calaboga.

Dr. J. Baker Edwards then submitted the following analysis and report of waters of the Assiniboine and Red Rivers:

ANALYSIS.

	Red River.	Assiniboine.
Degree of hardness	9	$10\frac{1}{2}$
Organic matter	5.28	7.71
Calcic sulphate	2.42	4.39
Calcic carbonate	10.50	7.05
Iron and alumina	2.80	1.09
Silica	.98	....
Magnesia sulphate	....	7.81
Alkaline salts as chlorides	5.08	9.75
Per imp. gal.	27.06	37.80

REPORT.

The samples of water of which I now submit the analysis were handed to me by Prof. Robert Bell last spring, but were collected by him on October 18th, 1873, above the affluence of the two rivers a few miles above Fort Garry.

Although therefore the mineral constituents are approximately determined by the present analyses, it is probable that the amount of organic matter is under-estimated in consequence of the lapse of time during which these samples have been kept corked and sealed, during which some decomposition has occurred. The general characters of the waters are however well shown by their mineral constituents, and although they may have passed over a different class of rocks in their approach to this affluence, the points of difference in their character are not remarkable, and are well calculated to produce a mingled water of a more potable character than either would be separately.

The leading feature of the Assiniboine water is Sulphate of Magnesia, which is not present in the Red River water, but is partially replaced by iron, giving it a slight and temporary chalybeate character.

This often occurs in Derbyshire, England, where the water passing over an ochre bed becomes turbid and red from the presence of iron, after which the water clears again, deprived of much of its bittern, viz. magnesic salts. This would be precipitated by ferric or alkaline carbonates and by soluble phosphates, and a perfectly sweet water obtained. It is quite probable that the Red River water has thus had its magnesic salts removed, and its iron and lime carbonate proportionately increased by the minerals which it has passed over in its course, and by this means it has been rendered potable and sweet, although slightly chalybeate. Artificial filtration might accomplish the same result for the Assiniboine water.

Principal Dawson presented the following list of the land shells of Prince Edward Island by Francis Bain, Esq. of North River, P. E. I.:

Helix (Patula) striatella, Anthony.
* *Helix (Zonites) arborea*, Say.
Helix (Z.) ferrea, Morse.
* *Helix (Z.) chersina*, Say.
Helix (Vallonia) minuta, Say.
Helix (Helicodiscus) lineata, Say.
Vitrina limpida, Gould.
Succinea Totteniana, Morse.
Succinea ovalis, Gould.
Zua (Ferussaceia) lubricoides, Stimpson.
Zoogenetes (Acanthinula) harpa, Say.

The species marked thus *, and also *Helix (Tachea) hortensis* Müll (the yellow variety), have been noticed in Dawson and Harrington's Report on the Geology of Prince Edward Island.

The stouter shelled species are all something smaller than the same occurring in the New England States; but these with very fragile shells, as *Helix chersensis* and *Vitrina limpida* are fully equal in size.

In presenting the list the Principal remarked it is of interest as including species which may have crossed into Prince Edward Island in the later continental period succeeding the glacial subsidence, or have passed across Northumberland Strait on floating timber or by means of migratory birds.

It is to be observed that while Prince Edward Island is rich in vegetation, it has less variety in point of stations for land snails and in exposures of calcareous rocks than neighbouring parts of the mainland.

The President then read a lengthy paper entitled "Further remarks on the Stratigraphy of the Quebec Group." This was a reply to Mr. Thos. Macfarlane, who in an article published in our issue of June 23rd, 1879, had criticised a former paper by Mr. Selwyn. The paper forcibly presented the author's views to the effect that certain crystalline rocks known as diorites, dolerites, and amygdaloids, were of volcanic origin, as was shewn by their physical and mineralogical characters as well as by their microscopic structure.

Prof. Hitchcock, Director of the State Geological Survey of New Hampshire, being present said a few words on the subject discussed by Mr. Selwyn, expressing the hope that he might have an opportunity of studying this Quebec Group in the light of the views set forth.

Dr. T. Sterry Hunt followed in a speech of close reasoning, in which he assailed the views of the last generation, which supported Mr. Selwyn's position. He said what they had listened to that evening was a re-statement of an old theory built up by the Murchison, Lyell and Sedgwick school, eminent men in their own special field of study, but since their time a generation of geologists had appeared, who, qualified by a more comprehensive knowledge of mineralogy, microscopy, chemistry and lithology, had come to the conclusion that the rocks claimed as volcanic were not so. He was supported in the view he held by the ablest geologists of Europe, and the leading scientists of England were entirely of this view.

Dr. Dawson held that there was not sufficient evidence to prove these rocks volcanic. He had suggested the term aqueo-igneous as the best description of the cause of their formation.

A unanimous and hearty vote of thanks being tendered to Mr. Selwyn for his paper, the meeting closed.

The fourth meeting was held on Monday evening, February 22nd. In the absence of the President, Mr. Whiteaves, F.G.S., occupied the chair.

After routine business, the Chairman exhibited some remains of *Elephas primigenius*, obtained from the Youcan and Porcupine Rivers, and presented to the Society by the Ven. Archdeacon MacDonald of Fort MacPherson, N. W. T. These remains comprise a lumbar vertebra, the ulna and radius of a foreleg, a tibia, an almost entire lower jaw, and several molars. These bones were supposed to represent several individuals.

Dr. J. Baker Edwards then read a paper on "Molybdenite and its useful products."

Mr. J. T. Donald followed with a paper on "The Helderberg Rocks of St. Helen's Island," which appears in another part of this issue.

The fifth meeting was held on Monday evening, April 5th. Principal Dawson occupied the chair.

Messrs. C. S. Baker, Thomas Chambers and T. C. Brainerd were elected ordinary members of the Society.

W. J. Morris, Esq., exhibited and presented to the Society two fine specimens of *Eozöon Canadense*, from North Burgess, Ont. The exhibitor stated that the mass from which these specimens were obtained was not embedded, but had the appearance of a reef resting upon a crystalline limestone.

Mr. J. B. Goode exhibited his fine collection of Canadian Ferns, and read a paper describing the species and varieties obtained by him last summer, and mentioning the localities in which they were found.

Principal Dawson then presented a paper entitled "New facts respecting the geological relations of the Iron Ores of Pictou, Nova Scotia." In this paper he stated the results of the comparison of his own observations on the rocks of the East River of Pictou with those of E. Gilpin, Esq., F.G.S., and with the inferences deducible from large collections of fossils made by request of the author by Mr. D. Fraser.

It appears that the older rocks represented on the rising grounds bounding the valley of the East Branch of the East

River may be referred to the Lower and Upper Cobequid series of the author. In rocks of the latter series occurs the great vein of specular iron on the west side of the river. To the former belong the ridges of so called trap and much of the slate and quartzite of the east side. Unconformably superimposed on these as detached troughs and constituting a long line of outcrop on the north-east side, are slates and iron ores holding fossils of the middle and upper part of the Arisaig series (Upper Silurian). There are two beds of iron ore differing somewhat in the fossils associated with them, but both Upper Silurian and newer than the Clinton age. The ore is a red Hematite, and the lower bed is in some places thirty feet in thickness. The upper bed is of less thickness, but apparently superior in quality. The upper Silurian rocks holding these ores are traceable all the way to Arisaig on the coast, though at that place less rich in iron.

The valley of the East Branch of the East River is occupied by a narrow band of Lower Carboniferous beds, and at the junction of these with the older rocks there are fissures holding a rich vein of Limonite.

The geological structure of this region is therefore similar to that of the Cobequids, though more complicated, and the iron ores are of different ages and occur under different conditions of deposit. These are, 1st, large and irregular veins of crystalline ores in the rocks of the Cobequid series; 2nd, bedded ores in the Upper Silurian rocks; and 3rd, Limonite veins at the junction of the Carboniferous with the older rocks.

As to the age of the Cobequid series, this is certainly older than the Upper Silurian; but probably newer than the gold series of the Atlantic Coast. It may be of the age of the English Borrowdale and Skiddaw series as the author has elsewhere suggested.

The paper was illustrated by maps, diagrams, samples of ore and a large collection of rocks and fossils.

The sixth meeting was held on Monday evening, April 26th. The President occupied the chair.

Mr. W. J. Morris presented to the museum a mass of apatite interstratified with chert and pale amethyst, from North Burgess, Ont.

Mr. J. B. Goode laid on the table several flowers of *Hepatica acutiloba* and *Sanguinaria Canadensis*, as representatives of our earliest flowering plants.

A paper "On some Silurian and Devonian fossils collected by Dr. Bell in Manitoba and Hudson's Bay," was read by Mr. Whiteaves. After stating that Prof. D. Dale Owen, in 1851, had shown that the limestones of Lower Fort Garry were of the same age as his Upper Magnesian limestone, now known as the Galena limestone, from the quantities of lead ore that it contains, the lecturer exhibited fossils from St. Andrews, Manitoba, and from various localities in the valleys of the Nelson and Churchill Rivers, collected by Dr. Bell, and claimed that they belonged to the same geological horizon as the Galena limestone of Wisconsin and Iowa. In Quebec, Ontario, and the State of New York, the Utica shale intervenes between the Hudson River group and the Trenton limestone, but in Manitoba and in the country between it and Hudson's Bay, the equivalents of the Galena limestone take the place of the Utica shale. The mass of Stony Mountain, Manitoba, was shown to consist of typical Hudson River rocks, which overlie directly and conformably the equivalents of the Galena limestones, so that the age of the latter can be established on stratigraphical as well as on palæontological grounds. At Fort Churchill and at two localities on the Nelson River some fossils were found which appear to be either of Upper Silurian or Devonian age, and at York Factory two corals were found which are certainly Devonian, but as these latter were found loose they may have drifted from a long distance.

Mr. Selwyn reviewed the subject generally, and Dr. Bell followed, describing the geographical distribution of the palæozoic rocks of Hudson's Bay, and their relations to the occurrence of economic minerals. He showed that in the southern part of this region the Upper Silurian formation rests directly upon the Laurentian, while to the north and west we have the Lower Silurian. The importance of palæontology in relation to economic geology was well illustrated in the present case where, as Dr. Bell pointed out, the determination by means of fossils of the identity of limestones of the Nelson Valley with the lead-bearing formation of the Western States may lead to important results.

Principal Dawson then read a paper written by Dr. B. J. Harrington entitled "Notes on Chrome Garnet, Pyrrhotite and Titaniferous Iron Ore," which we publish in full.

Previous to the close of the meeting the question of holding the annual Field Day was discussed, and a proposition to go to Yamaska Mountain was referred to the Field Day Committee.

Meteorological Abstract for the Year 1879.

Monthly results derived from tri-hourly observations taken at McGill College Observatory. Height above sea level, 187 feet.

C. H. McLeod, Superintendent.

Month.	Thermometer.				Barometer.				Mean pressure of vapor.	Mean relative humidity.
	Mean	Max.	Min.	Range.	Mean.	Max.	Min.	Range.		
January	12.74	35.9	-15.4	51.3	29.9166	30.547	29.115	1.432	.0705	82.3
February	10.92	37.3	-14.5	51.8	30.0257	30.854	29.112	1.742	.0598	74.7
March	24.96	49.2	-5.4	54.6	30.0530	30.718	29.324	1.394	.1090	82.2
April	38.29	65.8	8.5	57.3	29.8478	30.457	29.115	1.342	.1480	61.6
May	57.06	85.6	33.1	52.5	29.9767	30.523	29.483	1.040	.2956	61.6
June.......	62.19	87.1	38.2	48.9	29.8866	30.276	29.495	0.781	.4225	74.2
July	67.95	83.1	51.6	31.5	29.8699	30.241	29.490	0.751	.4820	70.6
August	65.21	85.2	47.0	38.2	29.8939	30.159	29.368	0.791	.4335	69.6
September	57.76	81.4	33.1	48.3	30.0215	30.392	29.498	0.894	.3613	73.9
October	54.00	80.0	22.0	58.0	30.0132	30.659	29.339	1.320	.3218	71.2
November	31.53	59.5	2.2	57.3	30.0276	30.513	29.305	1.208	.1552	79.3
December........	15.82	47.4	-25.2	72.6	30.1433	30.752	29.456	1.296	.0854	80.5
Means for '79. ..	41.536	66.46	14.60	51.86	29.97298			1.1659	.24538	73.47
Means for 5 years ending with '79.	42.362				29.95634				.25688	74.66

Month.	Wind.		Sky clouded per cent.	Rain and snow melted.
	Mean direction.	Mean velocity in miles ℔ hr.		
January	W.	13.32	67	4.08
February	W. N. W.	14.32	50	2.82
March	W. S. W.	12.25	59	4.57
April	W. N. W.	14.31	66	0.96
May	W. S. W.	11.15	54	0.80
June................................	W.	9.07	63	4.82
July.	W. S. W.	7.98	56	4.79
August..............................	W.	7.79	55	1.40
September...........................	S. W.	9.64	59	3.18
October	W. S. W.	12.47	64	1.70
November	W. S. W.	13.90	81	4.56
December........	W.	11.70	69	5.48
Means for '79	W. by S.	11.492	61.9	3.263
Means for 5 years ending with '79	W.	10.99	62.4	3.279

Greatest heat was 87.1 on the 25th of June. Greatest cold was 25.2 below zero on December 21st, giving a range of temperature for the year of 112.3 degrees. Greatest range of the thermometer in one day was 48.7 on December 30th. The warmest day was August 2nd, the mean temperature being 77.9. The coldest day was December 21st, the mean temperature being §16.2 below zero. Highest barometer reading was 30.854 on February the 28th; lowest was 29.112 on February the 12th;

giving a range for the year of 1.742 in. The lowest relative humidity was 21 on the 26th May. Greatest mileage of wind in one hour during the year was 43 on January 3rd. Greatest velocity in gusts was 56 on the 26th of February. Mean direction of the wind, West by South.

NOTES.—Wheel traffic commenced April 21st, interrupted on November 20th and December 2nd, and closed on December 20th.

The heaviest rainfalls were on June 5th when rain fell for 15 minutes at the rate of 3 in. per hour, on June 28, when rain fell for 10 minutes at the rate of 3.6 in. per hour, and on July 15th.

The first snow of autumn fell on October 24th, which was inappreciable; the first appreciable snow was on the 3rd of November.

There was a slight earthquake at 10 p.m. on June the 11th, the vibration was not sufficient to give any indication of its direction.

§ The mean of max. and min. temperatures, being Sunday. The next coldest day was December 31st, when the mean temperature, was 11.2 below zero.

RAIN AND SNOW FALL DURING 1879.

McGill College Observatory.

MONTH.	Inches of rain.	No. of days on which rain fell.	Inches of snow.	No. of days on which snow fell.	Inches of rain and snow melted.	No. of days on which rain *and* snow fell.	No. of days on which rain *or* snow fell.
January	0.00	0	39.5	23	4.08	0	23
February	0.03	1	27.4	16	2.82	1	16
March	1.23	10	32.6	16	4.57	5	21
April	0.27	5	6.9	5	0.96	0	10
May	0 80	12	0.0	0	0.80	0	12
June	4.82	21	0.0	0	4.82	0	21
July	4.79	19	0.0	0	4.79	0	19
August	1.40	13	0.0	0	1.40	0	13
September	3.18	15	0.0	0	3.18	0	15
October	1.70	9	s	1	1.70	0	10
November	2.81	14	16.8	8	4.56	1	21
December	1.74	7	37.4	21	5.48	2	26

Total rainfall during the year was 22.77 inches.
Total snowfall during the year was 160.6 inches.
Total rain and snow melted was 39.16 inches.
Total number of days on which rain fell, 126.
Total number of days on which snow fell, 90.
Total number of days on which rain *or* snow fell, 207.
Total number of days on which rain *and* snow fell, 9.

The Function of Chlorophyll.—One of the most important recent contributions to physiological botany, is contained in a recent communication to the Berlin Academy of Sciences, by Dr. Pringsheim, which appears to throw considerable fresh light on the function of chlorophyll in the life of the plant.

Having been led by previous researches to the conclusion that important results might be obtained by the use of intense light, he combined an apparatus by which the object under view should be brightly and constantly illuminated by a strong lens and a heliostat. If in this way an object containing chlorophyll—a moss-leaf, fern-prothalium, chara, conferva, or thin section of a leaf of a phanerogam—be observed, it is seen that great changes are produced in a period varying from three to six or more minutes.

The first and most striking result is the complete decomposition of the chlorophyll, so that in a few minutes the object appears as if it had been lying for some days in strong alcohol. Although however, the green color has disappeared, the corpuscles retain their structure essentially unaltered. The change then gradually extends to the other constituents of the cell; the circulation of the protoplasm is arrested; the threads of protoplasm are ruptured and the nucleus displaced; the primordial utricle contracts and becomes permeable to coloring matters; the turgidity of the cell ceases; and the cell presents, in short, all the phenomena of death.

That these effects are not due to the action of the high temperature to which the cell is exposed under these circumstances is shown by the fact that they are produced by all the different parts of the visible spectrum. The result is the same whether the light has previously passed through a red solution of iodine in carbon bisulphide, through a blue ammoniacal solution of cupric oxide, or through a green solution of cupric chloride. If the carbon disulphide solution of iodine be so concentrated that only rays of a greater wave-length than 0.00061 mm. can pass through it, these effects are not produced, although about eighty per cent. of the heat of white sunlight is transmitted. On the other hand, if the ammoniacal solution of cupric oxide be so concentrated that the whole of the rays of a less wave-length than 0.00051 mm. are absorbed, a rapid and powerful effect is produced, although the amount of heat that passes is very small. It is thus seen that the phenomena in question are not the result of heat.

The next point determined by Dr. Pringsheim, is that the effects are not produced in an atmosphere devoid of oxygen. This was the case whether the oxygen was replaced by pure hydrogen or by a mixture of hydrogen and carbon dioxide; while the removal of the carbon dioxide from atmospheric air was altogether without effect on the phenomena. The conclusion drawn is that the decomposition of chlorophyll in the living plants is a process of combustion which is influenced and promoted by the action of light, and which is not related to the decomposition of carbon dioxide by the plant. When the green color of the chlorophyll-grains has been partially destroyed, it cannot be restored, even though the cell continues to live; from which it is inferred that the result is not a normal physiological, but a pathological effect. No substance was found in the cells which might be regarded as the product of the decomposition of the chlorophyll, nor was any oil or starch detected in the etiolated cell, nor any formation of grape-sugar or dextrine. The assumption is therefore that the products of decomposition are given off in the gaseous form.

The conclusion is drawn that the decomposition produced in the protoplasm, and in the other colorless cell contents, is the direct effect of the photochemical action of light. That it is not due to the injurious influence of the products of decomposition of the coloring matter of the chlorophyll, is shown by the fact that it takes place equally in cells destitute of chlorophyll, such as the hairs on the filaments of *Tradescantia*, the stinging hairs of the nettle, &c. It is, on the other hand, dependent on the presence of oxygen, or is a phenomenon of combustion.

The results of a variety of experiments leads Dr Pringsheim to the important and interesting conclusion that the chlorophyll acts as a protective substance to the protoplasm against the injurious influence of light, diminishing the amount of combustion, or in other words, acting as a regulator of respiration.

He than proceeds to investigate what are the substances which become oxidized in the process of respiration. In every cell, without exception, that contains chlorophyll, Pringsheim finds a substance that can be extracted by immersion in dilute hydrochloric acid for from twelve to twenty-four hours, to which he gives the name *hypochlorin* or *hypochromyl*, and which he believes to be the primary product of the assimilation of the chlorophyll. It occurs in the form of minute viscid drops or masses of a semifluid consistency, which gradually change into long red-brown imperfectly crystalline needles. It is soluble in alcohol, ether, turpentine and benzol, but insoluble in water and in a solution of sodium chloride. It becomes gradually oxidized on exposure to an imperfectly crystalline resinous substance. It is probably an ethereal oil, and an invariable accompaniment of the coloring substance of chlorophyll, and even more universally distributed than starch or oil. It has not yet been detected in those plants which do not contain true green chlorophyll, such as the Phycochromaceæ, Diatomaceæ, Fucaceæ and Florideæ. Starch and oil appear to be reserve substances produced by the oxidation of the hypochlorin caused by light, it being the most readily oxidizable constituent of the cell, more so even than chlorophyll itself.

That the hypochlorin—present in variable quantity in every chlorophyll grain under normal circumstances—is subject to continual increase and decrease, may be proved without difficulty. All comparative observations on chlorophyll grains in younger and in older conditions, point unmistakably to the conclusion that the collection and increase of the starch enclosed in the ground substance of the chlorophyll, goes on *pari passu* with a decrease of the hypochlorin. In dark, the hypochlorin, which does not take any direct part in the transport of food materials, is more permanent than starch; and this fact again is in agreement with the conclusion that its transformation in the cell into more highly oxidized bodies is hindered by the increased respiration in light.

In the facts here detailed, and the conclusions derived from them, Dr. Pringsheim believes that an entirely new light is thrown on the cause of the well-known fact that assimilation takes place only in those cells of the plant which contain chlorophyll. This substance acts universally as a moderator of respiration by its absorptive influence on light, and hence allows the opposite phenomena of respiration and elimination of carbon dioxide to go on in those cells which contain it. A more detailed account of the experiments and results is promised by the author in a future paper.—*American Naturalist*.

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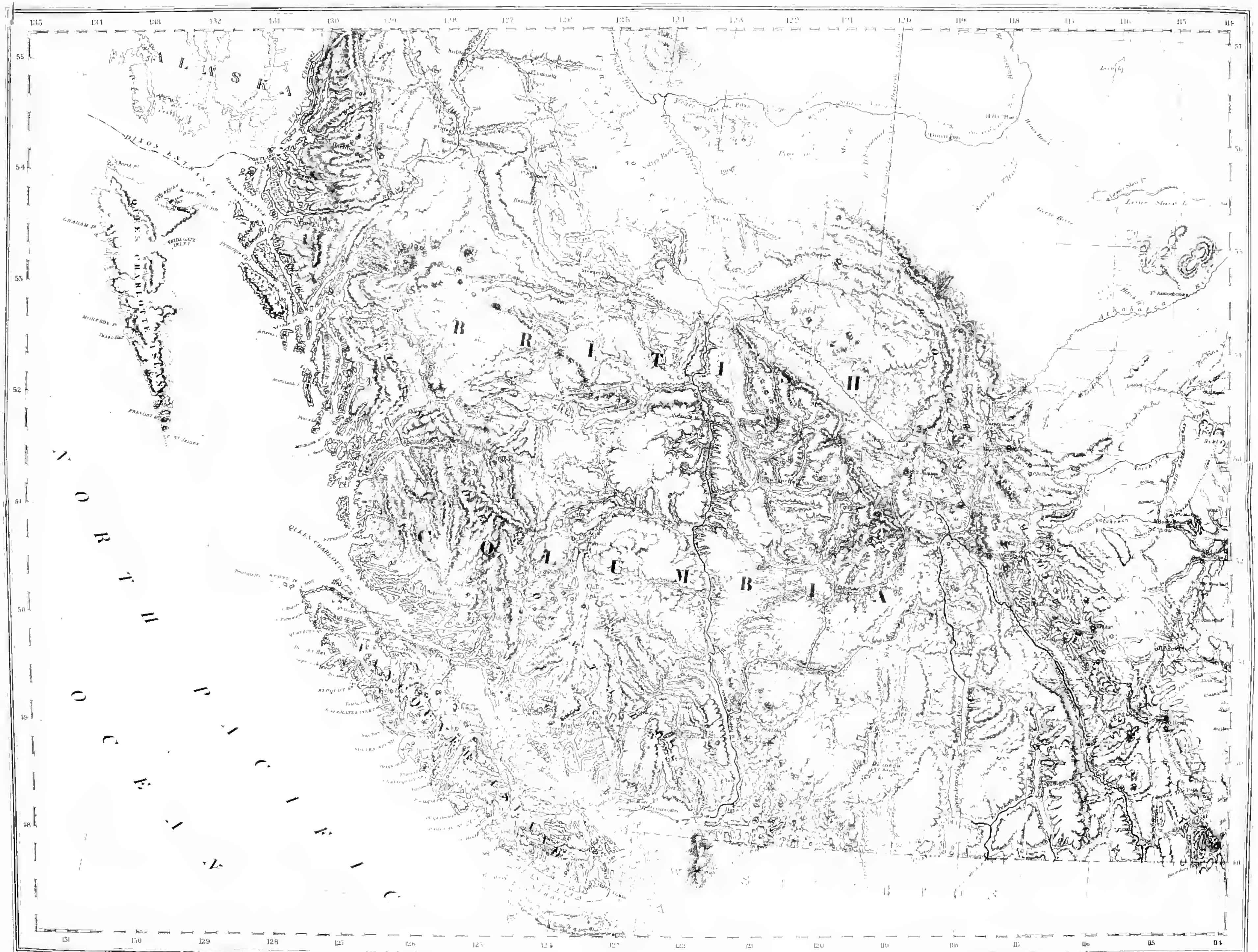

MAP illustrating the Distribution of some of the more Important Trees in British Columbia, by George M. Dawson.

THE

CANADIAN NATURALIST

AND

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NOTE ON THE DISTRIBUTION OF SOME OF THE MORE IMPORTANT TREES OF BRITISH COLUMBIA.

(Printed in advance of the Report of Progress of the Geological Survey of Canada for 1879-80.)

BY GEORGE M. DAWSON, D.S., A.R.S.M., F.G.S.

British Columbia forming a portion of the Cordillera region of the west coast of America, with diversified and bold physical features, the lines indicating the geographical range of the various species of plants do not assume in it the broad rounded forms found in less mountainous districts. The peculiarities in distribution while adding interest to the study, render an intimate knowledge of the topography of the country an essential prerequisite to its prosecution. As large tracts of the province are as yet geographically unknown owing to their remoteness and singular impenetrability, we are far from possessing complete information on the distribution of many of even the more important species. The following notes and map are presented as a contribution towards our knowledge of the range of some of the trees of British Columbia, based on notes and observations made by myself while engaged in the work of the Geological Survey from 1875 to 1879. I am indebted to Mr. H. J. Cambie of the Canadian Pacific Railway for valuable notes on the extension of certain trees from the coast up the valleys of the Homathco and Dean or Salmon Rivers, and in a few cases have availed myself of facts published in Prof. Macoun's reports. I have also to thank Dr. Engelmann for notes furnished in regard to specimens collected in various parts of the province.

It is not intended to give a description of the orography of the province, though as above indicated this is closely connected with the extension of the various species of plants. The following general statement made by me in a note on agriculture and stock raising and extent of cultivable land in the province,* may, with little alteration, be repeated here, as outlining the conditions to be found within its area:—The flora of British Columbia as a whole may be broadly divided into four great groups, indicating as many varieties of climate, which may be named as follows:—the *West Coast*, the *Western Interior*, the *Canadian*, and the *Arctic*. The first, with an equable climate and heavy rainfall, is characterized by a correspondent luxuriance of vegetation, and especially of forest growth. This region is that west of the Coast Range, and is well marked by the peculiarity of its plants. In a few spots only—and these depending on the dryness of several of the summer months owing to local circumstances—does a scanty representation of the drought-loving flora of the Californian coast occur. The second is that of the southern part of the interior table-land of the province, and presents as its most striking feature a tendency to resemble in its flora the interior basin of Utah and Nevada to the south and the drier plains east of the Rocky Mountains. It may be said to extend northward to about the 51st parallel, while isolated patches of a somewhat similar flora occur on warm hill-sides and the northern banks of rivers to beyond the Blackwater. In the northern part of the interior of the province, just such an assemblage of plants is found as may be seen in many parts of eastern Canada, though mingled with unfamiliar stragglers. This flora appears to run completely across the continent north of the great plains, and characterizes a region with moderately abundant rainfall, summers not excessively warm, and cold winters. The arctic or alpine flora is that of the higher summits of the Coast, Selkirk, Rocky and other mountain ranges, where snow lies late in the summer. Here plants lurk which deploy on the low grounds only on the shores of Hudson Bay, the Icy Sea and Behring's Strait.

In the following notes the Coniferæ are placed first as having the greatest importance both from an economic point of view, and from the vast extent of country which they cover almost to the exclusion of other trees.

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* Report Can. Pacific Railway, 1877. Appendix S.

Pseudotsuga Douglasii, Lindl. Douglas spruce, Douglas fir, sometimes commercially named Oregon pine. This is the most important timber tree of British Columbia, and the only one of which the wood has yet become an article of export on a large scale. It is found in all parts of Vancouver Island with the exception of the exposed western coast, but does not occur in the Queen Charlotte Islands or coast archipelago to the north of Vancouver. On the mainland, near the forty-ninth parallel, it extends from the sea to the Rocky Mountains, growing at a height of 6000 feet in a stunted form, and occurring even on the eastern slopes of the Rocky Mountains. In the dry southern portion of the interior of British Columbia it is confined to the higher uplands between the various river valleys. Northward it comes down to the general level of the country. It does not extend into the mountainous and comparatively humid region of Cariboo, and is probably absent from the higher portions of the Selkirk and Gold Ranges generally. Its northern line is singularly irregular. It is found about Fort George, and north-eastward as far as McLeod's Lake, but does not occur on the Parsnip. It extends about half-way up Tacla Lake, and on Babine Lake to the bend or knee. A few specimens occur on the Skeena River. It is common about Fraser and François Lakes. It is found from the Fraser to the coast mountains on the line of the Chilcotin and its tributaries, and occurs on the Nazco and up the Blackwater to the mouth of the Iscultaesli, but is absent from an extensive tract of country bounded by the last-named localities to the south and east and extending northward to François Lake. It occurs abundantly on the coast of the mainland as far north as the north end of Vancouver Island, but beyond that point is found only on the shores of the inlets at some distance from the sea. It is found on the upper part of Dean Inlet and on the Salmon River which runs into it, but about forty-five miles from the salt water becomes small and stunted, and as above stated, is not seen in that part of the interior lying to the eastward.

The extent of its range to the north-eastward. in the Rocky Mountain range, though broadly indicated on the map, is still uncertain.

The best grown specimens are found near the coast in proximity to the waters of the many bays and inlets which indent it. Here the tree frequently surpasses eight feet in diameter, at a considerable height above the ground, and reaches a height of from 200 to over 300 feet, forming prodigious and dark forests. The wood varies considerably in appearance and strength according to its locality of growth and other circumstances. It is admirably adapted for all ordinary purposes of construction, and of late has obtained favourable notice in ship-building, remaining sound in water for a long time. For spars and masts it is unsurpassed both as to strength, straightness and length. Masts for export are usually hewn to octagonal shape from 20 to 32 inches in diameter and 60 to 120 feet in length. On special orders they have been shipped as large as 42 inches in diameter by 120 feet long. Yards are generally hewn out from 12 to 24 inches in diameter and 50 to 102 feet long.

Masts and spars are generally sent to Great Britain; other forms of lumber to South America, Australia, India, China and the Sandwich Islands.

Tsuga Mertensiana, Lindl. Western hemlock. The hemlock occurs everywhere in the vicinity of the coast, and extends up the Fraser and other rivers to the boundary of the region of abundant rainfall. It reappears in the Selkirk and Gold Ranges, where sufficient moisture for its growth is again found. The tree attains a large size on the coast, reaching a height of 200 feet, and yields a good wood, but has not yet been much used. The bark is employed successfully in tanning. *Tsuga Mertensiana* closely resembles the eastern hemlock (*T. Canadensis*) but attains a larger size than that tree ever does.

In the Queen Charlotte Islands it is particularly abundant and large. On the Salmon River, running into Dean Inlet, it is not found in abundance beyond eighteen miles from the sea at an elevation of 600 feet. It occurs again, however, sparingly on the lower part of the Iltasyouco River, a tributary to the last, and within the Coast Range. On the Homathco River, flowing into Bute Inlet, it ceases at fifty-three miles from the sea at an elevation of 2320 feet. On the Uz-tli-hoos it extends to a point six or ten miles east of the Fraser, on the Coquihalla to the summit between that river and the Coldwater.

Thuja gigantea, Nutt. Western arbor vitæ, giant cedar, red cedar. This tree in its distribution nearly follows that of the hemlock, abounding along the coast and lower parts of the rivers of the Coast Range, being unknown in the dry central plateau, but reappearing abundantly on the slopes of the Selkirk and Gold

Ranges. On the Salmon River the cedar ceases at forty-five miles from the head of Dean Inlet at an elevation of 2400 feet, though like the hemlock it is again found sparingly and in a stunted form in the lower part of the Iltasyouco Valley. On the Homathco it ceases at a distance of sixty-three miles from the coast at an elevation of 2720 feet. On the Uz-tli-hoos it ends with the hemlock at about six miles east of Boston Bar, on the Coquihalla, just south of the summit between that river and the Coldwater. Cedars are also found sparingly on the Skaist River or east branch of the Skagit, and a few were observed on the banks of the Similkameen, about thirteen miles below Vermilion Forks. It extends westward from the flanks of the Gold Range in the Coldstream Valley sparingly to within eight miles of the head of Okanagan Lake. It abounds round the shores of the north-eastern part of Shuswap Lake, and on the North Thompson Valley to about twenty miles below the mouth of the Clearwater. It is said that there is also a small grove of these trees on the Fraser below Fort George.

On the coast it not unfrequently surpasses fifteen feet in diameter with a height of 100 to 150 feet, but such large trees are invariably hollow. The wood is good, pale yellowish or reddish, and very durable, but it is not yet extensively used except for the manufacture of shingles. From this tree the Indians split out the planks which they use in the construction of their lodges along the coast, and in the north make the carved posts which ornament their villages. They also hollow their large and elegant canoes in it, and use the fibre of the inner bark for rope making and other purposes.

Picea Engelmanni, Parry. Engelmann's spruce. This tree resembles the black spruce of the east, but reaches a larger size, frequently surpassing three feet in diameter, and running up tall and straight. It appears to characterize the interior plateau and eastern part of the province, with the exception of the dry southern portion of the former, and forms dense forests in the mountains. Varieties occur, which, according to Dr. Engelmann, who has examined my specimens, are almost indistinguishable from *Picea alba*, and to the north-eastward these varieties preponderate. Specimens collected on the Peace River plateau (lat. 55° 46′ 54″, long. 120° 20′, altitude 2600 feet) are still referable to *P. Engelmanni*, but trees on the Athabasca (lat. 54° 7′ 34″, long. 118° 48′) belong to *P. alba*. The northern and north-eastern range of Engelmann's spruce is therefore undeterminate.

It borders nearly all the streams and swamps in the northern portion of British Columbia between about 2500 and 3500 feet in elevation. It is probably this tree which forms dense groves in the upper alpine valleys of the Rocky Mountains in the vicinity of the forty-ninth parallel. The wood has not yet been extensively employed, but it is excellent, and in some cases very durable.

Picea Menziesii, Lindl. Menzie's spruce. This tree seems to be confined chiefly to the immediate vicinity of the coast, where it attains a large size, and is to some extent used for lumber. It was, however, observed on the summit between the Coldwater and Coquihalla Rivers (3280 feet); also on the Nicolume a few miles beyond the summit between that stream and the Sumallow, and on the west side of the Spioos valley near the trail crossing. It was noted (doubtfully) on the summit between the Forks of Skeena and Babeen Lake, and may probably occur in the humid region of the Gold and Selkirk Ranges. The wood is white and free.

Abies grandis, Lindl. Confined to the vicinity of the coast, where its range is even more strictly limited than that of the cedar or hemlock. The wood is said to be white and soft, but too brittle for most purposes, and moreover liable to decay rapidly. Grows to a large size.

Abies subalpina, Engelm. (= *A. lasiocarpa* Hook.) Balsam spruce. Appears to take the place of *Abies grandis* in the region east of the Coast Ranges. It is not found in the southern dry portion of the interior plateau, but occurs abundantly in the Gold and Selkirk Ranges in the Rocky mountain region east of McLeod's Lake. Elsewhere it occurs in scattered groves, in the northern portion of the interior plateau, generally in localities nearly reaching or surpassing 4000 feet, but even in low valleys in the eastern portion of the Coast Ranges. It crosses the Rocky mountains in the Peace River district and occurs in cold damp situations in the county between Lesser Slave Lake and the Athabasca River. The tree often exceeds two feet in diameter, but the wood is said to be almost worthless.

Pinus ponderosa, Dougl. Yellow pine, red pine, pitch pine. A remarkably handsome tree, which grows only in the central dry region of British Columbia, occurring between the Coast Ranges and Selkirk and Gold Ranges northward from the forty-ninth parallel to latitude 51° 30′ and probably also to about latitude 51° in the valley of the upper portion of the Columbia. Found also I believe sparingly on the east side of the Rocky Mountains near Waterton Lake on the forty-ninth parallel. On the Similkameen this tree is seen furthest east three miles above Nine-mile Creek. On the Coldwater it reaches to eighteen or twenty miles from the Nicola; down the Fraser to thirty miles above Yale, and northward on the main waggon road to "the Chasm" beyond Clinton. It extends about forty miles up the North Thompson, is found on the northern slopes of the South-western Arm of Great Shuswap Lake, and also sparingly on the southern part of the Salmon Arm, west of Okanagan Lake towards Cherry Creek nearly to the Camel's Hump Mountain.

It is used pretty extensively in the region which it characterizes, yielding sawn lumber of good appearance, but rather brittle and not very durable when exposed to the weather. It grows in open groves in the valleys, where it often occurs almost to the exclusion of other trees; and stretches up the slopes of the mountains and plateaux to a height of over 3000 feet, where it is replaced by the Douglas fir and *Pinus contorta*. Its diameter in British Columbia does not seem to exceed four feet, though further south it is said to reach a diameter of twelve to fifteen feet.

Pinus contorta, Dougl. Western scrub pine, also called the bull or black pine. Occurs throughout British Columbia from the sea-coast to the eastern slopes of the Rocky Mountains, and from the forty-ninth parallel northward. It is the characteristic tree over the northern part of the interior plateau, and densely covers great areas. In the southern part of the province it is found on those parts of the plateau and hills which rise above about 3500 feet, where the rainfall becomes too great for the healthy growth of *P. ponderosa*. It grows also abundantly on sandy benches and river flats at less elevations. On the coast it occurs rather sparingly on sandy dunes and the most exposed rocky points, becoming gnarled and stunted. In the Queen Charlotte Islands it is scarcely seen except on the western coast, and does not occur near the water level for a considerable distance up the Skeena. In the interior it often forms dense groves, the trees being 60 to even 100 feet in height, but seldom exceeding a diameter of two feet. It does not extend upward to the timber limit in the higher mountains. The tree characteristic of the interior is *var. latifolia* of Engelmann, and differs considerably in appearance and character of wood from that of the coast to which the name *contorta* may appropriately be applied. Dall states the northern limit of this tree in Alaska to be on the Youkon at Fort Selkirk, latitude 63°. In the Peace River region it crosses the Rocky Mountain range, and occurs more or less abundantly over a great area generally on the higher parts of the plateau with poor soil. It is replaced by the Banksian pine at the watershed between the Athabasca and Saskatchewan.

The wood is seldom used as lumber on account of its small size, but is white and fairly durable. The cambium layer, containing much sugar, is eaten by the Indians in the spring, and in some instances large quantities of it are collected and dried for winter use.

Pinus flexilis, James *var. albicaulis*, Engelm. White pine, white-barked pine. Wood not employed as lumber; the trees being in general small and in inaccessible situations. Observed in the Coast or Cascade Ranges as far north as the Iltasyouco River (lat. 53°), occurs in the mountains south of the upper part of the Dean or Salmon River, in the vicinity of Lillooet and at Yale, and on the summit of Iron Mountain at the mouth of the Coldwater. The seeds are collected and used as food by the Indians.

Pinus monticola, Dougl. White pine. This tree is abundant in certain districts of the interior of Vancouver Island, and is also found in all parts of the southern portion of the Coast Range where there is an abundant rainfall. It is found on the Hope-Similkameen trail, some miles beyond the summit on the Sumollow, about the summit between the Coquihalla and Coldwater on the Hope-Nicola trail; and to the west bank of the Spioos at the trail crossing. On the Homathco River it disappears at fifty-one miles from the sea at an elevation of 2235 feet. It reappears in the region of heavy rainfall of the Gold Range, being abundant about Cherry Creek and on the shores of Great Shuswap and Adam's Lakes. It has not been observed in the Queen Charlotte Islands, though it may exist there. It appears to flourish best in the higher mountain regions. The tree attains sixty to eighty feet in height with a diameter of two to three feet, but is generally most abundant in situations inaccessible to the lumberer. The wood is coming into use for some purposes. It is not considered equal to that of the eastern white pine (*P. strobus*) which it resembles. The Indians collect and eat the seeds of this tree.

Chamæcyparis Nutkaensis, Lamb. Yellow cypress. Commonly known as the yellow cedar. This tree is confined to the vicinity of the coast and adjacent islands. It is found in the vicinity of Burrard Inlet on the slopes of the mountains, several hundred feet above the sea level. Further north it descends to the coast. It occurs in the interior of Vancouver Island, and is abundant in some parts on the Queen Charlotte Islands, particularly on the west coast. It often exceeds six feet in diameter. This wood is as yet comparatively unknown in commerce, but is strong, free and of fine grain, with a pale golden yellow tint and a slight peculiar resinous smell. It is very durable and has been used to a limited extent in boat-building and for various ornamental purposes.

Larix occidentalis, L. Western larch. Is found in the Rocky mountains and in the valleys of the Selkirk and Gold Ranges, its limit there being co-extensive with that of abundant rainfall. Stretches westward nearly to the head of Okanagan Lake. Not found on the coast. The timber is said to be strong and durable but coarse.

A species of larch, which from imperfect specimens submitted to him Dr. Engelmann supposes to be *L. America*, occurs abundantly in swampy spots on the Peace River plateau and on the Athabasca.

Taxus brevifolia, Nutt. Yew. Occurs on Vancouver Island, and on the shores of the mainland adjacent, attaining sometimes a diameter of two feet. Not found, or very sparingly in the Queen Charlotte Islands. A very tough hard wood of beautiful rose color, employed for various ornamental purposes. Formerly used by the Indians in making bows, spear handles, fish-hooks &c.

Juniperus virginiana, L. Juniper, red cedar, savin. Has been observed assuming an arboreal form along the shores of Kamloops, François and other lakes, and elsewhere, with a diameter of about a foot. Commonly known as pencil cedar.

Acer macrophyllum, Pursh. Maple. Found on Vancouver and adjacent Islands, and on the mainland in the immediate vicinity of the coast northward sparingly to latitude 55°, and in the Queen Charlotte Islands. Never found inland. Occasionally attains a diameter of four feet. A valuable hard wood, sometimes well adapted for cabinet-making, and also used as fuel.

Acer circinatum, Pursh. Vine maple. Like the last strictly confined to the vicinity of the coast, but does not appear to go far north. A small tree, seldom over a foot in diameter, but yielding a very tough and strong white wood, which is used, in the absence of ash, for the manufacture of helves, &c.

Pyrus rivularis, Dougl. Crab-apple. Occurs along the coast of Vancouver and the Queen Charlotte Islands and the whole coast of the mainland of British Columbia. On the Skeena abundant to the mouth of the Lakelse and a few trees seen at ninety miles from the sea. A small tree or shrub. Wood very hard, susceptible of a good polish, and especially valuable in those parts of mill machinery intended to withstand great wear. Fruit prized by the Indians as food.

Pyrus sambucifolia, Cham. and Schlect. Mountain ash. Sparingly in various parts of the interior of the Province. A small tree or bush.

Amalanchier alnifolia, Watson. Service-berry, 'la poire.' Occurs on Vancouver Island and very rarely and in a stunted form in the Queen Charlotte Islands. Abundant in some parts of the interior plateau and beyond the Rocky mountains to the north eastward in the Peace River country. Generally a shrub. Under favourable circumstances a small tree. The wood is very hard and is used for various purposes by the Indians. The berries are dried and stored away in large quantities for winter use.

Quercus Garryana, Dougl. Oak. Grows only in the south-eastern portion of Vancouver Island, though Mr. A. C. Anderson mentions the existence of a few trees near Yale, on the Fraser River, which have probably now disappeared. Reaches a diameter of three feet and a height of about seventy feet. Used for flooring and other purposes in building, and also in the manufacture of barrels and kegs. A hard wood but not very tough.

Alnus rubra, Bongard. Alder. Attains the dimensions of a small tree, on Vancouver and Queen Charlotte Islands and the coast of the mainland. Wood sometimes employed for making charcoal.

Betula occidentalis, Hook. Birch. Occurs sparingly over almost the entire area of the province. Well grown trees are found in the northern part of the Fraser basin and in the Peace River country.

Populus tremuloides, Michx. Aspen poplar. Abounds over the whole interior of the province, growing everywhere in the north and characterizing some of the most fertile lands. In the southern dry portions of the interior found usually along the borders of streams, and on the higher plateaux. First noticed in abundance on the Skeena at about 110 miles from the sea. It forms the usual second growth after fires in the Peace River country. Attains frequently a diameter of two feet.

Populus trichocarpa, T. & G. Cottonwood. Grows chiefly in the valleys of streams and on the banks of rivers, throughout the province, and north-eastward in the Peace River district. Frequently four to five feet in diameter. Used by the Indians of the interior for the manufacture of canoes. *Populus balsamifera & P. monilifera* may also occur in some parts of the region, all going under the general name of Cottonwood.

Arbutus Menziesii, Pursh. Arbutus, madrona. Occurs on Vancouver and the neighbouring islands, but never far from the sea. It is sparingly represented as far north as Seymour Narrows. A very handsome evergreen yielding a white close-grained heavy wood, resembling box. Attains a diameter of from eighteen inches to two feet, and a height of fifty feet.

Cornus Nuttallii, Aud. Dogwood. On Vancouver Island and the coast of the mainland adjacent, attaining the dimensions of a small tree. Wood close-grained and hard.

NEW FACTS RESPECTING THE GEOLOGICAL RELATIONS AND FOSSIL REMAINS OF THE SILURIAN IRON ORES OF PICTOU, NOVA SCOTIA.

By J. W. Dawson, LL.D., F.R.S.

(Read before the Natural History Society of Montreal, April 5th, 1880.)

The subject of this paper has already been discussed by me in various previous publications; and most recently in a paper read at the Portland meeting of the Association for the Advancement of Science in 1874, and published in the Journal of this Society; and in the Supplement to the second edition of "Acadian Geology," 1878. In these publications I have described the general arrangement of the Rocks of the Cobequid Series in the rising grounds on both sides of the East Branch of the East River of Pictou, the superposition on these of Upper Silurian rocks holding bedded red hematite, and the occupation of the valley itself by a narrow band of Lower Carboniferous beds.

I may explain that the name "Cobequid group" was proposed in my Acadian Geology, 1868, for the series of schistose and crystalline rocks constituting the axis of the Cobequid hills, and extending eastward from these, with some partial interruption, through the hilly districts of southern Pictou. In the Cobequid hills, where these rocks are well exposed, they consist of two members: (1) an upper series of gray and dark slates and quartzites with a band of crystalline limestone and veins of iron ores; (2) a lower series consisting largely of felsite, porphyry and agglomerate. Both series are penetrated by dykes and masses of red syenite and dark-coloured diabase, the latter cutting also the overlying Silurian rocks. These last, as seen at Wentworth and New Annan, overlie unconformably the Cobequid group, and afford fossils characteristic elsewhere of the Upper Silurian system. The least antiquity that can be assigned to the Cobequid rocks is thus that of the Siluro-Cambrian; and by some, on the ground chiefly of mineral character, they have been regarded as Huronian. I have ventured to suggest, on the evidence of their relations to the Upper Silurian beds, and to the apparently older Cambrian series of the Atlantic coast, that they may be representatives of the Skiddaw and Borrowdale series of England, and of the Quebec group of the Lower St. Lawrence.

These rocks, in their extension into Pictou County, present characters not dissimilar from those seen in the Cobequids. On the high ground on the west side of the east branch of the East River, they consist of thick beds of gray and dark slate and quartzite, having a general strike of N. 20° to 30° W., and with very high dips to the S.W. They include a great vein of specular iron ore, associated with magnetite, ankerite, and limonite, of the same character with that so well known on the south side of the Cobequids in Londonderry.

The river valley, which not improbably occupies an ancient line of fracture, presents a narrow trough of Lower Carboniferous rocks, containing limestone and gypsum; and at the junction of these Carboniferous beds with the older rocks, on the east side of the river, there is a fissure vein, filled with limonite, and in some places attaining to large dimensions.

The hills on the east side of the river consist largely of hard gray slates, nacreous slates, obscure diorites, agglomerate and felsite, with syenitic dykes and masses. They correspond very nearly in mineral character with the Lower Cobequid series, and though rudely parallel to the slates on the opposite side of the river, they have so suffered from fractures and unequal denudation that they present a very irregular surface, in the depressions of which are the Upper Silurian hematites and their associated beds; and these rocks also succeed those of the Cobequid series to the north-eastward, forming a long line of outcrop extending from the East River of Pictou towards Arisaig. Thus the general geological character of the region is similar to that of the Cobequid hills, though locally more irregular and with larger areas of Upper Silurian beds.

So far the structure of the district has been pretty well known for some time, but its somewhat complex details have been little worked out, except in connection with the tracing of the iron deposits, in which some explorations have been made, more especially by Dr. G. M. Dawson, Mr. Gilpin, and the writer. For several years the principal iron properties have been under the care of E. Gilpin, Esq., F.G.S., now Inspector of Mines for Nova Scotia, aud his surveys have thrown much light on the distribution of the strata containing the bedded iron ores, indicating approximately the dimensions and direction of the troughs resting on the Cobequid series, and the distribution of those which flank that series on the north-east. More especially these researches have shewn that there are two horizons of iron ore, separated by a considerable thickness of slaty and quartzose strata,* and underlaid by slate, sandstone, and conglomerate or breccia, differing from those of the Cobequid series. I do not propose here to enter into the details of these observations, but merely to notice their relations to the palæontology of the district.

The fossils collected in the district were obviously referable to the "Arisaig series," ranging from the Clinton to the Lower Helderberg inclusive, but the new facts indicated in Mr. Gilpin's manuscript map, which he has kindly communicated to me, suggested more careful local comparisons; and as my collections, though extensive, had not been made with reference to the new details of distribution, I thought it desirable to supplement them with additional material. This was obtained by Mr. Donald Fraser of Springville, a well known explorer of these rocks, who by my request visited all the exposures of the iron ores, and collected the fossils found in the ore itself and the including beds, keeping the specimens from each locality separate. In this way a large number of additional specimens were obtained, forming a series of local collections representing the different ore horizons.

The general result of the study of these specimens is to show that both sets of ore-beds are Upper Silurian, and approximately of Lower Helderberg age. As compared with the typical Arisaig series, as defined in Acadian geology, they represent the middle and upper part of that series.

The fossils referred to are unfortunately not always in the best state of preservation. They are contained in hard rock, from which they are extracted with difficulty, and are often best studied in the impressions left when they are weathered out. They are also not infrequently distorted. For these reasons it is not always possible to be certain as to their identification; and in cases of doubt I have given a reference to the known species which they most nearly resemble.

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* In a work on the "Mines and Mineral Lands of Nova Scotia," received while this paper was in the press, Mr. Gilpin estimates the thickness of intervening beds at 700 feet.

In the lower beds of iron ore, as represented at the Webster and Blanchard locations, the following fossils have been recognized; though in these beds the fossils are neither so abundant nor so well preserved as in the upper beds. Those marked with an asterisk are found also at Arisaig.

* *Stenopora* (*Chaetetes*) (allied to *S. fibrosa*).
* *Crinoid* stems.
* *Chonetes Novascotica*, Hall.
* *C. tenuistriata*, Hall.
* *Spirifer rugae-costa*, Hall.
S. —— (a large species allied to *S. arenosa.*)
* *Strophomena profunda*, Hall.
* *S. rhomboidalis*, Wilck.
* *Rhynchonella Saffordi*, Hall.
R. —— (large species with about 20 prominent undivided ribs, very characteristic of some parts of the iron ore.)
R. allied to *R. nobilis*, Hall.
Pentamerus (allied to *P. pseudo-galeatus*).
Stricklandinia Billingsi, n. s. (see infra).
Rensselæria æquiradiata, Conrad.
* *Orthis testudinaria*, Dalman.
Platyceras, sp.
Platyostoma depressa, Hall, or allied.
* *Orthoceras*, annulated (allied to *O. ibex*).
* *O. punctostriatum*, Dawson.
* *Cornulites flexuosus*, Hall.
* *Calymene Blumenbachii*, Brong.
* *Homalonotus Dawsoni*, Hall.
Homalonotus (finely banded pygidium ? n. s.)

These fossils are not numerous, but they present the same partly Clinton and partly Upper Helderberg facies seen in the middle portion of the Arisaig series.

At the Ross location, East River, at the Holmes location, west side of Sutherland's River, and at the east side of Sutherland's River, in outcrops believed to be those of the upper beds, the following species occur:—

* *Stenopora* (allied to *S. fibrosa*).
Syringopora, sp.
Cladopora (slenderly branching species).
* *Crania Acadiensis*, Hall.

* *Spirifer subsulcatus*, Hall.
* *Sp. rugae-costa*, Hall.
Sp. (large species similar to that in last list.)
* *Chonetes Nova Scotica*, Hall.
* *Strophomena rhomboidalis*, Wilck.
* *S. Gilpini*, n. s. (see infra).
* *Orthis testudinaria*, Dalman.
O. perelegans, Hall (or allied).
O. discus, Hall (or allied).
Strophodonta varistriata, Hall (or allied).
* *Rhynchonella Saffordi*, Hall.
R. vellicata, Hall (or allied).
R. pyramidata, Hall (or allied).
* *Atrypa reticularis*, Linn. (coarsely ribbed variety).
Stricklandinia Billingsiana, n. s. (see infra).
Pentamerus sp.
Discina (smooth conical species like *D. oblongata*, Portlock (see infra).
* *Cytherodon sulcatus*, Billings.
* *Megambonia cancellata*, Hall (see infra).
* *M. striata*, Hall.
* *Pteronitella curta*, Billings.
* *P. oblonga*, Billings.
* *P. venusta*, Billings (or allied).
Avicula textilis, Hall (or allied).
A., new species ? (see infra).
* *Clidophorus concentricus*, Hall.
* *C. elongatus ?* Hall.
* *Grammysia remota*, Billings.
* *Murchisonia Arisaigensis*, Hall.
* *M. acicula*, Hall.
Platyostoma depressa, Hall (or allied).
Cyrtoceras subrectum, Hall.
Cyrtoceras, n. s. (see infra).
* *Orthoceras punctostriatum*, Dawson.
* *Cornulites flexuosus*, Hall.
C. n. s. (see infra).
* *Homalonotus Dawsoni*.
H. (smooth pygidium, allied to *H. delphinocephalus*).
* *Calymene Blumenbachii* (large and small varieties or sub-species).

Phacops caudatus (or allied).
Dalmania, allied to *D. micrurus*, Hall.
* *D. Logani*, Hall.

It will be seen that, while the majority of the species found in the lower bed occur also in the upper, the latter is much richer in species, and especially in those of the Upper Arisaig or Lower Helderberg proper. It is also remarkable for its much greater number of Lamellibranchiate shells and Trilobites. On the other hand it presents no points of resemblance with the Oriskany fossils which accompany the ore of Nictaux in the western part of Nova Scotia.*

The fossils above referred to are derived from the beds immediately containing the iron ore deposits, or from the ore-beds themselves. But in many parts of the district there are rich fossiliferous beds, the relation of which to the iron ores is not so manifest, though they obviously belong to the same great series of deposits. From these beds I have obtained specimens of nearly all the species above catalogued, and some others in addition. The most important of these latter are the following:

Zaphrentis, sp. not determinable.
Meristella didyma, Dalman. A well-known European Upper Silurian species, plentiful in some beds on the East River, but which I have not yet seen from Arisaig.
Lingula sp.
Rhynchonella transversa, Hall (or allied).
R. allied to *R. acutiplicata*, Hall.
R. equiradiata, Hall (or allied).
Orthis multistriata, Hall (or allied).
* *Atrypa emacerata*, Hall.
* *Trematospira Acadiæ*, Hall.
* *Goniophora consimilis*, Billings.
* *Grammysia Acadica*, Billings.
* *Clidophorus concentricus*, Hall.
* *C. cuneatus*, Hall.
* *Modiolopsis rhomboidea*, Hall.
* *M. sub-nasutus*, Hall.
* *Bucania trilobita*, Hall.
Bellerophon, allied to *B. carinatus*, Sowerby.

* See paper in this Journal, 1879, on 'Recent Papers on the Geology of Nova Scotia.'

Platyceras, allied to *P. pyramidatum*, Hall.
* *Orthoceras exornatum*, Dawson.
O. Pictoense, n. s. (see infra).
O. elegantulum, Dawson.
* *Beyrichia pustulosa*, Hall.
Acidaspis, a small species allied to *A. tuberculata* of Hall (see infra.)
Illænus.—pygidium.

In the second edition of Acadian Geology, 1868, the author published a list of fossils, including many of the more characteristic species above-named, and summed up his conclusion as to their age, as follows: "On the whole I regard the beds seen on the East River of Pictou as belonging to the same line of outcrop with the Arisaig series; but as probably containing in addition to the Upper member of that series beds somewhat higher in position." The fossils more recently collected so far modify this conclusion that I cannot affirm the existence of beds upward as far as the Oriskany, but must be content to regard the highest fossiliferous beds of the East River Silurian as about the horizon of the highest of those seen at Arisaig.

It still remains to inquire as to beds older than the Upper and Middle Arisaig series. As to these great caution is necessary, owing to the paucity of fossils, and to the liability to confound the Upper Silurian rocks with those of the Cobequid group.

Coming up in the anticlinals, and along the flanks of the masses of older rock, there are beds of conglomerate, brown and white quartzite and hard slates, which seem to underlie the fossiliferous beds holding the iron ores, and may represent lower members of the Upper Silurian series. In these beds vermicular markings, perhaps fucoidal and perhaps burrows of annelids, occur near Cameron's brook, and in the same beds are fragments of *Lingulæ*. I have little doubt that these beds are lower than those holding the iron ores, though probably not below the base of the Upper Silurian. On McLellan's Brook, Mr. Fraser has found beds holding casts of *Zaphrentis*, which may not improbably be older than the Lower Helderberg. The tail of *Illænus* referred to above was found in a small ore-bed on the Fraser (Saddler) location, and which I believe to be not improbably lower than the great beds of Hematite. These are the only fossils known to me at present, which indicate a horizon older than the Middle Arisaig. There a;e, however, great masses of older rock which have afforded no fossils, and which probably underlie those just referred to and may be Lower Silurian beds tending downward to the Cobequid series and connected with it.

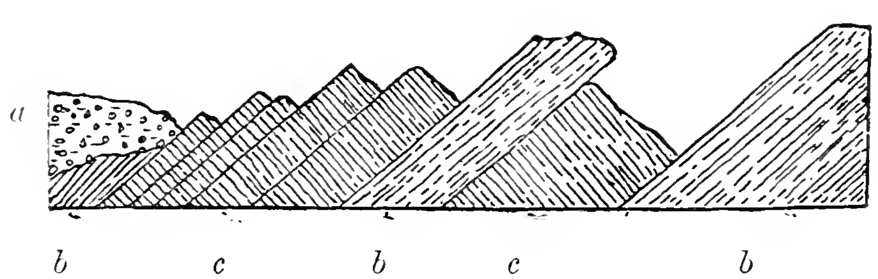
Rocks of this character are well developed in the basin of Lake Murdoch, where, according to Mr. Gilpin, they are cut off from the Blanchard ore-series by a fault on the southern side. They are traceable to the eastward, apparently underlying the beds associated with the "Webster" ore-bed, and are well seen still further to the eastward on the upper waters of the French River. These beds differ considerably in mineral character from any others in the district, though resembling in this respect rocks seen at the Blue Mountain, near Eden Lake, and on the East Branch of the St. Mary's River. They contain thick beds of Nacreous or Hydro-mica slates, coarse slates, sometimes having a conglomerated or brecciated appearance, green chloritic or epidotic rocks, quartzite and agglomerate, and felsitic rocks. They have afforded no fossils, and appear to me to be quite distinct from the Upper Silurian formation. In the meantime they may be connected with the Cobequid series, with the typical rocks of which series they are certainly closely associated farther to the eastward.

One of the marked features of the Upper Silurian in the district in question is the great development of bedded red hematite, and of rocks more or less impregnated with this ore. With reference to its origin, this ore is evidently a marine deposit, and formed under conditions sufficiently favorable to marine life to enable it to contain many shells of Brachiopods and remains of other animals. It is probably a chemical deposit or precipitate, and often assumes an oolitic structure. In the coarser or more impure beds the little concretions of oxide of iron often surround grains of sand, and the ore passes into a ferruginous sandstone. The following section (p. 340), from a MS. Report of Dr. G. M. Dawson, shows the great development of the lower bed in one of its exposures. These deposits of iron ore apparently began locally in an early part of the Upper Silurian period, and were continued into the Lower Helderberg period, while in the western part of Nova Scotia, in the Nictaux district, we have evidence of their continuance into the Oriskany age.

Another marked feature of these deposits is the absence of any representative of the great Niagara limestone, and the consequent passage upward of Clinton deposits into those of Lower Helderberg age. This absence of the Niagara limestone is general in Nova Scotia, and along the Atlantic margin of North America. Farther West, in Northern New Brunswick, and in Gaspe, massive limestones appear, but they attain their greatest development in the interior plateau south of the great lakes.

With reference to the dates and disturbances of these deposits, it may be affirmed that there was much volcanic action at the time of the deposition of the Cobequid series; that this series experienced no little disturbance and alteration before the Upper Silurian rocks were laid down; that the latter were subsequently much folded and fractured before the Carboniferous Period, and that since that period there has been sufficient movement to cause the carboniferous rocks to be locally highly inclined and faulted. In the trappean beds, interstratified with the Lower Carboniferous conglomerates of the coast to the eastward, there is evidence of the continuance of igneous action up to that time. As to the age of the iron deposits, the formation of the great veins of specular iron and ankerite was probably contemporaneous with the earliest disturbances of the Cobequid series, and previous to the Lower Helderberg age. The great interstratified beds of Hematite are undoubtedly of the latter age, unless the lowest bed should be regarded as between this and the Clinton. The veins of Limonite, mixed with oxide of manganese, are later than the Lower Carboniferous, and constitute here as in the Cobequids a secondary product of the decomposition of the carbonate of iron contained in the ankerite and spathic iron of the Cobequid series.

IRON ORE BED. WEBSTER LOCATION.



a. drift. *b.* slaty rock. *c.* iron ore.

NOTES ON FOSSILS.

A few of the species observed are new, and concerning others new facts were brought out in the examinations made. The more important of these points are referred to below.

Chaetetes or *Stenopora* and *Cladopora*.—Two branching corals referable to these genera are very abundant in the East River beds, and the former also occurs plentifully at Arisaig. The former is a coral of the family *Chaetetidæ*, very closely resembling *S. fibrosa*, but the specimens are not in such a condition as to permit a close comparison. The latter is found only in the state of casts, and is a large-celled species resembling *C. fibrosa* of Hall.

Stricklandinia Billingsiana, n. s.

This is a large shell, 6 centims. in breadth and 4 in length, with a pointed beak and the sides spreading at an angle of about 120° to the broadly rounded lateral corners, which are united by a nearly straight margin. The surface presents unequal lines of growth, and in the middle of the dorsal valve is a low flat ridge with a slight furrow in the centre. The ventral valve has a corresponding flat sulcus. This shell is closely allied to *L. Davidsoni*, Billings, from the Upper Silurian of Gaspé, but is much broader in form.

Strophomena Gilpini, n. s.

Shell, when full grown, nearly an inch in diameter; length and breadth nearly equal; hinge line equal to breadth; valves little elevated; hinge area narrow. Surface marked with numerous fine radiating elevated lines, between which others are introduced as they diverge from the beak. When the surface is well preserved microscopic concentric striæ are seen to cross the radiating lines, and when the outer surface is removed the structure of the shell appears punctate. Muscular impressions oval, elongate and narrow. This shell is very abundant near the Sutherland River ore-bed. It appears to differ from any described American species, but in general form and the style of the muscular impressions resembles *S. ornatella* of Salter from the Upper Ludlow of Britain, though it has finer and sharper superficial sculpture.

Rhynchonella, sp.

In the upper bed of iron ore one of the most freqnent shells is a simply ribbed *Rhynchonella*, somewhat resembling *Rh. vellicata* of Hall, but too much distorted and too imperfectly preserved to enable it to be determined with certainty.

Discina, sp.

A small elevated smooth *Discina*, marked only with very delicate lines of growth and near in form to the more elevated varieties of *D. oblongata*, Portlock, from the Middle Silurian of England.

Megambonia cancellata, Hall.

Perfect specimens of this beautiful little shell show that the right valve is flatter than the left, and destitute of the cancellated markings, having only concentric lines. When the valves are closed the basal sulcus has very much the aspect of a byssal aperture. These characters would ally this shell with *Aviculidæ* rather than with *Arcadæ*.

Avicula lamellosa, n. s.

Hinge line somewhat longer than the breadth of the shell, and about equal to its length. Left valve tumid, right valve less so, umbones appressed, base broadly rounded, anterior wing short, but decidedly separated from the body of the shell, posterior wing much larger. Surface smooth, but ornamented with concentric thin raised lamellæ, which are continuous over the wings and body, and are elegantly waved, becoming distant from each other on the lower side. Largest specimen 3 centim. long, 3·5 broad. At first sight this species resembles *A. equilatera* of Hall, but is quite distinct in form and markings.

Avicula, sp.

A single left valve of a well-characterised species with the anterior wing nearly as broad as the posterior, and both flat and smooth, or with microscopic concentric lines on the posterior one. Body of the shell with about 15 radiating ribs, crossed by obscure concentric ridges. I had at first regarded this shell as a variety of *A. Honeymani* of Hall, but the anterior wing, when exposed, showed it to be altogether different. I find it difficult to distinguish the last-named species from *A. emacerata* of Hall, as some specimens show radiating striæ on the posterior wing, and otherwise approach to that species.

Pteronitella curta, Billings.

More perfect specimens of this shell enable me to add to Mr. Billings'* description, that the left valve is considerably more convex than the right, and ornamented with concentric, crowded, raised lamellæ. There are two muscular impressions, the anterior small, oval and near the beak, the posterior large and round.

Murchisonia, sp.

In addition to *M. Arisaigensis* and *M. acicula*, which are common on the East River, there is a third species, much less elongated than the former, and with a single revolving band in the middle of the body whorl. The specimens are not very perfect.

Holopea, sp.

A species not distinguishable from *H. sub-conica* of Hall from the L. Helderberg.

Platyceras, sp.

A small but beautifully perfect specimen of a conical and somewhat pyramidal Platyceras, with slight plications on one side. It is not distinguishable from young shells of *P. pyramidatum* of Hall from the Lower Helderberg; and is the only shell of this type I have seen in Nova Scotia.

Orthoceras Pictoense, n. s.

Transverse section oval, perhaps partly a result of pressure. Chambers narrow, 8 in an inch in a specimen 1·5 inch in greatest diameter. Shell scarcely tapering in five inches. Surface when perfectly preserved with delicate longitudinal striæ. Siphuncle not well seen but apparently inflated in the chambers. This is seemingly a representative in our Upper Silurian of *O. bullatum* of England.

Orthoceras (allied to *O. ibex*).

This species has long been known to me from Arisaig, and I have specimens also from the East River, but not sufficient to make absolutely certain its identity or difference.

* Palæozoic Fossils of Canada.

Cyrtoceras, sp.

Two species of this genus occur in the East River collections. One is not distingutshable from the *C. subrectum* of Hall (L. Held.) The second is flattened laterally, distinctly bent, the septa one-third centim. distant, in a specimen one centim. in diameter.

Cornulites.

Shells of this species are very abundant in the East River beds. Hall referred the Arisaig specimens to his species *C. flexuosus;* but from their more slender form named them variety *gracilis.* At the East River the majority of the specimens are of the Arisaig type, but some more robust. There are however others more slender than any found at Arisaig. Specimens 1.3 centimetre in length are only 1 millimetre in breadth at the large end, so that from their slenderness they might be mistaken for *Tentaculites*, though the annulations are those of *Cornulites.* But for the apparent connecting forms, these slender specimens might be regarded as types of a distinct species.

Trilobites.

There appear to occur at the East River no less than three species of *Homalonotus*. The most common is *H. Dawsoni*, Hall, and the others are known to me only by fragments. One has much more numerous annulations on the pygidium than that above named, the other has a nearly smooth pygidium, with about twelve very flat annulations on the axis, and resembling that of *H. Vanuxemii*, Hall, from the Lower Helderberg. The East River collections also add an *Acidaspis* to the Upper Silurian fauna of Nova Scotia; but the single specimen found is unfortunately too imperfect for description.

Note.—For information as to the economic geology of this district, I may refer to "Acadian Geology," and to a valuable Report on the "Mines and Mineral Lands of Nova Scotia," by E. Gilpin, A.M., F.G.S. (Halifax, 1880.)

HITTITES IN AMERICA.

By John Campbell, M.A.

Professor in the Presbyterian College, Montreal.

(*Continued from page* 296.)

In a paper recently read before the Canadian Institute I set forth the radical unity of the Peruvian vocabulary with that of the Iroquois. This well known North American family might naturally be expected to connect with the Basques, since the Huron god Tawiscara and the tribe of the Tuscaroras preserve the Euskara name.* The following table shews how valuable an adjunct to ethnological research mythological and tribal names are, and how great is the vitality of words even under what are generally supposed to be the most unfavourable conditions. Judged by the vocabulary, there are few languages which exhibit relationship more perfectly than those widely separated tongues, the Basque and the Iroquois; and it must be remembered that their grammatical systems, while not agreeing in all points, are far from discordant, as has been proved by that distinguished Basque and Oriental scholar, M. Julien Vinson of Bayonne.

Basque.		Wyandot-Iroquois.
all	gueia	agwegough *Mohawk.*
basket	otarra	atere *Iroquois.*
below	beherra	karo "
bird	choria	garioha "
blue	urdina	horanhiahen *I.*
brother	anaya	haenyeha *Wyandot.*
cloud	edoya	odsadah *M.*

* The permanence among uncivilized peoples of tribal and even of personal names is a doctrine that has not received the support which the evidence in its favour demands. It is well illustrated among the Hurons, as I have learned from "Historical Notes on the Environs of Quebec," written by my esteemed colleague, J. M. LeMoine, Esq. Many distinguished chiefs of the Lorette Hurons, from the time when Europeans first became acquainted with them, have borne the name Atsistari or Ahatsistari, *the fearless man*; and at the present day it is the Indian title of M. A. N. Montpetit, an honorary chief of the nation. This Ahatsistari is undoubtedly the Hasisadra of the Accadians, the Ashtar of the Khita, and the Haitor of the Basques. The Hittite proper name Ahashtari, which is that of the brother of Zohar, father of Ephron, who sold Machpelah to Abraham, is almost identical in form with the Huron Ahatsistari of to-day.

	Basque.	Wyandot-Iroquois.
cold	otza	otoxe *Onondaga.*
come	etorri	karo *M.*
copper	urraida	rawist *I.* (metal)
day	eguna	eghnisera *M.*
dog	ora	erhar "
	chacurra	cheer *Nottoway.*
drink	edan	uttanote *Seneca.*
end	ondoa	entas *I.*
face	ausquia	ookahsah *Tuscarora.*
father	aita	ata "
fight	guda	kedarioch *I.*
fire	su	seesta *W.*
fish	arraina	runjiuh *T.*
flesh	oquela	wauahloo *Oneida.*
food	oquia	kakh *I.*
girl	batsaya	yaweetseutho *W.*
good	egun	oogenerle *M.*
hair	ulea	arochia *W.*
hand	escua	shake *M.*
head	burua	anuwara *Onondaga.*
hear	aditu	hagatonde *I.*
heart	biotza	yootooshaw *W.*
heaven	cerua	oughruhyai *T.*
hot	beroa	otorahaute *W.*
husband	senarra	teakneederoo *M.*
kill	il	kerios *I.*
leaf	orria	ourata *W.*
make	eguin	gonniaha *I.*
man	gizon	aquehun *Hochelaga.*
moon	illarguia	kelanquaw *M.*
mother	ama	ena *T.*
mountain	mendia	onontah *W.*
nail	itzea	ohetta "
name	icena	chinna *I.*
night	gau	asohe *Cayuga.*
no	ez	gwuss *T.*
rain	euria	wara "
salt	gatza	hotchiketa *I.*
see	ikhus	wahikea *M.*
shoe	osquea	ohtahquah *M.*
sister	aizta	auchtchee *T.* akzia *I.*
small	tipia	diwatsa *T.*
snow	elurra	ogera *Onondaga.*
speak	edas	atakea *W.*
stone	arri	ariesta "
sun	iguski	kachquaw *S.*
	iluzki	garachqua *Onondaga*, kelanquaw *M.*
tail	atzequia	otahsa *I.*
thunder	curciria	kawseras "
tongue	mina	wennasa "
tooth	hortz	honozzia "
tree	aiecha	oughruheh *T.*
white	churia	kearagea *M.*
wind	egoa	gao *I.*
	aiza	izuquas *W.*
woman	emakume	yonkwe *M.*
wood	egurra, zura	kara *I.* (forest), geree *N.* (tree)

As the Euskara thus manifest their relationship with the Tuscaroras and the Wyandot devotees of Tawiscara, so the Seepohskah and other Dacotah tribes give unmistakable evidence of a common origin with the Schapsuch and other members of the Circassian family. Although I cannot find that the Circassians make use of any words denoting relation, either as prepositions or postpositions, in all other respects their grammar agrees with that of the Dacotahs and Iroquois. The pronouns, whether in their full or construct state, are prefixed, as the adjective seems to be. The genitive is formed by prefixing the noun possessor to the object; the accusative precedes its governing verb; and the order of the verb is pronoun, verbal root and temporal index. This is thoroughly Japanese or Peninsular, and thus the order of the American languages I have associated with the Peninsular family.

	CIRCASSIAN.	DACOTAH.
all	eezahk	hooahcasse *Upsaroka.*
arm	eh	ishto *Dacotah.*
bad	bzaghey	pehia *Osage.*
	bobzaghey	kubbeek *U.*
beard	shagha	eshaesha "
belly	neebey	ikpi *D.*
black	shoodzah	shebhah *Winnebago.*
blood	kleh	eehree *Minetaree.*
blue	skhautey	shuaheat *U.*
bone	kutsha	hidu *Hidatsa.*
boy, son	sim shagha	shinzoshinga *Omaha.*
bread	tshakhu	hohhazzsu *U.*
chief	pshee	bettshettoa "
clothes	shooghoon	sheena *D.*
cloud	washabshey	apahi *H.* mahpiya *D.*
cold	tsheeyeh	tasaka "
come	kahkooyeh	kuwa "
corn	bemshesh	wamunuyzah "
dark	mezahshe	pasa "
day	mahpey	mahpaih *Min.* hampah *Seepohskah.*
death, die	hadeygho, tlagha	tshe *H.* tha *D.*
do, make	tshah, sogha	kagha "
drink	yeshwey	yatkang "
eagle	bzoooosh	iphoki *H.*
eat	teshesht	duti "
enemy	yedzeesho	toka *D.*
evening	tshaha	tassetoo "
face	ihtshooz	estah *S.*
father	yati, taht	ate *D.* dadai *Om.*
finger	efkhab	napchoopai *Yankton.*
	ebkhad	napsukazu *D.* buschie *U.*
fire	mahzwa	midahe *H.*
fish	bbzheh	poh *S.*
five	tpey	zapetah *D.*
flesh	ley	arookka *U.*
fruit	shaghah	waskuyeca *D.*

	Circassian.	Dacotah.
girl	sipshaz	submihi *S.*
go	yago	za *D.*
good	souy-yeh	shusu *S.*
	shoodet	washtay *D.*
great	asoodet	ictia *H.*
hail	yeehz	wahsoo *D.*
hand	oyg	shagai *Om.* onka *S.*
heaven	vouafey	apahi *H.*
heavy	zaaha	tekay *D.*
house	hadsheeshish	tshe *Ioway*, cheehah *W.*
kill	ooikkey	whaquetah *D.*
knife	soonee	eesahng "
leg	thlakoua	sagaugh "
life, live	nivsh	nee impe *Assiniboine.*
love	sidshaz	kideshi *H.*
moon	maathe	minnatatche *U.*
mother	yan	ina *D.*
mountain	mayzee	mahpo *U.*
mouth	shey	jhhah *Quappa.*
nail	gootshooghoon	shaka haugh *Os.*
name	tsah	dazi *H.*
navel	neezabtsee	itadehpa *H.* cekpa *D.*
neck	eddee	tahoo *D.*
	paoomey	pahee *Om.*
night	tshaytshee	htayetu *D.*
nose	pey	pa *I.* pahoo *S.*
rain	keyshoh	hkahoosh "
red	tleeshee	ishshee *Min.*
river	pse	passahah *S.*
	kodagheps	wakpa *D.*
road	oghogoo	cangku *D.*
shoe	paboosh	opah *Min.* hoompah *S.*
sister	tsheeyakh	itaku *H.*
skin	sheh	coku *D.*
small	booghoozey	wauhokah *Os.*
	tseegoodet, tjick	ecat *U.* tscheestin *D.*
snow	wooahsee	wahhah *W.*
	weyfsee	mahpai *Min.* copcaze *S.*
speak	sbaghey	bedow *U.* obraka *Os.*
star	ooshaghe	hkake *S.*
stone	mushey	mee-ee *Min.* imniza *D.*
strong	peetay	batsats *U.*
tree	frah	beeraiechtoet *Min.*
wash	ahghee sheehusht	yuzaza *D.*
water	psee	passah *S.*
wife	yeeshuhz	toweetshoo *D.*
wood	pkha	pazu *D.*
yellow	oghooshi	sehah *Os.*

By similar vocabularies the relation of the Cherokee-Choctaw, Muysca and Chileno languages to the Basque and Circassian might easily be established; but, as in a previous article I connected these and kindred tongues with the Peninsular family of Asia, it will simplify matters to make this family the basis of comparison. In the following table accordingly, I have compared a limited number of words, Japanese, Loo-Choo, Koriak-Tchuktchi, Aino, Corean and Kamtchatdale, with corresponding forms in the Accad, Basque and Circassian. The grammar of the Circassian, which, lying on the line of Khita migration, should represent the Khupuskian in its purest form, is virtually that of the Japanese and its allied languages.

	PENINSULAR.	ACCAD, BASQUE & CIRCASSIAN.
all	oowhoko *Loo C.*, issai, tshugo *Jap.*	kak *A.* gucia *B.* eezahk *C.*
axe	masakari *Japanese.*	haizcora *B.*
above	wee *L.*	ahpsee *C.*
accomplish	shitoge *J.*	sit. *A*
bad	wasa *L.*	bzaghey *C.*
	ashiki *J.*	su *A.* gaiztoa *B.*
basket	teeroo *L.* zaru *J.*	otarra *B.* zarea *B.*
	cago *J.*	sasquia *B.*
bear	kasa *Kamtchatka.*	sukh *A.*
beard	kkookat " hige *J.*	shagha *C.*
beautiful	utsukushii *J.*	dahshay *C.*
bed	coocha *L.*	she *B.*
bee	mitsu-bachi *J.*	bshay *C.*
before	koomat *Ka.*	gab *A.*
behind	atoni *J.*	oztean *B.*
belly	stabara, *J.*	sabella *B.*
	nam *Koriak*	neebey *C.*
below	stcha *L.* shita-ni *J.*	utu, cit *A.* ayshay *C.*
	ururu *J.*	bur *A.* beherra *B.*
bird	tori "	choria *B.*
black	mime " (dark)	mi *A.*
blood	auka *Tchuktchi*, chi *L. J.*	us "
boat	temma *J.*	ma "
	huni *L.* penzy *Insu.*	untzia *B.*
	cahani *Aino*, cajak *T.*	gaha, khassey *C.*
body	watta *L.* (belly)	wetshooz "
bone	kutsi "	kutsha "
book	somots *J.* sheemootzee *L.*	sumuk, samak *A.*
bow	yumi *L. J.*	bam *A.* gubia *B.*
boy	warrabee *L.* kozo, shoni *J.*	biru " gaztea, seme *B.*
bread	quashee "	oquia *B.*
	shokumotsu *J.*	tshakhu *C.*
bright	sayeru *J.*	sar *A.*
brother	ani "	anaya *B.*
	aki *T.*	cus *A.*
	ktshidzshi *Ka.*	istzshe *C.*
builder	daiku *J.*	duk *A.* (build)
burn	akka *L.* yaku *J.*	gi "
captain	kashira *J.*	gurza, "
centre	maru " (circle)	mur "
change	kayeru "	kur "
child	warrabee, *L.* shoni *J.*	aurra *B.* seina *B.*
chin	ootooga *L.* otogai "	dsha *C.*
clothes	chouksa *Corea*, isho "	sic *A.* jauci *B.* shooghoon *C.*
	choongay *C.*	soneeoa *B.*
cloud	kumo *J.*	gan *A.*
cold	seedasha *L.*	otza *B.* tsheeyetsha *C.*
come	itari, kitaru *J.*	etorri *B.*

	PENINSULAR.	ACCAD, BASQUE & CIRCASSIAN.
	koquasitch *Ka.*	kahkooyeh *C.*
country	inaka, kouni *J.*	zan *A.* unea *B.*
	awhfee *L.* hempi *J.*	ub *A.* zeppet *C.*
crown	kammuri, zetcho "	mir, sakkad *A.*
dark	kouni *A.* (black)	can *A.*
dawn	akebono *J.*	khebso *C.*
day	doh *Kurile.*	utu *A.*
	gaunak *T.*	eguna *B.*
demon	akuma *J.*	gigim *A.*
descend	kudaru "	tu, turi "
desire	nozomu "	sem "
die, death	gang *L.*	khan "
	tokok *T.*	hadeygho *C.*
dig	hojiru *J.*	engar *A.*
deep	fukai "	kook *C.*
divide	wari "	bar *A.*
dog	kossa *Ka.*	khah *C.*
door	kado *J.*	ea *A.*
	to "	atea *B.* tshey *C.*
drop	tarashi *J.*	tal *A.*
ear	qui *C.*	cagu "
earth	nuna *T.*	ma "
	duro *L.* hokori *J.* (dust)	zicura *A.* lurra *B.*
	ttati *C.*	yatte *C.*
east	higashi *J.*	hahshey *C.*
eat	kamoong *L.* hamu *J.*	jan *B.*
	ku *J.*	cu, kia *A.*
egg	kuga *L.*	kanghey *C.*
elbow	oondee *Insu* (arm).	ucondoa *B.*
enclosure	kakomi *J.*	gagunu *A.*
end	hate "	gudu "
	yuku *L.*	oish *C.*
face	skira *L.* tsura *J.*	cir *A.*
	quaagh *Ka.* kao "	caca " ausquia *B.*
father	atta *T.* teti "	ad " aita *B.* taht *C.*
fall	taore *J.*	eror *B.*
	tawshoong *L.*	yedeesho *C.*
fight, battle	ikusa *J.*	gu *A.* guda *B.*
fill	aku "	sig "
finger	yubi " askippi *I.*	efkhab *C.*
	pkoida *Ka.*	ebkhad "
fire	annak *T.*	ne *A.*
	hi. yoke *J.*	su *B.*
firmament	sora "	gir *A.*
fish	sakkana "	khan "
	ikahlik, ssaljuk *T.*	hal "
	karasacki *A.*	araga *B.*
	etshoo *Ka.*	zeyshee, tzey *C.*
flesh	shishi *L.*	uzu *A.*
	thaltal *Ka.*	glli *C.* guelia *B.*
foot	assi *J.*	essa *A.*
	shanna *L.*	ona *B.*
forehead	muki *J.*	becoquia *B.*
forest	hayashi "	basoa "
fortress	siro "	car *A.*
	toride "	durud "
	eegooscoo, gooseecoo *L.*	gisgal "
fortunate	saiwai *J.*	sa "

	Peninsular.	Accad, Basque & Circassian.
fowl	hotu *L.*	kattey *C.*
garden	sono *J.*	gana *A.*
girl	taekki *L.*	turrak "
	ungua " niyoshi *J.*	nesca *B.*
	ncipec *Ka.*	sipshaz *C.*
give	watasu *J.*	yetteh "
glory	homare "	impar *A.*
go	kungchung *L.*	joane *B.*
	yuku *J.*	jago *C.*
goat	jagi "	sikka *A.*
god	jebisu "	hubisega " pkhah *C.*
	hutka *Ka.* hotoke *J.*	duk " tkha "
	mitgk *Ka.*	mesitcha *C.*
good	jukka *J.*	khiga *A.* egun *B.* souy-yez *C.*
	hota *C.*	shoodet *C.*
goose	gocho *J.*	kaz "
grass	cossa *L.* kusa *J.*	sizi *A.*
great	weesa *L.* bakutai *J.*	bahsh *C.*
green	soo *A.*	sik *A.*
ground	tsuchi, tsuchibeta *J.*	cieu " zeppet *C.*
hair	kaeugny *Ko.*	shatzeh *C.*
	nujak *T.*	muz *A.*
hand	ki *L.*	su " escua *B.* ia, oyg *C.*
	te *J.*	id "
	settoo *Ka.*	khid "
hard	katai *J.* kibishii *J.*	keytoo *C.* shafe *C.*
have	ta "	du *A.*
head	kashko *T.* saki *J.*	sak "
	tchusa *Ka.* dzu "	tshkha *C.*
hear	sitchoong *L.*	aditu *B.*
heaven	cherwol *Ko.* sora *J.*	kharra *A.* cerua *B.*
hero	goketsu *J.*	gudhu "
high	kooung, *Ka.*	eu "
	takasa, toge *J.*	attaghagh *C.*
	in *A.*	an *A.*
hold	tamotsu *J.*	tab "
hole	anna "	oghan *C.*
horn	kaku "	sak *A.*
hot	atcheeroo *L.* karai *J.*	ur " beroa *B.*
house	taku *J.*	ziku "
	katchi *L.* uchi *J.*	etche *B.* hadsheeshish *C.*
hunger	hidaru *J.*	sugar *A.*
insects	sudaka "	saduguounu *A.*
iron	furoganni "	burnia, burdina *B.*
	quatshoo *Ka.* tetsu J.	ghootshey *C.*
knife	sigo *L.*	soozee "
know	shira J.	ru *A.*
learn	kicku *J.*	zu *A.* ikasi *B.* ghassa *C.*
leave	utcharu, udzuru *J.*	gadataccuru *A.*
life, live	inochi "	nivsh *C.*
lift	ageru "	sur *A.*
light	feeroo *L.* karui "	bir " arguia *B.*
lightning	inadzuma, hikari "	onaztea, iyurguria *B.*
lip	kkovan *Ka.* kuchibiru *J.*	okoofaree *C.*
low	karui, sagaru *J.* (lower)	car, zicura *A.*
make	suru "	gar *A.*
man	chu *L.* quaskoo *Ka.*	ka " guizua *B.*
	aino *A.* nin. *J.*	nen, un *A.*
	hito, otoko "	nit, nitakh "
	guru *Ku.*	khairu "

	Peninsular.	Accad, Basque & Circassian.
measure	shaku, hakari, hodo *J.*	sa, kha, gur, id *A.* tsshogha *C.*
middle	chiuhin "	guana *A.*
milk	chee *L.* chichi "	shah *C.*
mischief	aku "	su *A.*
month	wadii *L.* getsu "	itu, idu *A.*
moon	mangets, "	maathe *C.*
morning	kesa "	goiza *B.*
mother	umma *L.*	nen *A.* ame *B.* yan *C.*
mountain	aal *Ka.*	tal "
mouth	kuzha *Ka.* kuchi *J.*	ka " shey *C.*
	jeep *C.*	pa " auba *B.*
much	dake *J.*	dugu "
nail	thimmee *L.*	tabin "
	kouda *Ka.*	gootshooghoon *C.*
name	mei *J.*	mu *A.*
	hagaach *Ka.*	tsah *C.*
navel	feso *J.*	neebiush *C.*
neck	kubi *L.* kwabi *J.*	gubioa *B.*
	hitle *Ka.*	eddee *C.*
news	tayori *J.*	ticul *A.*
no	ny *I.* nu *J.*	nu "
	iski *Ka.* dzu "	ez *B.*
odour	ka "	quea *B.*
old	tassijori, furui *J.*	zarra, caharra *B.*
	tishui *L.*	zey *C.*
open	aku, hassu *J.*	ooshey *C.*
paint	iru *L.*	bir *A.*
pass, through	toru *J.*	tal "
place	skata *L.* basho *J.*	khash "
pour out	kobosu *J.*	gam "
put	oku "	cu, ka "
rain	ame "	aan "
	neptschuk *T.*	inotsi *B.*
	tshukutshoo *Ka.*	keyshoh *C.*
raise	aghe *J.*	jaike *B.* (rise) aca *A.*
reed	aze "	sa *A.*
red	akassa *L.* akai *J.*	gusci "
rise	okiru J.	khir "
river	wejim *Ko.* kawa J.	ibaya *B.*
salt	shio J.	shoogoo *C.*
sea	umi "	ab *A.*
	ooshoo *L.* kai J.	ichasoa *B.* shoo *C.*
see	quatshquikotsh *Ka.*	ikhus "
seed	nigh *L.*	meyshey *C.*
seize	tsukamu J.	sukh *A.*
servant	iri *L.* kerai J.	eri " ghar *C.*
shine	terasa J.	zir "
shoe	kwutsa "	osquea *B.*
	sabock *L.*	paboosh *C.*
shoulder	tanutar *Ka.*	tahmeh "
sickness	hotori J.	tura *A.*
silk	kinno "	danee *C.*
sister	zia *A.*	aizpa, aizta *B.* tsheeyakh *C.*
sit	zasuru J.	eseri *B.*
skin	ka *L.* kooogh *Ka.* kawa J.	shu *A.* sheh *C.*
small	kusa *L.* chiisai J.	guchi *B.*
	ekitachtu *T.*	guti " tseegoodet *C.*
speak	monoju *I.*	mintzo "
stand	tatsi J.	zutie "

	PENINSULAR.	ACCAD, BASQUE & CIRCASSIAN.
stone, rock	ishi *L.* aiyach *T.*	acha *B.*
straight	sagui, saguni J.	zak *A.* zaeena *B.*
strike	tataku "	takh "
strong	chicara, shikkari J.	sur " azearra *B.*
strength	riki, yuriki "	silik "
sun	tida *L.* tiyo "	ud, utuci *A.* teygha *C.*
	quaatsh *Ka.* hizashi J. (sun's rays)	iguzki *B.*
sweat	ackkaddee *L.*	sshad *C.*
tail	dzoo *L.* shippo J.	atzequia, opa *B.*
take	toru, orosu "	artu *B.* tzeereeshoh *C.*
tempest	arashi "	asagara *A.*
to-morrow	acha *L.* ashita "	yahoosh *C.*
tree	ki *L.* J.	gu, gis *A.*
water	ii *Ka.*	a "
	bool *C.*	ur *B.*
	pi *Ko.* wakha *I.* meze *L.*	psee, psoo *C.*
white	shiroi J. sheeroosa "	churia, zuria *B.*
wind	kaze "	egoa, aicea *B.*
wing	fanne, hagai J.	pa *A.* egoa "
within	naka "	nigin *A.*
woman	innago *L.* meanoko *I.* onnaJ.	ui, nin, mak *A.*
	meunokoosi *A.* newem *T.* mesu *J.*	emakume *B.*
	taekki *L.* jo *J.*	sak, turrak *A.* siz, shooz *C.*
write	shirushi *J.*	sar *A.*
yellow	cheeroo *L.* kiiro *J.*	khir *A.* (green)

alone	tada *Japanese.*	da *Accad.*
back	sabira "	guibelean *Basque.*
bucket	oke "	sa *A.*
bundle	taba, tutsumi "	dim, tim *A.*
burden	katsugi "	yitshi *Circassian.*
carry	motsu "	megushey "
destiny	temmai "	tzim *A.*
deviser	kuwadataru "	dadhru *A.*
do	suru "	gar "
dream	yume "	ametsa *B.*
empty	munashii "	netshey *C.*
enemy	kataki "	yedzeesho "
far	toku "	tsheehshey "
fathom	hiro "	gar *A.*
fealty	chiugi "	gu "
grief	urei "	larria *B.*
half	nakaba "	noohka *C.*
hour	jisetsu "	seesahet "
messenger	shisha "	succal *A.*
plant	uyeki "	suk "
plenty	takusan "	tak "
power	isei "	su "
property	kazo "	cuda "
prosperous	sakaye "	sakh "
pure	kirei, kiyoi "	gur " chaai *B.*
remember	oboyeru "	par "
rule	sadame "	siten "
shade	kageboshi "	katabsey *C.*
shut	fusagu "	pazaeesh "
throw	taosu "	dzey "
year	toshi "	tlaysee "

In the preceding table it will be seen that the Circassian agrees in many words with the Kamtchatdale, which again has much in common with the Dacotah dialects. The Accad, on the other hand, connects more clearly with the Japanese and Loo Choo, not only in the ordinary vocabulary but in certain terms denoting the transmission of culture, such as sar, shirushi, write, sumuk, shomots, book, car, gisgal, durud, siro, gooseescoo, toride, fortress, bir, iru, paint, and eri, iri, servant. The civilization of Japan, therefore, is to be regarded, neither as indigenous nor as borrowed from China, but a civilization regularly transmitted along the line of Accadian migration, and sufficiently established to be able to reproduce itself in such distant regions as New Granada and Peru. How it passed from Japan to these countries it is hard to say. Japanese junks have been cast on the western shores of North America, and it may be that navigation had something to do with the transference of the Khita from the one continent to the other. But the other tribes of Hittite origin, the Choctaws, Iroquois and Dacotahs, seem to have entered upon their American home at the far north-west by the stepping stones of the Aleutan chain, and by the same route the semi-civilized Mound Builders must have reached the scenes of their long forsaken labours. Were these Mound Builders not part of the Khita migration, and may they not even have been Quichuas and Muyscas on their way to a South-American home, where, under more favorable conditions, they rose to higher things and emulated the deeds of their ancestors in Japan and Chaldea?

There is a branch of the Khita dispersion which I have merely mentioned, but which deserves fuller attention. It is that which I supposed to have been driven into Nubia by the conquering Pharaohs of the eighteenth dynasty, the stock commonly known as Nubian or Barabra. I do not build anything upon the Barabra name, but simply allow their language to speak for itself. I am also ignorant of its grammatical forms, but these Dr. Lepsius states bear no likeness either to the Semitic or to the Egyptian. They may, therefore, be Turanian. The vocabulary is Hittite, if Basque and the other languages I have connected with it be Hittite; and, on a comparison with these languages, presents some of the most remarkable instances of the vitality of words that philology records. It is worthy of note that the Hittite Sheth or Ashtar was one of the principal divinities of Nubia.

	BARABRA.	KHITA.
bad	milli *Barabra.*	manalli *Quichua.*
	usk *Dongola.*	su *Accad*, itschge *Circassian*, ashiki *Japanese*, asitck *Kadiak*, ishia *Hidatsa*, washuh *Tuscarora*, ooyohee *Cherokee*, hucha *Quichua*.
bird	okera *Schabun*, koker *Koldagi*. kowertag *Kensy*, kowertyga *B.*	choria *Basque*, garioha *Iroquois*. chiroti *Aymara*.
boat	kub *B.*	kauuwau *Iroquois*, huampu *Quichua*, sabanne *Loo Choo*.
boy	tota *B.* tot *Ke.* tondu *Ko.*	du *Accad*, doji *Japanese*, tennohakh *Kadiak*, disi *Hidatsa*. doyato *Huron*, atsatsa *Cherokee*, tesunung *Uche*. chuta *Muysca*. votum *Araucan*.
bread	kabakka *B.*	shokumotsu *Japanese*, popkosu *Kamtchatka*, waubuskah *Osage*. puska *Choctaw*. okhapin *Adahi*. copque *Araucan*.
	kalg *D.*	galoa *Basque*. laak *Kadiak*. takelyge *Muskogee*.
brother	aninga *B.*	anagea *Basque*, ani *Japanese*, angagu *Kadiak*, soukakoo *Dacotah*, haenyeha *Huron*, unggenele *Cherokee*.
butter	tes *Ko.* desk *Ke.*	tkho *Circassian*.
day	aly *B.* onial *Ko.*	allo *Koriak*. angallak *Aleutan*. weeneeslaat *Oneida*. igl *Attacapa*. uru *Aymara*. anoqual *Fuegian*.
	ogreska *D.* ougresk *Ke.*	hiru *Japanese*. yorhuhuh *Tuscarora*. onisrate *Cayuga*.
dog	boal *Ko.* welk *Ke.*	lig. liku *Accad*, zabuloa *Basque*. alchaul *Oneida*. gele *Cherokee*. alljo. calatu *Quichua* locma *Atacama*. shilake *Fuegian*.
	mokka. *B.* monka *D.*	kykmyk *Tchuktchi*. mones *Mandan*. matshuga. *Minetaree*. anokara *Aymara*.
ear	ukkega *B.* okuga *D.*	cagu *Accad*, qui *Corea*, chudhka *Kadiak*, akuhi *Hidatsa*. ohuchta *Onondaga*, huchko *Muskogee*, aike *Atacama*, cuhuca *Muysca*, yaxyexke *Puelche*.
	uilge *Ko.* uluk *Ke.*	lahockee *Minetaree*, haklo *Choctaw*, gule *Cherokee*. calat *Adahi*.
earth	arykka *D.*	zicura *Accad*, sirikata *Aino*. ahonroch *Nottoway*, alawhi *Cherokee*, urakke *Aymara*.
	iskitta *B.*	yatta *Circassian*, tjidsi *Japanese*, tshekak *Aleutan*, ohetta *Iroquois*.
eye	manga *B.* missigh *D.*	neh *Circassian*, ni *Loo Choo*, manako, moku *Japanese*. nanit *Kamtchatka*, meishta *Upsaroka*, mishkin *Choctaw*, nockkochum *Caddo*. nahui *Quichua*, nagui *Quitena*, niyoco *Cayubaba*, nge *Araucan*.
father	abogo *B.* ambabk *D.*	jabow *Circassian*, apay *Corea*, pepe, empitch *Koriak*, menoomphhe *Upsaroka*, abishnisha *Natchez*, paba *Musyca*, idabapa *Cayubaba*.
fire	ika *B.* eka *Ko.* yk *Ke.* ik *D.*	su *Basque*, hi, yoke *Japanese*, tako *Ioway*, ocheeah *Tuscarora*, ioak *Choctaw*, yachtah *Uche*, yau *Woccoon*, iche *Itenes*. aquacake *Puelche*.
fish	karag *B.*	araga *Basque*, karasacki *Aino*, ikahlik *Tchuktchi*, kullo *Choctaw*, agaula *Cherokee*, challua *Quichua*, khalloua *Araucan*.
flesh	arykka *B.*	araguia *Basque*, glli *Circassian*. aroekka *Upsaroka*, wahra *Iroquois*.

	Barabra.	Khita.
foot	œntuga *B.* ossentuga *D.*	ona, oina *Basque*, onchidascon *Hochelaga*, sauknuthe *Chetimaca*, nocat *Adahi*.
hand	iddegh *B.*	id *Accad*, te *Japanese*, tsha *Aleutan*, istinkeh *Muskogee*, yta *Muysca*.
	igh *D.*	su *Accad*, oyg *Circassian*, esena *Basque*, ki *Loo Choo*, aiche *Kadiak*, sake *Dacotah*, shake *Mohawk*, agwoeni *Cherokee*, uish *Attacapa*. suyi *Atacama*, cue, cuugh *Araucan*, ieskup *Puelche*.
head	ourka *B. D.* oar *Ko.* ork *Ke.*	pir *Accad*, burua *Basque*, ootaure *Tuscarora*, anuwara *Onondagà*, abaracama, nahuaracama *Cayubaba*.
knife	gnadu *Ko.* kandyg *Ke.* kandyga *B.*	soonee *Circassian*, katana *Japanese*, tshangielk *Kadiak*, kainatra *Cayuga*.
man	ogikh *D.* ogedj *Ke.*	ka *Accad*, aga *Circassian*, guizua *Basque*, chu, ickkeega *Loo Choo*, oikyo *Insu*, okkai *Aino*, uika *Tchuktchi*, sewk *Kadiak*, ugig *Aleutan*, wica *Dacotah*, oonquich *Mohawk*, chauheh *Muskogee*, askaya *Cherokee*, aycutch *Dieguno* shoeh *Caddo*, ehha *Muysca*, hake *Aymara*, kosa *Quichua*, huataki *Itenes* auca, che *Araucan*, chia *Puelche*.
	itga *B.*	tas, nitakh *Accad*, otoko *Japanese*. tsioch *Aleutan*, oeeteka *Dacotah*, itaatsin *Minekussar*, hatak *Choctaw*, atseeai *Cherokee*, huataki *Itenes*, jadsi *Cayubaba*, het *Fuegian*.
	kordu *Ko.*	karra *Accad*, guru *Kurile*, kkari *Quichua*, cratasi *Cayubaba*.
milk	iddjc *B.*	shah *Circassian*, tji *Japanese*, ittuk *Tchuktch*, atsi-midi *Hidatsa*.
moon	noogy *Ke.* onateja *B.* ounatega *D.*	maathe *Circassian*, mangets *Japanese*, kounetson *Aino*, minnatatche *Upsaroka*, eghnida *Mohawk*, kanaughquaw *Cayuga*, nungdohsungnoyee, anantoge *Cherokee*, nachaoat *Adahi*, nee-ceish Caddo, weechaw-nootech *Catawba*, anoko *Fuegian*.
	norga *B.*	maroo *Loo Choo*, sonrekka *Iroquois*.
	scharappa *D.*	hahnip-weehah *Winnebago*, karakkwa *Iroquois*. kevasip *Natchez*, shafah *Uche*.
morning	mashanak *B.*	miyonichi *Japanese*, unakak *Kadiak*, chinnakshea *Upsaroka*.
mother	anenga *B.* indih *D.*	nen *Accad*, yani *Circassian*, ama *Basque*, anak *Tchuktchi*, anaan *Aleutan*, anaga *Kadiak*, enah *Dacotah*, aneheh *Huron*, ehneh *Caddo*, nuque *Araucan*.
mouth	akka *B.*	ka *Accad*, shay *Circassian*, kuchi *Japanese*, kuzha *Kamtchatka*, ekigin *Tchuktchi*, chaugh *Osage*, ihah *Omaha*, chique *Iroquois* heche *Natchez*, cha *Chetimaca*, ah *Dieguno*, guyhica *Muysca*.
	aul *Ko.* agilk *Ke.*	agiluk *Aleutan*, oskawruhweh *Tuscarora*, tsiawli *Cherokee*, wacatcholak *Adahi*, lakka *Aymara*. iapolk *Puelche*.
	chundeka *D.*	kandak *Tchuktchi*. kanhka *Kadiak*, chaknoh *Muskogee*, dunehwatcha *Caddo*.
neck	gummurk *B.*	zeymer *Circassian*, samea *Basque*, kubi *Japanese*, yoamuu *Kadiak*, sunyarlahghey *Mohawk*, ikunla *Choctaw*, kunka *Quichua*, comala *Atacama*.

Barabra.	Khita.
night.......qualal *Ko.*	kolkwa *Kamtchatka*, neillhe *Muskogee*, quilla *Quichua* (moon).
awaka *B.* ongouk *Ke.* anoka *D.*	ge *Accad*, kayshey *Circassian*, gau *Basque*, amgik *Aleutan*, oche *Upsaroka*, asohe *Cayuga*, weechawa *Catawba*.
nose.......szurringa *B. D.*	ar *Accad*, surra *Basque*, kohyoungsahli *Cherokee*, sol *Caddo*.
rain........omorka *B.*	muru *Accad*, euria *Basque*, obure *Japanese*, wara *Tuscarora*, iokennores *Iroquois*, para *Quichua*.
anessik *Ke.*	aan *Accad*, inotsi *Basque*, ame *Japanese*, neezhuh *Winnebago*, inaundase *Huron*, nasnayobic *Natchez*, ganic *Adahi*, tlinaci *Tehuilche*.
aveh *Ko.*	washghey *Circassian*, ami *Loo Choo*, umpa *Choctaw*.
river.......ser *Ko.*	aria *Accad*, kuli *Choctaw*, hahuiri *Aymara*.
assig *Ke.* ossiga *D.*	kogawa *Japanese*, kiigh *Kamtchatka*, kuik *Tchuktchi*, *Tchugaz*, kwikh *Kadiak*, wauchiseah *Osage*, ahesu *Upsaroka*, azi *Hidatsa* joke *Nottoway*, hucha *Choctaw*, kha *Dieguno*, eesaugh *Catawba*, sie *Muysca*.
amanga *B.*	neeshnoungai *Otto*, anges *Minetaree*, kneynugh *Tuscarora*, missi *Natchez*, mayu *Quichua*.
salt........ombotti *B.*	jamam *Koriak*, mashoo *Loo Choo*, pepum *Kamtchatka*, amahota *Hidatsa*, hupi *Choctaw*.
sheep......eget *B.*	uda *Accad*, hitsuji *Japanese*, chita *Quichua*.
shoes.......quare *Ko.* koresk *Ke.* derka *B.*	ihlhuchik *Kadiak*, oochekoora *Tuscarora*, ateraki *Iroquois*, shulush *Choctaw*, delahsuloh *Cherokee*.
sister......anissega *B.* onissega *D.*	ane, onnakiyodai *Japanese*, oni *Loo Choo*, angeen *Aleutan*, tunkshe *Dacotah*, aenyaha *Huron*, nocksishtike *Choctaw*, unggedo *Cherokee*, nanay *Quichua*.
sit.........tiko. *B.*	tize *Circassian*, tijay *Quichua*.
sea.........essi *B.*	ichasoa *Basque*, shey *Circassian*, ooshoo *Loo Choo*, kai *Japanese*, okhuttah *Choctaw*.
speak......bayn *B.*	sbaghey *Circassian*, hanasu *Japanese*, bedow *Upsaroka*, owenna *Iroquois* (speech), gahwonehah *Cherokee*, pouinyuy *Muskogee*, cubun *Muysca*, pin *Araucan*.
star........woussik *Ke.*	hoshi, fosi *Japanese*, weeweetheestin *Dacotah* weechahpee *Yankton*, ojistok *Mohawk*, phoutchik *Chickasaw*, owohchikea *Hitchitee* wahpeeknu *Catawba*, pacheta *Chetimaca*, fagua *Muysca*.
windjega *B.* ondou *Ko.*	dshogha *Circassian*, ojishonda *Cayuga*.
sun........maschekka *B.* mashake *D.*	matschak *Tchuktchi*, madzshak *Kadiak*, menakkah *Mandan*, meencajai *Omaha*, nungdohegah *Cherokee*, neetakhasseh *Choctaw*, neetahusa *Muskogee*, nyatch *Cuchan*, noteeh *Catawba*, nagg *Adahi*, antaigh *Araucan*.
es *Ko.*	iguzki *Basque*, hi *Japanese*, ahhiza *Upsaroka*, kachquaw *Seneca*, aheeta *Nottoway*, hushi *Choctaw*, sako *Caddo*, sua *Muysca*.

	Barabra.	Khita.
tooth	nyta *B.*	noontinga *Tchugaz.* onotchia *Iroquois,* noti *Choctaw,* innotay *Muskogee,* int *Natchez.*
	gehl *Ko.* nelky *Ke.*	aghalun *Aleutan,* onouwelah *Cayuga,* olosag *Nottoway,* kiru *Quichua,* lacaechaca *Aymara.*
tongue	nadka *D.* narka *B.*	nutshel *Kamtchatka,* neighjee *Minetaree,* ennasa *Iroquois,* undauchshean *Huron,* yahnohgah *Cherokee,* nedle *Attacapa.*
tree	sahleq *Ko.* saleyg *Ke.* galguela *D.*	arecha *Basque,* kerllitte *Mohawk,* geree *Nottoway,* yali *Atacama,* kullu *Quichua* (wood).
	goui *B.*	gu *Accad,* ki *Japanese,* jaga *Aleutan,* yahak *Unalashkan,* ehaongeena *Yankton,* kaeet *Seneca,* yah *Uche,* kagg *Attacapa,* yako *Caddo,* guye *Muysca,* hacha *Quichua,* ccoca *Aymara,* icheai *Atacama.*
water	esseg *D.*	a *Accad,* aga *Circassian,* wakha *Insu,* sui *Japanese,* hochneak *Oneida,* uckah *Choctaw,* okkee *Hitchitee,* eau *Woccoon,* ejau *Catawba,* ak *Attacapa,* ko *Chetimacha,* koko *Caddo,* aho *Cuchan,* haache *Maricopa,* sie *Muysca,* yaku *Quichua, Aymara,* ko *Araucan,* yagiy *Fuegian.*
	amanga *B.*	meze *Loo Choo,* mok *Tchuktchi,* nunak *Tchugaz,* minne *Upsaroka,* mini *Dacotah,* oneegha *Minekussar,* ommah *Cherokee,* huma *Aymara,* mouke *Araucan.*
wind	touga *B.*	itcheeshoong *Loo Choo,* ma-thuk *Aleutan,* tschang *Dacotah,* tattasuggy *Osage.*
	tourouck *Ke.* irschu *Ko.* kirguiata *D.*	tekawerakwa *Iroquois,* hotalleye *Muskogee.*
woman	ing *Ke.* enga *D.*	ni, min. mak *Accad,* emakume *Basque,* innago *Loo Choo,* mennokoosi *Aino,* meanako *Insu,* onna *Japanese,* angagenak *Aleutan,* eenah *Dacotah,* nogahah *Winnebago,* yonkwe *Mohawk,* ageyung *Cherokee,* waunehung *Uche,* ehneh *Caddo,* quochekinok *Adahi,* seen *Dieguno,* seenyack *Cuchan,* anu *Sapibocono,* nacuna *Patagonian,* iamokanika *Tehuilche,* iamokhonok *Puelche.*
	eaden *Ko.* edinga *B.* idingga *D.*	dam *Accad,* tackki *Loo Choo,* tawicu *Dacotah,* utehkeh *Huron,* tekchi *Choctaw,* tahmahl *Natchez,* tana *Itenes,* domo, thamo *Araucan.*
year	gemga *B.*	mogha *Circassian,* ning *Loo Choo.*

The vocabulary of the Barabra, judging by the limited specimen of which I have been able to avail myself, thoroughly coincides with those whose resemblances have already been set forth. Some of the Basque analogies are very striking. Thus we have okera Barabra and choria Basque, bird; aninga and anagea, brother; kalg and galoa, bread; arykka and araguia, flesh; karag and araga, fish (compare the Aino karasacki); igh and escua, hand; oar and burua, head; ogikh and guizua, man; ougouk and gau, night; szurringa and surra, nose; omorka, anessik and euria, inotsi, rain; enga and emakum, woman; owi and bi, two; bure and amar, ten. What closer resemblance is possible within the domain of comparative philology than that which is presented in the Barabra agilk, chundeka, mouth, on the one hand, and the Aleutan agilak, Tchuktchi kandak, on the other? Such another example is afforded in a comparison of the Barabra maschekka and the Tchuktchi and Kadiak matschak, the Sun. So again the Barabra Kehl is the Aleutan aghalun, tooth, while aly and onial are the Koriak allo and the Aleutan angallak, day. The Aleutan and Kadiak, with the allied Tchuktchi, seem to have preserved almost intact the old Hittite forms, which the Barabra carried into Nubia nearly four thousand years ago. The Aleutans and Barabra agree in being worshippers of the sun like other Hittites, in the manufacture of red waterproof leather, and in their manner of adorning the head, the only difference being that the Aleutans replace with beads the little pellets of yellow clay which the Nubians attach to their flowing locks. Physical ethnology would never have dreamt of uniting white Basques and Circassians, black Nubians, yellow Japanese and red American Indians; but philology, which knows no colour but that of words and constructions, makes them one. It may be that in the Barabra we shall yet find the purest surviving form of the ancient Hittite language. Some of its numerals help to connect those of the Peruvian dialects with other Hittite forms. Such are tosk 3 and kemsou 4, which the Quichua inverts, taking kimsa for 3 and tahua for 4; iscodon 9 is the Quichua iscon, and dimaga 10 the Aymara and Sapibocono tunca, while bure, another form of the same number, is the Cayubaba bururuche, and, at the same time, the Dacotah perakuk.

The subject of numerals, however, takes us into central Africa by way of Darfur as far as Haussa. The Furian and Haussa vocabularies are almost entirely made up of Khitan and Sumerian words, and the grammar of the latter language is virtually that of the Berber. Before I knew that Dr. Hyde Clarke had placed the Haussa among his Vasco-Kolarian languages, I had been struck with the resemblance of its numerals to those of the Basque, which have long been regarded as unique. Thus the Haussa bu 2 is the Basque bi, biga, bida, the Accad bi, Barabra owi, Corean fupu, Cadno bit, Muysca bosa, Aymara paya, Atacama poya, Cayubaba bbeta, Araucanian epu and Peulche petci.

In the Haussa biet, bere 5, we find the Basque bost and borzt, the Accad para, the Iroquois wish, the Quichua and Aymara ppisca and the Sapibocono pissica. The Haussa shiddah 6 appears in the Basque sei, the Uche chtoo, the Quichua and Aymara socta and the Sapibocono succuta. For the number 7 the Basque zazpi connects with the Furian szebbe, and thus with the Dacotah shapua, shawcopee and the Muysca cuhupqua; while the Haussa bookqua, buckeree furnish analogies to the Caddo bissickka, the Maricopa pakek, the Adahi pacaness and the Aymara pacalco. Nine in Haussa is farra or turrah, and in these forms we have the elements out of which the Basque bederatzi was formed. Ten again is gomar, the Basque hamar and the Araucanian mari. From the Barabra, Furian and Haussa many of the Peruvian forms of the numerals may be recovered and their antiquity established, as well as their relation to the old Khita Sumerian confederacy, which left such extensive traces on the African continent as well as those in Europe, Asia and America.

NUMERALS.

Peruvian.	Khita-Sumerian.
1....huc. suc *Quichua*. (? dik *Darfur*)	gi *Accad*. aki seka *Circassian*. ichi *Japanese*, soquo *Cherokee*. sah *Uche*. siba *Dieguno*.
mai *Aymara*. sema *Atacama*.	naya *Kashna*. kemmis *Kamtchatka*. unji *Tuscarora*, onje *Dacotah*. meeachchee *Omaha*. hommai *Muskogee*. hongo *Chetimaca* hannick. *Attacapa*. sin *Cuchan*. hina *Dieguno*. kine *Araucan*.
2....ycay. iscay *Q*.	eas *Accad*. au *Darfur*. oh *Circassian*. hokko *Muskogee*.
paya *A*. poya *At*. bbeta *Cayubaba*.	bi *Accad*. bi. bida. biga *Basque*. bu *Haussa*, biu *Kashna*, owi *Barabra*, wiba *Circassian*, futatsu *Japanese*. fupu *Corea*. ahwetie *Natchez*. bit *Caddo*, hupau *Chetimaca*, haveka *Maricopa*, bosa *Muysca*, epu *Araucan*, petei *Puelche*.
mitia *Sapibocono*.	mittanoo *Kamtchatka*. mitsu *Japanese* (3).
3....curapa "	raph *Aino*.
quinca *Q*.	san *Japanese*. sang *Loo Choo*. kankas *Aleutan*, aushank *Huron*.
kimsa *Q. A*., kimisa *C*.	kemsou, kemsoga, kemmisk *Barabra* (4). hamuc *Cuchan*, hamoka *Maricopa*, khamoc *Dieguno*. mica *Muysca*.
4....chalpa *At*.	tshopi *Winnebago*. chapop *Cuchan*. champapa *Maricopa*. tchapap *Dieguno*.
pusi *A. S*.	fudu *Haussa*. pshi *Circassian*. peaweh *Caddo*.
chadda *C*.	huddu *Kashna*, yotsu *Japanese*, tschitaami *Tchugaz*. ushta *Choctaw*.
tahua *Q*.	tosk. todje *Barabra* (3), tshusquat *Kamtchatka* (3). thascha *Kamt*. (4), toua *Otto*, towae *Ioway*, tsets *Attacapa*, tacache *Adahi*.

PERUVIAN.	KHITA-SUMERIAN.
5....ppisca *Q. A.*, pissica *S.*	beaha *Haussa*, biet *Kashna*, bost *Basque*, itsutsu *Japanese*, wisk *Mohawk*, &c., wiks *Onondaga*, wish *Cayuga*, hiskee *Cherokee*, seppacan *Adahi*, dissickka *Caddo*, hussa *Chetimaca*, hisca *Muysca*, kechu *Araucan*.
6....socta *Q. A.* succuta *S.*	shiddah *Haussa*, shaweo *Dacotah*, soodallih *Cherokee*, ehtoo *Uche*.
carata-rirobo *C.*	gordjou *Barabra*, roku *Japanese*.
michalo *At.*	mutsu *Japanese*, mohok *Maricopa*.
7....canchis *Q.*	ganah *Tuscarora*, pacaness *Adahi*.
pacalco *A.* pacaluca *S.*	bookqua, buckeree *Haussa*, kalo-pagy *Muskogee*, paghu *Attacapa*, pacalcon *Adahi* (8), bissickka *Caddo*, pakek *Maricopa*, passac *Quichua* (8), puasa *Tehuilche* (8), posa *Puelche* (8).
8....passac *Q.*	fakoa *Kashna*, fatchee *Loo Choo*, faz *Japanese*, pigajunga *Tchuktchi*, peefah *Uche*, upkutepish *Natchez* (see 7).
curapa-rirobo *C.*	kraerabane *Otto*, kraerapane *Ioway*, chinnabah *Muskogee*.
kimsa-calco *A.* kimisa-calcu *S.*	kamtshing *Aleutan*.
cholama *At.*	kollemgaien *Kadiak* (9).
9....iscon *Q.*	iiskodk, iskodon *Barabra*, kokonotsu *Japanese*, sickinish *Adahi*.
teker, tekara *At.*	tarra *Kashna*, turrah *Haussa*, chakali *Choctaw*, pewesickka *Caddo*.
pusicalco *A.*	
10... bururuche *C.*	pur *Accad.* bure *Barabra*, amar *Basque*, gomar *Haussa*, oyerih *Mohawk*, perug *Mandan*, peeraga *Minetaree*, perakuk *Upsaroka*, pahlen *Muskogee*, pocoli *Choctaw*, mari *Araucan*.
tunca *A. S.* chunca *Q.*	dimaga, dimega, dumming *Barabra*, teamatska *Puelche*.
such, suchi *At.*	siou *Japanese*, hasuk, asik *Aleutan*, ausai *Huron*, uhskohhih *Cherokee*, heissigu *Attacapa*, shahoke *Maricopa*.

The Haussa and Kashna connection of the Sumerians is valuable as aiding to establish the Biblical relations of that ancient stock. In a paper read before the Society of Biblical Archæology, I endeavoured to connect the Zimri of Jeremiah xxv. 25 and of the Assyrian inscriptions (Records of the Past, I. 22, V. 34, 41) with the Sumerian people, and these again with Zimran, the eldest son of Abraham by Keturah.* Zama-

* I have alluded to the same subject in an article which appeared in the January part of the "British and Foreign Evangelical Review." Since that article was in press, however, I have discovered that the Sumerian family was in existence prior to the time of Zimran, being that of the Yorham mentioned by many Arabian historians. The universal tradition is that the Katoorah, or descendants of Abraham by Keturah, united with the Jorham, from whom the original Aumri and Zemirai descended. As one of their ancestors, Beer, was commemorated

reni dwelt in Arabia in the neighborhood of megalithic structures, concerning one of which Palgrave, referring at the same time to Stonehenge, says: "There is little difference between the stone wonder of Kasseem and that of Wiltshire, except that one is in Arabia, and the other, more perfect, in England." According to Philostorgius, the Homeritæ were the descendants of Abraham by Keturah; and the relation between the Hebrew zimran a song, and the Erse amhran, having the same meaning, enables us to understand not only the connection of the forms Zimri and Homeritæ, but other pairs of words like Sumer and Aymara, and Zimuhr and Amor. The Celtic dialects again, both as regards their grammar and vocabulary, present many Semitic features, such as might be expected to exist in the speech of an Arabian family and the descendants of the patriarch Abraham. It is worthy of note that the people of Homeir or the Homeritæ were notorious for speaking a very corrupted dialect. In the Arabian historians, Homeir appears as a descendant of Kahtan, from whose son Saba the Kahtanites were called Sabeans; but many old writers, Arabian and others, distinguish between Sabeans and Homeritæ; and the conclusion of Dr. Russell, in his Connection of Sacred and Profane History, is that they were two distinct peoples, distinct yet closely related. Allowing the truth of the statement of Philostorgius that the Homeritæ were the descendants of Keturah, a fact rendered probable by their possession of the rite of circumcision, the most natural solution of the relation between Homeritæ and Kahtanite Sabeans is that the latter were the descendants, not of Joktan, the son of Eber, but of Jokshan, the son of Abraham, and brother of Zimran, who also had a son Sheba, his eldest son, while the Sheba of Joktan occupies a very subordinate place in the family of that patriarch. The language of the Himyaritic inscriptions confirms this, for we find that, like the Aramaean, it often replaces *shin*

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in Bokhara, it is natural to suppose that the Zemirai of his line were the originators of the name Samarcand. The Ait Amor of Africa with the Aymaras of Peru would naturally connect with this Becherite line rather than with that of Zimran, through the Aumri. I have not yet found the precise relation sustained by the posterity of Zimran, represented probably by the Zamareni of Arabia, to the family of Yorham. Yet from the intimate connection of the Zimri with the Matiani of Media as set forth in the Bible and in the Assyrian inscriptions, and of these again with tribes of Jorhamite descent, it would seem that the two stocks had amalgamated.

by *tau*. If Ashtar and Yasha can become Athtar and Yatha, Jokshan may certainly be changed to Joktan. These Jokshanites seem to have been driven by the Homeritæ into Ethiopia, where they founded the kingdom of Axum, and were known to the ancient geographers as the Auxumitae or Hexumitae, still retaining the rite of circumcision and manifesting the same hostility towards the Homeritae that characterized them in Yemen. Being allowed to give their own version of their name instead of Himyaritic, the Kahtan disappears and is replaced by Jokshan, which Greek travellers hellenized into Auxum. These Jokshanites, with Zimrites or Himyarites, made their way across the African continent, for the traditions of Bornou ascribe the foundation of its ancient kingdom to the Himyarites of Arabia; and, adjoining Bornou, lies the state of Kashna or Katsena, which, more perfectly than the Kahtan of the Arabs, preserves the name of the second son of Keturah. The language of Kashna is that of Haussa, which I have already associated with the Khita-Sumerian confederacy. Leo Africanus informs us that the Berbers were generally thought to be the descendants of the Sabeans, and Alexander Polyhistor, quoted by Josephus, tells the same story. There are many other authorities that might be quoted, did space permit, to the same effect. To link them with the Sumerians of Babylonia is an easy task. Sir Henry Rawlinson gives many proofs for an early connection of the Lower Euphrates with the people of Southern Arabia, and speaks of a brick from Hymar, a suburb of Babylon, as the only probable relic of the Arabian dynasty of Berosus, which Mr. Baldwin holds to be the same as the Median dynasty of that author, the word Madian or Midianite replacing the term Median. These Arabians, the leader of whom, according to the late George Smith, was Hammurabi, who built a city at Hymar, must have been the Homeritæ, Himyarites, Zimri or Sumerians, a Semito-Celtic people, and the constant allies of the Turanian Khita. The gods of Yemen were those of Babylonia. It is also worthy of note that Merodach, the name of a god introduced by Hammurabi and generally associated with Babylonian monarchy, enters as a constituent into the title of a king of the Zimri, Merodach-Mudammik. Samarcand was supposed by many Arabian historians to have been the seat of Arabian (Himyaritic) monarchs, and Humboldt favoured their view. It was no doubt a stage in the eastward journeyings of the

Sumerians with their Khita confederates. They left their traces in Media, as at Ujan, where druidical circles are found which "M. D. Hancarville regarded as resembling and probably coeval with the stupendous British monument Stonehenge." Dr. Ferguson, in his "Rude Stone Monuments in all Countries," finds these stonehenges in Northern Africa, Asia Minor, and even in India, and maintains their common origin. In Peru we have found them as the work of a Sumerian people; and I am firmly convinced that, wherever else they may be discovered, such, philology, coming to the aid of archæology, will show to have been their origin.

It may appear a somewhat improbable thing that a people speaking a Semitic language, such as was the ancient Himyaritic, should connect with the so-called Aryan Cymri and other Celts. Sir Gardner Wilkinson, however, speaking of that sub-Semitic language, the Egyptian, states that it has affinities with the Celtic and the languages of Africa, and adds: "Dr. Ch. Meyer thinks that Celtic in all its non-Sanscritic features most strikingly corresponds with the old Egyptian." We have already seen that the Berber and Haussa, both in point of grammar and vocabulary, present much in common with the Celtic, and that there are well defined Celtic traces in the Accad arising from the Sumerian relations of that language. The Sumerian seems to have been from the beginning a language peculiarly susceptible of surrounding influences, so that, while in Arabia and Africa it retained a Semitic character, in Europe it approached the Aryan, and in Chaldea and Peru became thoroughly Turanian. The Celtic dialects contain a great many Semitic roots, in the the possession of which they differ entirely from the Indo-European languages, as they also differ from them, while agreeing with the Semitic tongues, in several grammatical forms of no small importance.

The occurrence of megalithic structures, so much resembling the Cymric erection called Stonehenge as to call for comparison with that monument from many different writers, in constant connection with Sumerian forms, is an argument that applies to the Arabian Himyarites as well as to other peoples whose language agrees better with the Celtic. Stonehenge itself was known as the work of Emrys and was a Cymric structure; those erections of a similar nature, referred to by Ferguson, Catherwood and Pegot-Ogier, as found in Northern Africa, relate to the tribal and geographical names Amor, Zimuhr and Gomera; the monument of Kasseem, which Palgrave compared with that of Wiltshire, lies under the Shammar mountains in the land of the ancient Zamareni; that of Ujan in Media, called a stonehenge by D'Hancarville, is situated where Zimri and Gimirrai, doubtless the same people, once dwelt; and the great group of Tihuanaco, which Mr. F. A. Allen has named "a sort of Peruvian Stonehenge," was the work of the Aymaras. It would be a pleasing and satisfactory task to follow the track of the Sumerians and their Hittite allies from Media to the confines of America, but this my present knowledge of the intermediate countries and peoples, with their antiquities and languages, does not permit me to attempt. I have perhaps already, in seeking a fuller acquaintance with the Sumerian family, strayed too far away from my subject, the Hittites in America.

For the intermediate members of the Khita family between the Circassian and the Peninsular peoples of north-eastern Asia, I can only present the Kariens of Burmah and Siam, whom Dr. Hyde Clarke places on the line of Khita migration. The Karien Passuko are undoubtedly Hupuskians or Eastern Basques. The following short vocabulary shows their Hittite relationships:

Karien.		Hittite.
all	ahmak.	shimmete mataku, *Japanese*, ahhook *Upsaroka*, naka *Quichua*.
arm	tchoobah, tchoobauh.	ipik *Kadiak*, idaspa *Hidatsa* (shoulder), shukba *Choctaw*, shukbah *Chicasaw*, sakpa *Muskogee*, ieskup *Puelche*.
below	hoko.	ge *Accad*, ayshay *Circassian*, uchi *Japanese*, ichcu *Atacama*.
bad	gyia.	gaiztoa *Basque*, ashiki *Japanese*, cheja *Dacotah*, ooyohee *Cherokee*, hucha *Quichua*.
boy, son	possa, possaho, aposo.	bosan *Japanese*, paca *Kamtchatka*, pooskoos *Chickasaw*, chibouosi *Muskogee*.
death	mathi.	mutu *Haussa*, bat *Accad*, amaya *Aymara*.
ear	nakhu.	nakoha *Mandan*, noghe *Dacotah*. nocksoo *Catawba*, hinchu *Aymara*.
fish	ya.	kha *Accad*, zeyshee *Circassian*, eo *Loo Choo*, giyo *Japanese*, ho *Otto*, huh *Quappa*, haugh *Osage*, yee *Catawba*, gua *Muysca*.
	nga.	genjoh *Iroquois*, mua *Hidatsa*, nune *Choctaw*, makche *Chetimaca*.
fire	me.	midahe *Hidatsa*, pajah *Osage*, epee *Catawba*, aima *Yuracares*, maja *Patagonian*.
foot	kaw	sau *Haussa*, essa *Accad*, assa *Japanese*, jeo *Tchugaz*, siha *Dacotah*, auchsee *Tuscarora*, saseeke *Nottoway*, yeyeh *Chickasaw*, quicha *Muysca*, kayu *Aymara*, chaqui *Quichua*, ahei *Cayubaba*, khoche *Atacama*.

KARIEN.	HITTITE.
good......gha	khi, *Accad*. souyyey *Circassian*, yoi *Japanese*, shusu *Mandan*. cho *Muysca*, khaya *Atacama*.
great.......do. uddo. tau.	tak *Accad*. atto *Circassian*. andia *Basque*. tai dai. *Japanese*. ietia *Hidatsa*. tougo *Dacotah*. tatchanawikie *Nottoway*. ishto. chito *Choctaw*, tocat *Adahi*. hatun *Quichua* vuta *Araucan*. hati *Puelche*.
hair........khosu.	uz. sik *Accad*. ke *Japanese*. kaeuguy *Koriak*. hi *Hidatsa*. issi *Choctaw*. kutteks *Chetimacha*. zye *Muysca*. chuecha *Quichua*. echau *Sapibocono*.
hand.......su, kozu.	su. kat *Accad*. oyg *Circassian*. igh *Barabra*, esenа *Basque*. ki *Loo Choo*. aicha *Kadiak*, tsha *Aleutan*, sake *Dacotah*. shagai *Omaha*, shake *Mohawk*, kaschuchta *Seneca*. uish *Attacapa*. secat *Adahi*. suyi *Atacama*. cue cuugh *Araucan*.
head.......ko.	ku *Accad*. shkha *Circassian*. kai *Haussa*, kobe *Japanese*. kashko *Tchuktchi*. ischigi *Aleutan*. scotau *Huron*. ekuh *Muskogee*, ashkaw *Cherokee*. iska *Catawba*. ashhat *Attacapa*, zysquy *Muysca*, echuja *Sapibocono*. eacaa *Puelche*. iagoha *Tehuilche*.
leg.........poka.	buchoope *Upsaroka*, hepapeeah *Catawba*. (foot). hatpeshi *Natchez* (foot). goca *Muysca*. ebbachi *Sapibocono* (foot). iapgit *Puelche*.
leaf........lah, thela.	onerlachta *Mohawk*. oogahlogv *Cherokee*. llaka *Aymara*.
moon......luh.	lid *Accad*. illarguia *Basque*. igaluk *Kadiak*, ladicha *Huron*. kelanquaw *Mohawk*. halhisie *Muskogee*. tegidilesht *Attacapa*, hullash *Maricopa*. hullyar *Cuchan*. quilla *Quichua*.
name......maing.	mu *Accad*. ninna *Koriak*. mei. miyomoku *Japanese*.
red........gau.	gusci *Accad*. akai *Japanese*, akassa *Loo Choo*. shah *Dacotah*. quechtaha *Seneca*, keekahgeh *Cherokee*. sikechuh *Catawba*.
rain........tatchu. tchatchang.	tshukutshoo *Kamtchatka*. tshiotakik *Aleutan*. hade *Hidatsa*. oostaha *Seneca*. atan *Muysca*.
small......tcheka.	tzick *Circassian*. chiquia *Basque*. chiisai *Japanese*, tshukudak *Kadiak*. tscheestin *Dacotah*, chotgeose *Muskogee*. iseca *Aymara*, ichcai *Atacama*. agietee *Puelche*.
star.......shia, sa, za. tsah.	sa *Accad*, ooshaghe *Circassian*, hoshi *Japanese*. aghia *Kadiak*. sthak *Aleutan*, icka *Hidatsa*. hkaka *Mandan*, teghshu *Huron*, owohchikca *Hitchitee*. ish *Attacapa*, tsokas *Caddo*. gau *Araucan*.
water......ti.	dzeh *Circassian*, sui *Japanese*. tana *Aleutan*, tsach *Uche*, ata *Muysca*. ikita *Cayubaba*.
e t ....ang.	jan *Basque*. hamu *Japanese*. kaangen *Aleutan*, nukhwha *Kadiak*, hongauhooh *Huron*, maneatha *Aymara*. in *Araucan*, akenec *Puelche*.
raise.......heca.	aca *Accad*, aghe *Japanese*, haca *Aymara*.

My excuse for burdening these pages with so many comparative vocabularies is that this is the only way in which I can make patent to the ordinary student of comparative philology in its ethnological connections the relations which the various peoples I have had in review sustain to one another. The whole argument for a Hittite population in America turns, first of all, upon Dr. Hyde Clarke's identification of the Accadians with the Khita; and, secondly, upon my supposition that the Khu[illegible]uskai of Mesopotamia and Armenia were of the same stock. Be this as it may, I contend that there has been established a relationship of the most intimate kind between the Basques of Europe, the Nubians of Africa, the Circassians, on the borders of Europe and Asia, the Kariens, the Japanese and other Peninsular peoples of Asia, the Aleutans, Kaniagmutes (of Kadiak), the Dacotahs, Iroquois, Cherokee-Choctaws, Muyscas, Peruvian and Chilenos of America. Also I hold that the Celtic origin of the African Berbers and Guanches and of the Peruvian Aymaras has been demonstrated. To Dr. Hyde-Clarke belongs the merit of the discovery which bids fair to revolutionize the science of ethnology, a discovery which it has been a pleasure to me, as a labourer in the same field with that accomplished and veteran philologist, to confirm by new, and, I trust, not unimportant, evidence.

TIDAL EROSION IN THE BAY OF FUNDY.

By G. F. Matthew, M.A., F.G.S.

The causes which produced the phenomena of the Post-pliocene period in the northern parts of Europe and America have been the subject of controversy for many years; and even now, so far as some of them are concerned, are open to debate. Among the deposits whose origin seems obscure, may be classed the isolated ponds, gravel mounds, and "moraine ridges" met with in gravelly tracts in Canada and New England. By some geologists these deposits are attributed to the sudden melting of glaciers of great extent which once covered the northern parts of the continent; by others to heavy spring-floods from snow-clad regions, and by a third class to strong marine currents. Where such deposits are found in the neighborhood of mountains it may be supposed that one or other of the first two causes has produced the beds. But the absence of mountain chains from all parts of the Maritime provinces of Canada except the north, is an objection to the use of these hypotheses in explanation of the conditions of the deposits which exist there. Supposing from the condition of the gravel and sand beds spread over parts of southern New Brunswick that such accumulations may have been due to ocean currents, I was led to examine the effects of tidal currents in the Bay of Fundy in removing and rearranging the sediments on its bottom. The action of the tides in these respects was found to present phenomena analogous to those which ocean currents would have produced; though of course not identical with them, or on so large a scale.

The following results of observations on tidal erosion are based chiefly on an examination of the soundings in various parts of the Bay of Fundy obtained by the British Admiralty Survey, with supplementary data embodied in the map obtained from an article in the report of the Smithsonian Institution of 1874 by Prof. J. E. Hilgard, and results of the deep sea explorations of the Challenger expedition on this coast.

Investigations into the condition of the sea-bottom made in recent years, show that except where it is swept by currents, the ocean-floor is covered by a fine mud or even a flocculent ooze; while on the shallows along the coast are strewn the sand, gravel and boulders swept from the land. But though the Bay of Fundy is deep and is sheltered from the great ocean currents, the bottom in its deeper parts does not usually consist of mud, but of sand and coarser materials. The cause of this anomaly is apparent when we examine the action of the tidal currents upon the bottom of the Bay.

The sections of the North Atlantic between New York and Bermuda, and Halifax and Bermuda respectively, projected from the soundings of the Challenger, shew where the tidal impulse passing through the ocean is converted into a wave pressing up along the submerged border of the continent; and the form of the bight or indentation of the coast between Cape Cod and Cape Sable, called the Gulf of Maine, has the effect of compressing this wave laterally and driving it onward toward the entrance to the Bay of Fundy. From the shallowness of the sea from George's Banks westward toward Cape Cod, it is evident that the power of the rising tide is greatly broken in the western part of the Gulf of Maine; and that the tidal impulse which gives rise to the Bay of Fundy tides is propagated chiefly through the deep channel between George's and La Have banks. Off Cape Sable the tide attains a speed of $1\frac{1}{2}$ knots (which in tides is a wearing pace), and thence sweeps around into the Bay of Fundy.*

The apparent width of the Bay at its mouth is considerable, but the actual width of the deep-water passage is not great, as the shoals and reefs connected with the island of Grand Manan, block a large part of the opening. Owing to this the great tidal wave which enters the Bay twice a-day, is compressed between the Old Proprietor Ledge off Grand Manan and the North-west Ledge off Bryer Island into a space of 24 geographical miles, of which 20 miles has an average depth of 100 fathoms, with a bottom of rock, sand and gravel. Here the tide runs at the rate of three miles an hour, but immediately the strait is passed moderates its pace, the rocks and gravel disappear and the bottom becomes more sandy. On the north side of the Bay, this sandy condition of the bottom is found only in the deeper parts, and

* The influence of the Gulf of Maine on the tides of the Bay of Fundy may be inferred from the fact that unusually high tides in the Bay are generally accompanied by S.E. winds, not by S.W. winds as might be supposed likely from the direction towards which the Bay of Fundy opens.

up to the 40-fathom contour line; but on the south side the sand and gravel extend up to the shore. Of still coarser material is the bottom composed in Minas Channel, where the current pours over submarine ledges with great swiftness and force.

Such is the condition of the bottom of the Bay of Fundy as a whole, in the deeper parts; but both in the deep water and along the shores gravel banks have been formed or exposed by the currents which traverse it. Such are those which lie on each side of the deep water area off Grand Manan and in places along the Nova Scotian shore. The most considerable gravel-bank in the Bay is that which begins on the eastern side of Saint John Harbour, and extends, mostly in soundings of from 20 to 30 fathoms, nearly to Quaco Head. The tidal current along this shore, having escaped the in-draft of the Saint John River, runs at the rate of two knots an hour. A small gravel-bank also extends along the western shore of Grand Manan, where the tide runs at the rate of three knots an hour.

The New Brunswick shore has the greatest area of muddy bottom, for on that side the largest rivers enter the sea, and the tidal current is more sluggish than on the south side of the Bay. The *great mud bed* is chiefly an accumulation of the sediment which the Saint John River carries into the sea, and is spread along the New Brunswick shore by the ebb-tide. It begins at the harbour of Saint John and extends westward to the Wolves Islands. The outer limit of this bed is nearly coincident with the 50-fathom contour line. At the Wolves it connects by a narrow neck of clayey bottom with another deposit of mud, composed of the mingled sediment of the Saint John River and the rivers of Charlotte County. This extension of the mud-bed is in the deepest part of the Bay of Fundy, just eastward of Grand Manan. This island shields it from the rush of the great tidal wave which enters the Bay between the Old Proprietor and the North-west Ledge. Opposite the Old Proprietor Ledge the mud-bed narrows, and terminates at the last submerged ledge in the sea-bottom southwestward of that reef.

Less extensive mud-banks are found further up the Bay, fringing its northern shores. The chief of these is a narrow one extending from Quaco to Cape Enragé.* A knowledge of the

* These shores being now occupied mostly by an English-speaking population, the French names have been corrupted: C. Enragé, becomes C. "Rozhee," C. Maringuin, C. "Mangwin," C. Demoiselle, C. "Muzzle," or "Mussel," C. d'Or, C. "Dory," &c., &c.

position of these mud-beds and of the gravel banks is of great practical value to navigators in the Bay, owing to the prevalence of summer fogs, which make necessary a frequent use of the sounding lead.

While the tides have evidently affected the condition of the *surface* of the sea-bottom in the Bay of Fundy they have also cut deeply into its *substance*. At the mouth of the Bay where the run of the tide is moderate and the water deep, this result is not very noticeable; but at the head of the Bay its power in cutting and removing the soft mud and sand at the bottom is very great. Near the mouth of the Bay, however, this scouring action of the tide is seen in the shallow basin, called Passamaquoddy Bay. At all the entrances to this sheet of water the bottom is very rocky, and the channels are full of deep holes and pointed ledges, exposed by the constant churning of the current in these narrow passages. The rush of the tide causes a roaring sound that may be heard for many miles, and the whirlpools are strong enough to upset boats and careen larger vessels. Its great power in this shallow bay is also shown in the production of channels extending from these passages nearly across the Bay, while the largest rivers which enter the bay do not show channels even at their mouths, except such as the tide has helped to excavate. The Magaguadavic River, for instance, one of the largest which enters Passamaquoddy Bay, has not cut a channel in the bottom of that bay deeper than the 5-fathom contour-line; but right athwart the mouth of this stream runs atidal channel that extends up into Bocabec Bay (an indentation of Passamaquoddy Bay).

None of the rivers from the Magaguadavic eastward to the Saint John ha a heavy in-draft of tide, and so the work of the current at the mouth of these smaller streams has been slight. But at the mouth of the Saint John River very deep channels have been made by the ebb and flow of the tide in the narrow passage by which this river enters the sea. Although there is a depth of 36 feet only, at low water, on the reef which causes the rapid at the mouth of the Saint John called "The Falls," such is the force of the current that a trench 150 feet deep has been produced below "The Falls," and one of 200 feet deep above them.

But if the deeper part of the Bay of Fundy be examined, evidences of tidal erosion will be observed even more remarkable than those which the river mouths present. The first well defined trough lies in the middle of the Bay between Quaco and Margaretville, where there is a depression outlined by the 40 fathom contour line, nine miles long and three miles wide. In Chignecto Channel off Cape Enragé there is a trough scooped out by the tide to the depth of 30 fathoms, and further up the same arm of the bay in Cumberland Channel another, through which the tide runs at the rate of four miles an hour.

But it is in the eastern arm of the Bay of Fundy—Minas Channel and Basin—that the scouring action of the tide is most conspicuous. The curve of this arm of the bay to the eastward throws the weight of the current on the northern shore, where under Cape D'Or lies a trough scooped out to a depth equal to that of the deepest part of the Bay of Fundy between Saint John and Digby. Passing Cape D'Or and going further up, the bottom again rises to within 25 fathoms of the surface, but soon sinks into another trough 40 fathoms deep.

This extends to Cape Split where another sharp barrier reef comes to within 25 fathoms of the surface. Over this the tide runs swiftly, plunging down on the opposite side into a trench 50 fathoms deep, and rushes through the Parrsboro' Passage at the great velocity of 10 miles an hour. Beyond this the trough becomes shallower and branches off toward the Cornwallis, Avon and Shubenacadie Rivers.

A sudden elevation of the sea-bottom in the region of the Bay of Fundy to the extent of 250 feet would therefore now expose to view a chain of lakes varying from 50 to 150 feet deep, besides others of less extent and depth, all due to tidal erosion. If such a movement were continued till the whole of the basin of the Bay of Fundy were raised above the sea, there would then be, in addition, at the mouth of the Bay, a large lake, partly, but not entirely, the result of tidal wear. With such palpable results before us, of the cutting power of the tides, we cannot refuse to give weight to the similar action of deep-seated and powerful ocean currents as factors in modifying the surface of the earth in Post Pliocene times.

Wherever in the upper part of the Bay of Fundy the current has been confined by projecting headlands, or concealed submarine ridges, and hindered in its semi-diurnal impulse to enter the remotest creek at the head of the Bay, there it began like a wild beast to chafe and surge and roar against the obstacles in its path. Century after century the tide has thus been gnawing at the bottom of this remarkable arm of the Atlantic, and during all these years has been spreading its spoil of muddy sediment over the flats and marshes at its head; millions of tons of mud have been thus deposited since these flats began to grow, and it is said that there are now 80,000 acres of marsh-land at the head of the Bay of Fundy produced by this agency.*

The growth of these marshes has become possible owing to the slow but steady and continuous sinking of the land in the Bay of Fundy area. Those of Annapolis, Minas and Cumberland Basins along the Nova Scotian shore conceal the buried remains of hardwood and softwood trees. The trunks of these trees have fallen among stumps whose roots are still buried in the soil in which they grew, and are now covered with a great thickness of marsh mud. Although this land surface was once above the sea, the tide now rises over it to the height in some places of 40 feet. Similar indications of the sinking of the land are found on the New Brunswick side. In sheltered coves among the islands of Charlotte County, there are places where peat bogs may be seen to extend below low water mark (the rise of tides being 25 feet) and Dr. Abraham Gesner in his report on the Geology of New Brunswick (1840–43), mentions the fact that the anchors of vessels were sometimes caught in the buried stumps at the bottom of one of the harbours of Grand Manan. Another indication of depression of the land is obtained from the existence of a submerged channel of the Saint John River, outside of Partridge Island at the entrance of St. John Harbour. While these facts shew that a depression has occurred the condition of certain deposits within the coves near the mouth of the St. John, proves that the sinking of the land was slow and continuous, admitting of the accumulation between tide marks of the sediment carried in suspension by the agitated waters of the Bay. In these marshes and the extensive mud-flats connected with them is to be sought the place of deposit for much of the mud and fine sand of which the sea-bottom in most of the deeper parts of the Bay of Fundy is found to be deficient.

* P. S. Haliburton. Proceed. N. Scotian Inst. Nat. Sci. Vol. 2, Part 1.

NATURAL HISTORY SOCIETY.

ANNUAL MEETING, MAY 18, 1880.

The Annual Meeting of the Society was held on the evening of Thursday, 18th May. In the absence of the President, Principal Dawson occupied the chair.

The minutes of the last Annual Meeting were read and approved. The Chairman addressed the meeting, giving a very interesting sketch of the last visit of the American Association for the Advancement of Science to this city, which was in the year 1857. The preceding meeting was held in Albany, when all the delegates from the Montreal Society, including Sir William Logan, Dr. Smallwood, Dr. Hingston, Mr. Rennie, the then Secretary, himself and others, were requested to represent the Association at the meeting in this city. Three invitations were received by the Association, but the one from Montreal was preferred and accepted. The Society here succeeded in inducing two delegates from England to be present also, viz: — Professor Ramsay, representing the Geological Society, and Dr. Seaman representing the Linnæan Society. Owing to the difficulty of finding a suitable place to hold the meeting—the public halls, with the exception of Mechanics', not being built—the meeting was held in the Court House. Welcomes were tendered on behalf of the city and country, and the visitors were entertained by the Natural History Society, by the College, and by the Corporation of the city. Two excursions were organized, one to St. Helen's Island by Colonel Munro, and the other to Ste. Anne's and Beauharnois. Altogether it was a most successful meeting. In correspondence with the Secretary he learned an invitation from Montreal would be very popular now—among the members of the Association. It should be borne in mind that if the invitation were given, it should be carried out with the same spirit and generosity as it was then. For various reasons it had been considered unwise to extend the invitation before the summer of 1882.

It was then moved by Dr. De Sola, seconded by Dr. Hingston, and unanimously resolved: "That the Council now to be elected take measures to invite the American Association for the Advancement of Science to meet in Montreal in the summer of 1882, if on enquiry this should be found practicable and expedient."

Major Latour then addressed the meeting as follows:

ANNUAL ADDRESS.

In the absence of our learned and worthy President, I have been asked as ex 1st Vice-President, and as one of the oldest members of the Montreal Natural History Society, to deliver an address at this annual meeting. I could wish indeed that a more fitting and competent person had been chosen to represent the Society on this our fifty-third anniversary; for I fear I shall be able to satisfy neither myself nor you, nor do justice to the work of the Society. However I will do my best, and I ask your kind attention rather to what I say than to my manner of saying it.

I would first take a retrospective survey of the Society, that from seeing what it has been in the past we may the better understand its present position and its future prospects. In the year 1827 the Natural History Society was founded. The Earl of Dalhousie was its first Patron, and its first President was Stephen Sewell, Esq. In 1832 the Society was incorporated by an Act of the Provincial Parliament, and in 1833 this Act received the Royal sanction. In the beginning the members were few but they were earnest and devoted men, determined to make up for their lack of numbers by ardent zeal and honest work. Wishing to show signs of life and earnest action from the very beginning, the Society determined to give proof of its existence and its worth by having essays on scientific subjects read at its meetings and afterwards given to the public. Accordingly in 1835 two very interesting and instructive essays were prepared; one "On the Physical History of Rivers in general, and the St. Lawrence in particular," and another "On the circumstances affecting Climate in general and Canada in particular." The Society would show that it was interested in national as well as natural history and science, and therefore it had circulars sent to the various corresponding members and to the Governor of the Hudson's Bay Territory, calling attention to the subject of Meteorology in British North America. It was also partly at the suggestion of the Society that the Government thought of founding the Geological Survey of the Province; and this I may incidentally observe is at least one reason why the Society and the Survey should be permitted to continue to live together in Montreal.

In 1841 the Government thought of uniting the Society, the Mechanics' Institute, and the Montreal Library, and of forming one Institution to be known as the "Montreal Institution of Literature, Science and Arts." This new association was to have its home in the Bonsecours market building, and to receive from the city an annual donation of £300, but the intention of the Government was never carried out, and our Society still lives alone.

Its life was considerably strengthened and its length of days secured by a generous donation of £1000 given by the Rev. Mr. James Sommerville, in 1845, to establish and perpetuate a regular course of public lectures. In 1846 the Society, wishing to interest the citizens in its work, opened its museum to the public; and in the following year, when Lord Elgin was patron, the Society resolved to publish all the approved essays it possessed. To encourage the essayists and to increase the numbers, three prizes were voted for the best essays on subjects of natural history. That year the members num bered 144.

From the Report of the Chairman of Council you will learn what the Society has done during the past year. But I think I may supplement that report with some facts and reflections that will not be without interest. You will doubtless be gratified to learn that the Society has made considerable progress during the year. This progress indeed has not been perhaps all that could be desired, yet it has been steady and sure, and such as gives promise of lasting success. The monthly meetings have been regularly held, and many most interesting and valuable papers have been read, showing exact and extensive original research.

We believe that there is at present sufficient ability in our Society to raise it to the foremost rank of scientific and literary excellence. We need only to concentrate our mental energy and so to divide our forces that wise distribution may increase our strength. I would therefore suggest that committees be formed to consider the distinct and various subjects of the different departments.

Such a judicious division of labor would be likely to secure greater interest in individual work, and greater order in general arrangement. Would it not be well, for instance, to make a careful collection of duplicate specimens from our museum and to present them to kindred institutions in and beyond the Dominion? This act would no doubt be cordially reciprocated, and our museum would be enriched and enlarged thereby. But for such work it would be well to have a committee.

It is a matter of congratulation that our Society has accomplished so much for our city and our people, with pecuniary resources so limited. We have been fortunate in securing numerous and valuable exchanges with nearly all the countries of Europe, with the United States, and with the Provinces, and various parts of the Dominion. But we must now learn how best to preserve what we have acquired and how to complete and perfect our arrangement. Besides, to make our collection practically available a full and correct catalogue is indispensable—which need be only a reprint of our admirably named collection.

The losses by death and other causes, since our last annual meeting have been severely felt, and we are sorry to include the names of the Hon. L. S. Holton, M. P., life-member, and of Andrew Robertson, advocate, active ordinary member. We regret to be called upon to record also the demise of a distinguished honorary member, Professor Joseph Henry. Some of the members of the Society here present had the pleasure of meeting him at Montreal in 1857, at the general meeting of the American Association for the Advancement of Science (of which you have heard from Principal Dawson).

. . . .

I think it would be advisable to petition the Government for a copyright law making it obligatory on all publishers to contribute a copy of every publication to the several literary and scientific institutions of the Province.

I wish to remind you that members are not denied the privilege of contributing to the library and museum, a privilege I need scarcely say that is cordially extended to the public. We are ready to do our part in the work of the Society, but it will ever be a great inducement to earnest and continued labor that the members of the Society feel that they are not working alone. The records of the past show what has been done, and I think the Society has no reason to be ashamed of its history. But while past success gives hope of future progress, this very success shows, in its shortcoming, how that progress may be best secured.

Our library and museum are not yet what they should be in a city such as ours. It is in these two departments especially that we expect the practical co-operation of the public. The smallest contributions will be gratefully acknowledged. But may we not also hope that some of our more wealthy citizens may here leave monuments worthy of their memory.

The report of the past year's proceedings clearly proves that the Society is now established on a sure and solid foundation. Its future scientific success would seem secured if proofs from the past can be trusted. But we who have watched its early struggles and who take a pardonable pride in its present position, would earnestly desire that it may continue to prosper and always tend towards greater perfection. This Society should be as it were an index of our country's ever increasing prosperity. In its museum should be seen the results of the geological enterprise of Canadian scientists, and some tokens at least of the untold treasures of Canadian soil; while its well-selected and well-stocked library should prove to the world that Canada's mineral wealth is equalled if not surpassed by her mental worth and work.

It is sometimes said that ours is a scientific age; and the wonderful progress of the present century in the physical sciences and the useful arts would seem to warrant the assertion. But it would be well to remember that mere discovery is not science, and that theory is not always truth. The scientist must indeed begin by observation, go on to discovery, make nature disclose and yield up her secret sources of knowledge; he must learn to read the writing written on the walls of the world. But the true scientist must know more than his alphabet, he must not be content with the mere elementary characters. His observations may be extensive and profound and his collections rich and rare, and as yet he may have only specimens of nature and of nature's work, but specimens of nature are not necessarily specimens of knowledge, neither are they always proof of science acquired. In a word, nature will give the materials, but from these materials the scientist must build his system by honest and earnest work.

Now the object of our society is not merely to gather the materials—this, indeed, it will do—but it aims at doing more than this; its end is not merely manual labor, it is principally and primarily mental work, and this mental work is useful not merely to the worker but to all his fellow-countrymen, to all his fellowmen. It is this thought, indeed, that gives a dignity to his scientific labor, and cheers the scientist in researches that are sometimes weary. But this thought too should gain for him the sympathy and support of the public—he is working for them, he is working for his country. And speaking of our country reminds me of a special and recent relation of our city and our Society with our country's government and our country's capital. You are probably aware that the Federal Government has decided to transfer the Geological Survey of Canada from Montreal to Ottawa. We must express our deep regret that the Government should have thought it necessary or judicious to bring about this change of site; Montreal is the natural centre and the domicile of such a body, and hence it is that since its foundation the Survey has here made its home. Its removal to Ottawa will certainly injure our city, and will not, we think, in any way benefit the Survey itself. But what we have especially to regret is the loss this removal will inflict on our Society. In consequence of this act of the Federal Government we shall be partially deprived of the presence and assistance of some of our most active and efficient members. I say this privation will be only partial, for I hope and believe that our worthy president Mr. Selwyn, our learned scientific curator Mr. Whiteaves, and our respected members Professor Bell, Dr. G. M. Dawson, and Mr. Ells, who are about to leave us for Ottawa, will not altogether sever their connection with the Montreal Natural History Society. They have each and all done good work in the past, they have contributed much to make this Society what it is, and I hope that although their services may now be needed in Ottawa, they will be frequently seen at our meetings in Montreal, that we may again have the pleasure of listening to their learned lectures and papers, and that they may by their presence enliven our scientific discussions. Their occasional visits will be some compensation for the loss we shall sustain in their leaving us. And in appreciating their loss we have a further call upon the members of the Society to more active exertion in sustaining the Society and enlarging its collections.

On motion of Dr. De Sola, seconded by Dr. Edwards, it was resolved "that the thanks of the Society are due to Major Huguet Latour for his carefully prepared address, and that the bronze medal of the Society be conferred on him for the various important services he has rendered to the Society."

Mr. Whiteaves then read the report of the retiring Council.

REPORT OF THE CHAIRMAN OF COUNCIL.

Session 1879-80.

At the conclusion of their year of office your Council beg to report as follows:

The Sommerville Course of free public lectures, has also been duly delivered, to good audiences; the following being the titles of the lectures, the names of the lecturers and the dates at which the lectures were delivered:

1880.

February 5th.	Weights and Measures, with a plea for the Metric System. By Dr. J. B. Edwards, F.C.S., &c.
February 20th.	Women in Canadian History. By Professor F. W. Hicks, M.A.
February 26th.	Money. By H. Mott, Esq.
March 11th.	Claims of Pictorial Art. By John Popham, Esq.
March 18th.	Cosmic Matter. By Dr. T. Sterry Hunt, F.R.S.
April 8th.	Timber trees and their economic uses. By G. L. Marler, Esq.

An hour previous to each lecture, the Museum of the Society was lighted up and thrown open to the public. the latter privilege being taken advantage of by numbers who probably would not have visited the premises otherwise.

The Society accepted an invitation from the Ottawa Naturalists' Field Club to meet them at Calumet on the 12th of June last to hold a field-day together. The excursion proved to be an eminently enjoyable one, and four prizes were awarded for the best botanical and zoological collections made on the spot.

Your Council has also to report that the number of new members elected in the past session is seven, and that about 1500 persons have visited the Museum since the last Annual Meeting.

The Annual grant of $750 has been received, as usual, from the Legislature of the Province of Quebec.

The premises have been put in a thorough state of repair, a new gravel roof or metal covering has been provided, the woodwork inside and outside of the building has been repainted, the two furnaces have been repaired and put in good working order, and various other small but necessary repairs have been effected.

Out of the $750 received from the local legislature, $500 have been devoted to paying off a portion of the Society's indebtedness, and the debt previously existing upon its building has been thus reduced to $500.

The lecture room, library and committee room have been rented to Mr. T. M. Taylor, to the Medico-Chirurgical, Horticultural, Numismatic and Philharmonic Societies, at regular intervals, and the proceeds accruing therefrom, amounting to $461, will be found credited by the Treasurer in his report to be submitted this evening.

After mature consideration, but with much regret, your Council decided to terminate Mr. Passmore's engagement, as cabinet keeper and taxidermist to the Society, on the first of May, 1880; and this action of the Council having been duly endorsed at one of the monthly meetings, notice of the termination of the said engagement was given to Mr. Passmore, in writing, early in February. In consideration, however, of his long and valuable services, your Council has recommended that a gratuity of $200, (a sum equal to one years salary in advance) be paid to Mr. Passmore on his leaving, and this recommendation has been adopted by the Society.

Since the first of May, your Council has temporarily employed Mr. Potts as resident janitor, cabinet keeper, and custodian of the premises, leaving it to their successors in office to take such action as they may see fit, in reference to filling the situation formerly held by Mr. Passmore.

The number of donations to the Museum, during the past session, has been unusually small, an evil which can best be remedied by the active personal efforts of individual members of the Society.

Thanks to the diligence of our Treasurer, the financial position of the Society, during the past twelve months, may be looked upon as eminently satisfactory.

In retiring from office your Council venture to offer the following brief suggestions to their successors:

1. That special and vigorous efforts be made to improve the collections in the Museum, and more particularly to obtaining new and choice specimens of Canadian mammals and birds.

2. That, with this object in view, a sum of not less than fifty dollars be judiciously expended every year on the purchase of rare specimens of local interest, and that, from time to time, as such specimens are obtained, descriptive articles respecting them be published in the daily press.

3. That pains be taken, as heretofore, to secure the prompt publication of accurate abstracts of the papers read at the monthly meetings in each of the city papers, and to bring the whole proceedings of the Society as prominently before the public as possible.

4. To urge upon the Membership Committee the necessity for immediate action in order to recruit the ranks of the Society and to fill up vacancies in the list of members which are constantly being caused by removal, death, and a variety of causes.

The whole respectfully submitted.

Mr. Marler, the Treasurer reported:

TREASURER'S REPORT.

Your Treasurer has to report on the financial position of your Society for the past year, which is satisfactory. Notwithstanding that your Society has paid to the Royal Institution of Learning the sum of $585.00 capital and interest, there remains to the credit of your Society the sum of $268.61. That in order to pay off the Royal Institution we had to borrow a sum of $500. from Mr. H. Joseph at six per cent. That the total receipts of your Society during the year including the Government grant and the loan from Mr. Joseph amounted to $2166.97 and the disbursements including extensive repairs amounted to $1898.36. Leaving the above balance in hand. The repairs consisted in a thorough overhauling of the building—a new roof, painting the building, windows, &c., putting the furnaces in good repair. That the renting of the rooms produced $461.00 besides the amount due by the Horticultural and Numismatic Societies which up to this time are unpaid. Your Treasurer has full confidence in being able during the ensuing year to refund Mr. Joseph the sum so kindly loaned, if such is the case your Society will be free from debt.

G. L. Marler, *in account with* **The Natural History Society of Montreal,**
from 18th May, 1879, to 18th May, 1880.

Dr.		Cr.	
Paid Insurance Company	$35.00	Balance on Hand 18th May, 1879	$237.22
" Royal Institution (Capital and Interest)	1083.08	Government Grant	750.00
" Notarial fees for discharge	2.50	By Aquarium sold	12.00
" Gas, Water, and Coal	175.00	" Rent of Rooms	461.00
" Printing, Express charges, &c	57.18	" Members' Fees	182.00
" Salaries, Commission	191.67	" Entrance Fees to Museum	24.75
" Painting, Glazing, and Repairs	254.47	" Loan from Hy. Joseph	500.00
" Labor, Repairs, &c	99.46		
By Balance on Hand	268.61		
	$2166.97		$2166.97

DEBTS OUTSTANDING.

Loan to Hy. Joseph	$500.00	Balance on Hand	$268.61
To Dawson Brothers	53.00		
	$553.90		

Montreal, 29th April, 1880.

(Signed) M. H. Brissette, } *Auditors.*
" L. A. Huguet Latour. }

G. L. Marler,
Treasurer.

With regard to the *Naturalist* the Editors report that since the last annual meeting the publication of the Journal has been continued, four numbers having been issued during the year. They regret, however, the scantiness of material supplied for publication by members of the Society and would urge upon them the importance not only of doing more scientific work but of recording the results of their labors in the pages of the *Naturalist*. This, indeed, is an absolute necessity if the Journal is to be continued at all.

REPORT OF LIBRARY COMMITTEE.

The Library Committee have but little of importance to report at the close of the present session. There have been few additions to the Library proper, and the efforts of the Committee have been directed more to improving the condition of the present contents of the shelves than to adding to them. Much good work has been done by Mr. Curry in the arrangement and classification of the contents of the cupboards under the library cases. These contain a very large collection of the transactions of various learned societies and of periodicals, etc., received in exchange for the *Canadian Naturalist*. They have all been carefully arranged and labelled, and an alphabetical index has been prepared showing the contents of each cupboard. A considerable number of very valuable and important volumes of these works is now ready for the binder, and the Committee would recommend that an effort be made to have them bound as soon as possible and placed in the Library.

It was then moved by Mr. Joseph, seconded by Major Latour, and resolved "that the reports read be adopted and printed in the *Naturalist*, as usual."

The election of Officers then took place with the following results:

President—Principal Dawson, LL.D., F.R.S.

Vice-Presidents—Mr. A. R. C. Selwyn, F.R.S.; Dr. De Sola, Dr. T. Sterry Hunt, Mr. H. Joseph, Mr. Whiteaves, Dr. Hingston, Prof. P. J. Darey, Prof. B. J. Harrington, B.A., Ph.D.; Dr. J. B. Edwards, F.C.S.

Corresponding Secretary—Dr. Edwards.

Recording Secretary—Mr. Frank W. Hicks.

Treasurer—Mr. G. L. Marler.

Cabinet-Keeper—Mr. Wm. Muir.

Council—Messrs. Brissette, Sanborn, Bemrose, Donald, Dr. Bell, Dr. G. M. Dawson, Rev. Mr. Empson, and Major Latour.

Library Committee—Messrs. Hicks, Donald, Brisette, Bemrose and Brown.

Published August 13th, 1880.

THE

CANADIAN NATURALIST

AND

Quarterly Journal of Science.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The twenty-ninth meeting of this Association met at Boston, Mass., on the 25th of August, under the Presidency of Professor Lewis H. Morgan, of Rochester N. Y. It was probably the largest and in many respects the most successful ever held, the membership reaching nearly to a thousand, and the city of Boston, with the educational and other institutions within and near it, having made most liberal promises for the comfort and entertainment of the members.

The Association is divided into two sections, namely :

A.—Mathematics, Astronomy, Chemistry and Mineralogy.

B.—Geology, Zoology, Botany and Anthropology.

These, again, are subdivided, and the late meetings have embraced subsections of Chemistry, Microscopy, Biology and Anthropology. The last though a new department was one of the most popular and energetic, if it may be judged by the crowded audiences and earnest discussions. The other sections were characterised rather by solid papers than by lively discussions. A detailed account of all that was done and said would far exceed the limits of this journal, but we propose to give a few extracts from or abstracts of some of the more important addresses and papers presented during the meeting.

Address of Professor George F. Barker, the retiring President of the Association.

Professor Barker's able address was upon the all absorbing topic of "Life," and was entitled "Some Modern Aspects of the Life Question." After a few preliminary remarks he continued :

"What now are we to understand by the word 'Life' in this discussion ? A noteworthy parallel is disclosed in the progress of human knowledge between the ideas of life and of force. Both conceptions have advanced, though not with equal rapidity, from a stage of complete separability from matter to one of complete inseparability. Life is now universally regarded as a phenomenon of matter, and hence of course, as having no separate existence. But there still exists a certain vagueness in the meaning of the term 'Life.' Two distinct senses of this word are in use ; the one metaphysical, the other physiological. The former, synonymous with mind and soul, at least in the higher animals, has been evolved from human consciousness ; the latter has arisen from a more or less careful investigation of the phenomena of living beings. It need scarcely be said that it is in the sense last mentioned that the word "Life" is used in science. The conception represents simply the sum of the phenomena exhibited by a living being.

"Moreover, the progress which has been made in the solution of the life-question has been gained chiefly by investigation of special functions. But the functions of a vital organism are themselves vital. What then is the meaning of 'vital' as applied to a function ? Fortunately the answer is not difficult. 'Life,' says Küss, the distinguished Strasburg physiologist, 'is all that cannot be explained by chemistry or physics.' Guided by such a definition the work of the physiological investigator is simple. He has only to test each separate oparation which he finds going on in the organism and to declare whether it be chemical or physical. If it be either, then since each function is non-vital, the entire organism must be non-vital also. Hundreds of able investigators, provided with the most effective appliances of research, are now in full cry after the life principle. Naturally, a vast amount of collateral knowledge is accumulated in the process. The quantitative as well as the qualitative relations of things are fixed, and many important facts are collected.

"As a first result of recent work, the living organism has been brought absolutely within the action of the law of the Conservation of Energy. Whether it be plant or animal, the whole of its energy must come from without itself, being either absorbed directly or stored up in the food. An animal, like a machine, only transforms its energy. Lavoisier's guinea-pig, placed on the calorimeter, gave as accurate a heat-return for the energy it had absorbed in its food, as any thermic engine would have done. But the parallel goes further. The mechanical work of an engine is measured by the loss of its heat and not of its substance. So the mechanical or intellectual work of living beings is measured by the amount of food rather than the amount of tissue which is burned. The energy evolved daily by the human body would raise it to a height of about six miles."

The subject of muscular contraction is then discussed and regarded as due to electric discharges generated within the muscle itself and not carried to the muscle by the nerves. The electrical charge which appears in the muscular fibre, may, it is supposed, have its origin in so purely a physical cause as the contact of the heterogeneous substances of which the tissue is built up; the maintenance of this charge being effected by chemical changes going on constantly in the substance of the muscle, by which the carbon dioxide is produced, which is shown to be a measure of the work done.

"Conceding now, that muscular contraction is of the nature of an electric discharge, by what mechanism is the contraction effected? A string of electrical masses, like a muscular fibril, would seem at first to oppose the view now advanced. Such a row of particles would indeed attract each other when electrified, and shorten the length of the whole. But the force of contraction would increase as the length diminished; whereas the fact in the case of the muscle is precisely the reverse. Two theories have been advanceed to account for the result. The first, proposed by Marey, likens the muscular fibre to a string of india-rubber which, when stretched. contracts upon the application of heat, thus transforming heat directly into work. The other, brought forward and strongly supported by Radcliffe, explains contradiction by direct electric charge. Each fibre of the muscle, together with its sheath, constitutes a veritable condenser. the charge upon the exterior being positive, and upon the interior negative. When a charge is communicated to the fibre, literal compression results from the attraction of the electricities of opposite name, and since the volume remains constant, elongation is the consequence—precisely as a band of caoutchouc, having strips of tin-foil upon its sides, may be shown to elongate when charged like a condenser. In this view of the matter the normal condition of the muscle is one of charge, of elongation. Contraction results from the simple elasticity of the muscle itself, the function of the nerve being only that of a discharger. Whether this theory represents the actual fact or not, in all its details, it is supported by the existence of *rigor mortis*, by the continued relaxation of muscle during the flow of the current, by the cessation of contraction on the free access of blood, and by many other phenomena otherwise difficult to explain.

"From this brief review, does it not seem probable that the phenomenon of muscular contraction may be satisfactorily accounted for without the assumption of 'vital irritability,' so long invoked? May it not be conceded that the theory that muscular force has a purely physical origin is at least as probable as the vital theory?

"Time would fail me to discuss the many other phenomena of the living body which have been found, on investigation, to be non-vital. Digestion, which Prout said it was impossible to believe was chemical, is now known to take place as well without the body as within it, and to result from non-vital ferments. Absorption is osmotic, and its selective power resides in the structure of the membrane and the diffusibility of the solution. Respiration is a purely chemical function. Oxyhæmoglobin is formed wherever hæmoglobin and oxygen come in contact, and the carbon dioxide of the serum exchanges with the oxygen of the air according to the law of gaseous diffusion. Circulation is the result of muscular effort both in the heart and capillaries, and the flow which takes place is a simple hydraulic operation. Even coagulation, so tenaciously regarded as a vital process, has been shown to be purely chemical, whether we adopt the hypothesis of Shmidt that it results from the union of two proteids, fibrinogen and fibrinoplastic substance, or the latter theory of Hammarsten that fibrin is produced from fibrinogen by the action of a special ferment."

Professor Barker then considers the function of the nervous system and states that "the nerve-cell and the nerve-fibre are occupied solely in the transmission of energy which is in all probability electrical." The only objection to the electrical character of nerve energy is based upon its slow propagation; but considering that it has been shown by Weber that animal tissues in general have a conductivity only one fifty-millionth of that of copper, the fact that the energy of nerve moves at the rate of only twenty-eight metres per second is really no proof that it is not electricity.

Of the "physical aspects of the mind-question," Professor Barker says:

"The problem of the quantitative changes which take place in the organism is a very curious and interesting one. That the energy of the brain comes from the food will be disputed by no one in these days. Hence, the brain must act like a machine and transform energy. There is then a purely physiological representation of mental action, concerned with forces which are known and measurable. The researches of Lombard long ago showed the concomitant heat of mental action. Recent researches are equally interesting, which show that mental operations are not instantaneous but require a distinct time for their performance. By accurate chronographic measurement, Hirsch has shown that an irritation on the head is answered by a signal with the hand only after one-seventh of a second; that a sound on the ear is indicated by the hand in one-sixth of a second; and that when light irritates the eye, one-fifth of a second elapses before the hand moves."

. . . .

"Another important fact concerning nervous action is that its amount may be measured by the quantity of blood consumed in its performance. Dr. Mosso of Turin has devised an apparatus called the Plethysmograph—drawings of which were exhibited at the London Apparatus Exhibition of 1876—designed for measuring the volume of an organ. The fore-arm, for example, being the organ to be experimented on, is placed in a cylinder of water and tightly enclosed. A rubber tube connects the interior of the cylinder with the recording apparatus. With the electric circuit by which the stimulus was applied to produce contraction, were two keys, one of which was a dummy. It was noticed that, after using the active key several times, producing varying current strengths, the curve sank as before on pressing down the inactive key. Since no real effect was produced, the result was caused solely by the imagination, blood passed from the body to the brain in the act. To test further the effect of mental action, Dr. Pagliani, whose arm was in the apparatus, was requested to multiply 267 by 8, mentally, and to make a sign when he had finished. The recorded curve showed very distinctly how much more blood the brain took to perform the operation. Hence the plethysmograph is capable of measuring the relative amount of mental power required by different persons to work out the same mental problem. Indeed Mr. Gaskell suggests the use of this instrument in the examination room, to find out, in addition to the amount of knowledge a man possesses, how much effort it causes him to produce any particular result of brain-work. Dr. Mosso relates that while the apparatus was set up in his room in Turin, a classical man came in to see him. He looked very contemptuously upon it and asked of what use it could be, saying that it could'nt do anybody any good. Dr. Mosso replied, "Well now, I can tell you by that whether you can read Greek as easily as you can Latin." As the classicist would not believe it, his own arm was put into the apparatus and he was given a Latin book to read. A very slight sinking of the curve was the result. The Latin book was then taken away and a Greek book was given him. This produced immediately, a much deeper curve. He had asserted before that it was quite as easy for him to read Greek as Latin and that there was no difficulty in doing either. Dr. Mosso, however, was able to show him that he was labouring under a delusion. Again, this apparatus is so sensitive as to be useful for ascertaining how much a person is dreaming. When Dr. Pagliani went to sleep in the apparatus, the effect upon the resulting curve was very marked indeed. He said afterward that he had been in a sound sleep and remembered nothing of what passed in the room —that he had been absolutely unconscious; and yet, every little movement in the room, such as the slamming of a door, the barking of a dog, and even the knocking down of a bit of glass, were all marked on the curves. Sometimes he moved his lips and gave other evidences that he was dreaming; they were all recorded on the curve, the amount of blood required for dreaming diminishing that in the extremities. The emotions too left a record. When only a student came into the room, little or no effect appeared in the curve. But when Professor Ludwig himself came in, the arteries in the arm of the person in the apparatus contracted quite as strongly as upon a very decided electrical stimulation."

Professor Barker is a strong believer in the capacities of the chemist and the great things yet to be accomplished by him With reference to protoplasm he says:

"Because life is unlike other properties of matter, it by no means follows that it is not a property of matter. No dictum is more absolute in science then the one which predicates properties upon constitution. To say that this property exhibited by protoplasm, marvellous and even unique though it be, is not a natural result of the constitution of the matter itself, but is due to an unknown entity, a *tertium quid*, which inhabits and controls it, is opposed to all scientific analogy and experience. To the statement of the vitalist that there is no evidence that life is a property of matter, we may reply with emphasis that there is not the slightest proof that it is not.

"Chemistry tells us that complexity of composition involves complexity of properties. The grand progress which Organic Chemistry has made in recent times has been owing to the distinct recognition of the influence of structure upon properties. Isomerism is one of its most significant developments. The number of possible isomers increases enormously with the complexity of the molecule. Granted that we now know several of the proteid group of substances: how many thousand may there be yet to know? Bodies of such extreme complexity of constitution may well have an indefinite number of isomers. Not only does chemistry not say that there cannot be such a thing but she encourages the expectation that there will be yet found the precise proteid of which the changes of protoplasm are properties. The rapid march of recent organic synthesis makes it quite certain that every distinct chemical substance of the living body will ultimately be produced in the laboratory; and this from inorganic material. Given only the exact constitution of a compound, and its synthesis follows. When, therefore, the chemist shall succeed in producing a mass constitutionally identical with protoplasmic albumin, there is every reason to expect that it will exhibit all the phenomena which characterize its life; and this equally whether protoplasm be a single substance or a mixture of several closely allied substances."

Address of Professor Alexander Agassiz on Paleontological and Embryological Developmont.

Prof. Agassiz read a paper on Paleontological and Embryological Development. He said: "Since the publication of the 'Poissons Fossiles' by Agassiz and of the 'Embryologie des Salmonidées' by Vogt, the similarity, traced by the former between certain stages in the growth of young fishes and the fossil representatives of extinct members of the group, has also been observed in nearly every class of the animal kingdom, and the fact has become a most convenient axiom in the study of paleontological and embryological development. This parallelism, which has been on the one side a strong argument in favor of design in the plan of creation, is now, with slight emendations, doing duty on the other as a newly discovered article of faith in the new biology.

"But while in a general way we accept the truth of the proposition that there is a remarkable parallelism between the embryonic development of a group and its paleontological history, yet no one has attempted to demonstrate this or rather to show how far the parallelism extends. We have up to the present time been satisfied with tracing the general coincidence, or with striking individual cases.

"The resemblances between the pupa stage of some Insects and of adult Crustacea, the earlier existence of the latter, and the subsequent appearance of the former in paleontological history, furnished one of the first and most natural illustrations of this parallelism; while theoretically the necessary development of the higher tracheate insects from their early branchiate aquatic ancestors seemed to form an additional link in the chain, and point to the Worms, the representatives of the larval condition of Insects, as a still earlier embryonic stage of the Articulates."

Whilst stating there was hardly a class of the animal kingdom which would not admit of some most interesting parallelism being drawn, he remarked he had chosen for the illustration and critical examination of this parallelism the limited group of Sea-urchins, on account of his own familiarity with their development, and with the living and extinct species. Noticing the paleontological history of several families of the Echinodermata he speaks of the Clypeastridæ as follows:

"We find there as among the Desmosticha that the earliest type, Pygaster, has existed from the Trias to the present time; and that, while we can readily reconstruct, on embryological grounds, the modifications the earliest Desmosticha-like Echini should undergo in order to assume the structural features of Pygaster, yet the early periods in which the precursors of the Echinoconidæ and Clypeastridæ are found have thus far not produced the genera in which these modifications actually take place. But, starting from Pygaster, we naturally pass to Holectypus, to Discoidea, to Conoclypus, on the one side, while on the other, from Holectypus to Echinocyamus, Sismondia, Fibularia, and Mortonia, we have the natural sequence of the characters of the existing Echinanthidæ, Laganidæ, and Scutellidæ, the greater number of which are characteristic of the present epoch. If we were to take in turn the changes undergone in the arrangement of the plates of the test, as we pass from Pygaster to Holectypus, to Echinocyamus, and the Echinanthidæ, we should have in the genera which follow each other in the paleontological record an unbroken series showing exactly what these modifications have been. In the same way, the modifications of the abactinal and anal systems, and those of the poriferous zone, can equally well be followed to Echinocyamus, and thence to the Clypeastridæ; while a similar sequence in the modifications of these structural features can be followed from Mortonia to the Scutellidæ of the present period."

Passing next to the embryological development of the several families, he remarked: "Among the Clypeastroids the changes of form they undergo during growth are most instructive. We have in the young Fibularinæ an ovoid test, a small number of coronal plates surmounted by few and large primary tubercles, supporting proportionally equally large primary radioles, simple rectilinear poriferous zones, no petaloid ambulacra,—in fact, scarcely one of the features we are accustomed to associate with the Clypeastroids is as yet prominently developed. But rapidly with increasing size, the number of primary tubercles increases, the spines lose their disproportionate size, the pores of the abactinal region become crowded elongate, and a rudimentary petal is formed. The test becomes more flattened, the coronal plates increase in number, and it would be impossible to recognize in the young Echinocyamus, for instance, the adult of the Cidaris-like or Echinometra-like stages of the Sea-urchin, had we not traced them step by step. Most interesting, also, is it to follow the migrations of the anal system which, to a certain extent, may be said to retain the embryonic features of the early stages of all Echinoderm embryos, in being placed in more or less close proximity to the actinostome. What has taken place in the growth of the young Echinocyamus is practically repeated for all famillies of Clypeastroids; a young Echinarachnius, or Melita, or Encope, or a

Clypeaster proper, resembles at first more an Echinometra than a Clypeastroid; they all have simple poriferous zones and spines and tubercles out of all porportion to the size of the test."

Comparing in the same way the paleontological development of the several families, he said: "We find that the Echinidæ proper, on the whole, agree well with the changes of growth we can still follow to-day in their representatives, and that, as we approach nearer the present epoch, the fossil genera more and more assume the structural features which we find developed last among the Echinidæ of the present day. Very much in the same manner as a young Echinus develops, they lose, little by little, first their Cidaridian affinities, which become more and more indefinite, next their Didematidian affinities, if I may so call the young stages to which they are most closely allied, and, finally, with the increase in number of the coronal plates, the great numerical development of the primary tubercles and spines, and that of the secondaries and miliaries which we can trace in the fossil Echini of the Tertiaries, we pass insensibly into the generic types characteristic of the present day."

He then adds: "The comparison of the genera of Echini which have appeared since the Lias with the young stages of growth of the principal families of Echini, shows a most striking coincidence amounting almost to identity between the successive fossil genera and the various stages of growth. This indentity can, however, not be traced exactly in the way in which it has usually been understood, while there undoubtedly exists in the genera which have appeared one after the other a gradual increase in certain families in the number of forms, and a constant approach in each succeeding formation, in the structure of the genera, to those of the present day. It is only in the accordance between some special points of structure of these genera and the young stages of the Echini of the present day that we can trace an agreement which, as we go further back in time, becomes more and more limited. We are either compelled to seek for the origin of many structural features in types of which we have no record, or else we must attempt to find them existing potentially in groups where we had as yet not succeeded in tracing them. The parallelism we have traced does not extend to the structure as a whole. What we find is the appearance among the fossil genera of certain structural features giving to the particular stages we are comparing their characteristic aspect. Thus, in the succession of the fossil genera, when a structural feature has once made its appearance, it may either remain as a persistent structure, or it may become gradually modified in the succeeding genera of the same family, or it may appear in another family, associated with other more marked structural features which completely overshadow it."

Summing up, he says: "We may, however, in a very general way, state that we know the earliest embroyonic stages of the order of Echinoderms of to-day, which, with the exception of the Blastoidea and Cystideans, are identical with the fossil orders, and that as far as we know they all begin at a stage where it would be impossible to distinguish a Sea-urchin from a Star-fish, or an Ophiuran, or a Crinoid, or an Holothurian,—a stage in which the test, calyx, abactinal and ambulacral systems are reduced to a minimum. From this identical origin there is developed at the present day, in a comparatively short period of time, either a Starfish, a Sea-urchin, or a Crinoid; and if we have been able successfully to compare, in the development of typical structures, the embryonic stages of the young Echini with their development in the fossil genera, we may fairly assume that the same process is applicable when instituting the comparison within the different limits of the orders, but with the same restrictions. That is, if we wish to form some idea of the probable course of transformations which the earliest Echinoderms have undergone to lead us to those of the present day, we are justified in seeking for our earliest representatives of the orders such Echinoderms as resemble the early stages of our embryos, and in following, for them as for the Echini, the modifications of typical structures. These we shall have every reason to expect to find repeated in the fossils of later periods, and, going back a step further, we may perhaps get an indefinite glimpse of that first Echinodermal stage which should combine the structural features common to all the earliest stages of our Echinoderm embryos. And yet, among the fossil Echinoderms of the oldest periods, we have not as yet discovered this earliest type from which we could derive the Star-fishes, Ophiurans, Sea-urchins, or Holothurians."

"This may not seem a very satisfactory result to have attained. It certainly has been shown to be an impossibility to trace in the paleontological succession of the Echini anything like a sequence of genera. No direct filiation can be shown to exist, and yet the very existence of persistent types, not only among Echinoderms, but in every group of marine animals, genera which have continued to exist without interruption from the earliest epochs at which they occur to the present day, would prove conclusively that at any rate some groups among the marine animals of the present day are the direct descendants of those of the earliest geological periods. When we come to types which have not continued as long, but yet which have extended through two or three great periods, we must likewise accord to their latest representatives a direct descent from the older."

"But in spite of the limits which have been assigned to this general parallelism, it still remains an all-essential factor in elucidating the history of paleontological development, and its importance has but recently been fully appreciated. For, while the fossil remains may give us a strong presumptive evidence of the gradual passage of one type to another, we can only imagine this modification to take place by a process similar to that which brings about the modifications due to different stages of growth,—the former taking place in what may practically be considered as infinite time when compared to the short life history which has given us as it were a *résumé* of the paleontological development. We may well pause to reflect that in the two modes of development we find the same periods of rapid modifications occurring at certain stages of growth or of historic development, repeating in a different direction the same phases. Does it then pass the limits of analogy to assume that the changes we see taking place under our own eyes in a comparatively short space of time,—changes which extend from stages representing perhaps the original type of the group to their most complicated structures,—may, perhaps, in the larger field of paleontological development, not have required the infinite time we are in the habit of asking for them ?"

THE PHOTOPHONE.

By Alexander Graham Bell.

In bringing before you some discoveries made by Mr. Sumner Tainter and myself, which have resulted in the construction of apparatus for the production and reproduction of sound by means of light, it is necessary to explain the state of knowledge which formed the starting point of our experiments. I shall first describe the remarkable substance selenium. and the manipulations devised by various experiments; but the final result of our researches has evidenced the class of substances sensitive to light-vibrations, until we can propound the fact of such sensitiveness being a general property of all matter. We have found this property in gold, silver, platinum, iron, steel, brass, copper, zinc, lead, antimony, German silver, Jenkin's metal, Babbitt's metal, ivory, celluloid, gutta percha, hard rubber, soft vulcanized rubber paper, parchment, wood, mica and silvered glass; and the only substances from which we have not obtained results are carbon and thin microscopic glass. We find that when a vibratory beam of light falls upon these substances they emit sounds,—the pitch of which depends upon the frequency of the vibratory change in the light. We find farther that, when we control the form or character of the light-vibration on selenium, and probably on the other substances, we control the quality of the sound and obtain all varieties of articulate speech. We can thus, without a conducting wire as in electric telephony, speak from station to station, wherever we can project a beam of light We have not had opportunity of testing the limit to which this photophonic influence can be extended, but we have spoken to and from points 213 meters apart; and there seems no reason to doubt that the results will be obtained at whatever distance a beam of light can be flashed from one observatory to another. The necessary privacy of our experiments hitherto has alone prevented any attempt at determining the extreme distance at which this new method of vocal communication will be available. I shall now speak of selenium.

In the year 1817 Berzelius and Gottlieb Gahn made an examination of the method of preparing sulphuric acid in use at Gripsholm. During the course of this examination they observed in the acid a sediment of a partly reddish, partly clear brown color, which, under the action of the blow-pipe gave out a peculiar odor, like that attributed by Klaproth to tellurium. As tellurium was a substance of extreme rarity, Berzelius attempted its production from this deposit; but he was unable, after many experiments, to obtain further indications of its presence. He found plentiful signs of sulphur mixed with mercury, copper, zinc, iron, arsenic and lead, but no trace of tellurium. It was not in the nature of Berzelius to be disheartened by the result. In science every failure advances the boundary of knowledge as well as every success, and Berzelius felt that, if the characteristic odor that had been observed did not proceed from tellurium, it might possibly indicate the presence of some substance then unknown to the chemist. Urged on by his hope he returned with renewed ardor to his work. He collected a great quantity of the material, and submitted the whole mass to various chemical processes. He succeeded in separating successively the sulphur, the mercury, the copper, the tin, and the other known substances whose presence had been indicated by his tests:—and after all these had been eliminated, there still remained a residue which proved upon examination to be what he had been in search of—a new elementary substance. The chemical properties of this new element were found to resemble those of tellurium in so remarkable a degree that Berzelius gave to the substance the name of "Selenium," from the Greek word *selene*, the moon—("tellurium," as is well known being derived from *tellus*, the earth.) Although tellurium and selenium are alike in many respects, they differ in their electrical properties; tellurium being a good conductor of electricity, and selenium, as Berzelius showed, a non-conductor. Knox discovered in 1837, that selenium became a conductor when fused; and Hittorff, in 1852, showed that it conducted, at ordinary temperatures, when in one of its allotropic forms. When selenium is rapidly cooled from a fused condition, it is a non-conductor. In this, its vitreous form, it is of a dark brown color, almost black by reflected light, having an exceedingly brilliant surface. In thin films it is transparent, and appears of a beautiful ruby red by transmitted light. When selenium is cooled from a fused condition with extreme slowness, it presents an entirely different appearance, being a dull lead color, and having throughout a granulated or crystalline structure, and looking like a metal. In this form it is perfectly opaque to light, even in very thin films. This variety of selenium has long been known as "granular" or "crystalline" selenium, or, as Regnault called it, "metallic" selenium. It was selenium of this kind that Hittorff found to be a conductor of electricity at ordinary temperatures. He also found that its resistance to the passage of an electrical current diminished continuously by heating up to the point of fusion, and that the resistance suddenly increased in passing from the solid to the liquid condition. It was early discovered that exposure to sunlight hastens the change of selenium from one allotropic form to another; and this observation is significant in the light of recent discoveries.

Although selenium has been known for the last sixty years it has not yet been utilized to any extent in the arts, and it is still considered simply as a chemical curiosity. It is usually supplied in the form of cylindrical bars. These bars are sometimes found to be in the metallic condition; but more usually they are in the vitreous or non-conducting form. It occurred to Willoughby Smith that, on account of high resistance of crystalline selenium, it might be usefully employed at the shore-end of a submarine cable. in his system of testing and signalling during the process of submersion. Upon experiment, the selenium was found to have all the resistance required—some of the bars employed measuring as much as 1400 megohms—a resistence equivalent to that which would be offered by a telegraph wire long enough to reach from the earth to the sun! But the resistance was found to be extremely variable. Experiments were made to ascertain the cause of this variability. Mr. May, Mr. Willoughby Smith's assistant, discovered that the resistance was less when the selenium was exposed to light than when it was in the dark.

In order to be certain that temperature had nothing to do with the effect, selenium was placed in a vessel of water so that the light had to pass through from one to two inches of water in order to reach the selenium. The approach of a lighted candle was found to be sufficient to cause a marked deflection of the needle of the galvanometer connected with the selenium, and the lighting of a piece of magnesium wire caused the selenium to measure less than half the resistance it did the moment before.

These results were naturally at first received by scientific men with some incredulity, but they were verified by Sale, Draper, Moss and others. When selenium is exposed to the action of the solar spectrum, the maximum effect is produced, according to Sale, just outside the red end of the spectrum, in a point nearly coincident with the maximum of the heat rays; but, according to Adams, the maximum effect is produced in the greenish-yellow or most luminous part of the spectrum. Lord Rosse exposed selenium to the action of non-luminous radiations from hot bodies. but could produce no effect: whereas a thermopile under similar circumstances gave abundant indications of current. He also cut off the heat rays from luminous bodies by the interposition of liquid solutions, such as alum, between the selenium and the source of light, without affecting the power of the light to reduce the resistance of the selenium; whereas the interposition of these same substances almost completely neutralize the effect upon the thermopile. Adams found that selenium was sensitive to the cold light of the moon, and Werner Siemens discovered that in certain extremely sensitive varieties of selenium, heat and light produced opposite effects. In Siemens's experiments, special arrangements were made for the purpose of reducing the resistance of the selenium employed. Two fine platinum wires were coiled together in the shape of a double flat spiral in the zig-zag shape, and were laid upon a plate of mica so that the discs did not touch one another. A drop of melted selenium was then placed upon the platinum-wire arrangement, and a second sheet of mica was pressed upon the selenium, so as to cause it to spread out and fill the spaces between the wires. Each cell was about the size of a silver dime. The selenium cells were then placed in a paraffine bath, and exposed for some hours to a temperature of 210° C., after which they were allowed to cool with extreme slowness. The results obtained with the cells were very extra_ ordinary; in some cases the resistance of the cells, when exposed to light, was only one-fifteenth of their resistance in the dark.

Without dwelling farther upon the researches of others, I may say that the chief information concerning the effects of light upon the conductivity of selenium will be found under the names of Willoughby Smith. Lieutenant Sale, Draper and Moss, Professor W. G Adams, Lord Rosse, Day, Sabini, Dr. Werner Siemens and Dr. C. W. Siemens. All observations by these various authors had been made by means of galvanometers; but it occurred to me that the telephone, from the extreme sensitiveness to electrical influences, might be substituted with advantage. Upon consideration of the subject, however, I saw that the experiments could not be conducted in the ordinary way for the following eason: The law of audibility of the telephone is precisely analogous to the law of electric induction. No effect is produced during the passage of a continuous steady current. It is only at the moment of change from a stronger to a weaker state, or *vice versa*, that any audible effect is produced, and the amount of effect is exactly proportional to the amount of variation in the current. It was, therefore, evident that the telephone could only respond to the effect produced in selenium at the moment of change from light to darkness, or *vice versa*; and that it would be advisable to intermit the light with great rapidity, so as to produce a succession of changes in the conductivity of the seleninm corresponding in frequency to musical vibrations within the limits of the sense of hearing. For I had often noticed that currents of electricity, so feeble as to produce scarcely any audible effects from a telephone when the circuit was simply opened or closed, caused very perceptible musical sounds when the circuit was rapidly interrupted, and that the higher the pitch of sound the more audible was the effect. I was much struck by the idea of producing sound by the action of light in this way. Upon farther consideration it appeared to me that all the audible effects obtained from varieties of electricity could also be produced by variations of light acting upon selenium. I saw that the effect could be produced at the extreme distance at which selenium would respond to the action of a luminous body, but that this distance could be indefinitely increased by the use of a parallel beam of light, so that we could telephone from one place to another without the necessity of a conducting wire between the transmitter and receiver. It was evidently necessary, in order to reduce the idea to practice, to devise an apparatus to be operated by the voice of a speaker, by which variations could be produced in a parallel beam of light, corresponding to the variations in the air produced by the voice.

I proposed to pass light through a large number of small orifices, which might be of any convenient shape, but were preferably in the form of slits. Two similarly perforated plates were to be employed. One was to be fixed and the other attached to the centre of a diaphragm actuated by the voice, so that the vibration of the diaphragm would cause the moveable plate to slide to and fro over the surface of the fixed plate, thus alternately enlarging and contracting the free orifices for the passage of light. In this way the voice of a speaker could control the amount of light passed through the perforated plates without completely obstructing its passage. This apparatus was to be placed in the path of a parallel beam of light, and the undulatory beam emerging from the apparatus could be received at some distant place upon a lens, or other apparatus, by means of which it could be condensed upon a sensitive piece of selenium placed in a local circuit with a telephone and galvanic battery. The variations in the light produced by the voice of the speaker should cause corresponding variations in the electrical resistance of the selenium employed: and the telephone in circuit with it should reproduce audibly the tones and articulations of the speaker's voice. I obtained some selenium for the purpose of producing the apparatus shown; but found that its resistance was almost infinitely greater than that of any telephone that had been constructed, and I was unable to obtain any audible effects by the action of light. I believed, however, that the obstacle could be overcome by devising mechanical arrangements for reducing the resistance of the selenium, and by constructing special telephones for the purpose. I felt so much confidence in this that, in a lecture delivered before the Royal Institute of Great Britain, upon the 17th of May, 1878, I announced the possibility of hearing a shadow by interrupting the action of light upon selenium. A few days afterwards my ideas upon this subject received a fresh impetus by the anouncement made by Mr. Willoughby Smith before the Society of Telegraph Engineers that he had heard the action of a ray of light falling upon a bar of crystalline selenium, by listening to a telephone in circuit with it.

It is not unlikely that the publicity given to the speaking telephone during the last few years may have suggested to many minds in different parts of the world somewhat similiar ideas to my own.

Although the idea of producing and reproducing sound by the action of light, as described above, was an entirely original and independent conception of my own, I recognize the fact that the knowledge necessary for its conception has been disseminated throughout the civilized world, and that the idea may therefore have occurred to many other minds. *The fundamental idea, on which rests the possibility of producing speech by the action of light, is the conception of what may be termed an undulatory beam of light in contradistinction to a merely intermittent one.* By an undulatory beam of light, I mean a beam that shines continuously upon the selenium receiver, but the intensity of which upon that receiver is subject to rapid changes, corresponding to the changes in the vibratory movement of a particle of air during the transmission of a sound of definite quality through the atmosphere. The curve that would graphically represent the changes of light would be similar in shape to that representing the movement of the air. I do not know whether this conception had been clearly realized by "J. F. W.," of Kew, or by Mr. Sargent, of Philadelphia; but to Mr. David Brown of London, is undoubtedly due the honor of having distinctly and independently formulated the conception, and of having devised apparatus—though of a crude nature—for carrying it into execution. It is greatly due to the genius and perseverance of my friend, Mr. Sumner Tainter, of Watertown, Mass., that the problem of producing and reproducing sound by the agency of light has at last been successfully solved.

The first point to which we devoted our attention was the reduction of the resistance of crystalline selenium within manageable limits. The resistance of selenium cells employed by former experimenters was measured in millions of ohms, and we do not know of any record of a selenium cell measuring less than 250,000 ohms in the dark. *We have succeeded in producing sensitive selenium cells measuring only* 300 *ohms in the dark, and* 155 *ohms in the light.* All former experimenters seemed to have used platinum for the conducting part of their selenium cells, excepting Werner Siemens, who found that iron and copper might be employed. We have also discovered that brass, although chemically acted upon by selenium, forms an excellent and convenient material; indeed, we are inclined to believe that the chemical action between the brass and selenium has contributed to the low resistance of our cells by forming an intimate bond of union between the selenium and brass. We have observed that melted selenium behaves to the other substances as water to a greasy surface, and we are inclined to think that when selenium is used in connection with metals not chemically acted upon by it, the points of contact between selenium and the metal offer a considerable amount of resistance to the passage of a galvanic current. By using brass we have been enabled to construct a large number of selenium cells of different forms. The mode of applying the selenium is as follows: The cell is heated, and, when hot enough, a stick of selenium is rubbed over the surface. In order to acquire conductivity and sensitiveness, the selenium must next undergo a process of annealing.

We simply heat the selenium over a gas stove and observe its appearance. When the selenium attains a certain temperature, the beautiful reflecting surface becomes dimmed. A cloudiness gradually extends over it, somewhat like the film of moisture produced by breathing upon a mirror. This appearance gradually increases, and the whole surface is soon seen to be in the metallic, granular or crystalline condition. The cell may then be taken off the stove and cooled in any suitable way. When the heating process is carried too far, the crystalline selenium is seen to melt. Our best results have been obtained by heating the selenium until it crystallizes, and continuing the heating until signs of melting appear, when the gas is immediately put out. The portions that had melted instantly re-crystallize, and the selenium is found upon cooling to be a conductor, and to be sensitive to light. The whole operation occupies only a few minutes. This method has not only the advantage of being expeditious, but it proves that many of the accepted theories on this subject are fallacious. Our new method shows that fusion is unnecessary, that conductivity and sensitiveness can be produced without long heating and slow cooling; and that crystallization takes place during the heating process. We have found that on removing the source of heat immediately on the appearance of the cloudiness, distinct and separate crystals can be observed under the microscope, which appear like leaden snow-flakes on a ground of ruby red. Upon removing the heat when crystallization is further advanced, we perceive under the microscope masses of these crystals arranged like basaltic columns standing detached from one another, and at a still higher point of heating the distinct columns are no longer traceable, but the whole mass resembles metallic pudding-stone, with here and there a separate snow-flake, like a fossil, on the surface. Selenium crystals formed during slow cooling after fusion present an entirely different appearance, showing distinct facets.

We have devised about fifty forms of apparatus for varying a beam of light in the manner required, but only a few typical varieties need be shown. The source of light may be controlled or a steady beam may be modified at any point in its path. The beam may be controlled in many ways. For instance, it may be polarized, and then affected by electrical or magnetic influences in the manner discovered by Faraday and Dr. Ker. The beam of polarized light, instead of being passed through a liquid may be reflected from the polished pole of an electro-magnet. Another method of affecting a beam of light is to pass it through a lens of variable focus. I observe that a lens of this kind has been invented in France by Dr. Cusco, and is fully described in a recent paper in "La Nature;" but Mr. Tainter and I have used such a lens in our experiments for months past. The best and simplest form of apparatus for producing the effect remains to be described. This consists of a plain mirror of flexible material—such as silvered mica or microscopic glass. Against the back of this mirror the speaker's voice is directed. The light reflected from this mirror is thus thrown into vibration corresponding to those of the diaphragm itself.

In arranging the appàratus for the purpose of reproducing sound at a distance, any powerful source of light may be used, but we have experimented chiefly with sunlight. For this purpose a large beam is concentrated by means of a lens upon the diaphragm mirror, and, after reflection, is again rendered parallel by means of another lens. The beam is received at a distant station upon a parabolic reflector, in the focus of which is placed a sensitive selenium cell, connected in a local circuit with a battery and telephone. A large number of trials of this apparatus have been made with the transmitting and receiving instruments so far apart that sounds could not be heard directly through the air. In illustration, I shall describe one of the most recent of these experiments. Mr. Tainter operated the transmitting instrument, which was placed on the top of the Franklin schoolhouse in Washington, and the sensitive receiver was arranged in one of the windows of my laboratory, 1325 L street at a distance of 213 metres. Upon placing the telephone to my ear I heard distinctly from the illuminated receiver the words: "Mr Bell, if you hear what I say, come to the window and wave your hat." In laboratory experiments the transmitting aud receiving instruments are necessarily within earshot of one another, and we have therefore been accustomed to pooling the electric circuit connected with the selenium receiver, so as to place the telephones in another room. By such experiments we have found that articulate speech can be reproduced by the oxy-hydrogen light, and even by the light of a kerosene lamp. The loudest effects obtained from light are produced by rapidly interrupting the beam by the perforated disk. The great advantage of this form of apparatus for experimental work is the noiselessness of its rotation, admitting the close approach of the receiver without interfering with the audibility of the effect heard from the latter; for it will be understood that musical tones are emitted from the receiver when no sound is made at the transmitter. A silent motion thus produces a sound. In this way musical tones have been heard even from the light of a candle. When distant effects are sought another apparatus is used. By placing an opaque screen near the rotating disk the beam can be entirely cut off by a slight motion of the hand, and musical signals, like the dots and dashes of the Morse telegraph code, can thus be produced at the distant receiving station.

We have made experiments, with the object of ascertaining the nature of the rays that affect selenium. For this purpose we have placed in the path of an intermittent beam various absorbing substances. Prof. Cross has been kind enough to give me his assistance in conducting these experiments. When the solution of alum, or bisulphide of carbon, is employed the loudness of the sound produced by the intermittent beam is very slightly diminished; but a solution of iodine in bisulphide of carbon cuts off most but not all, of the audible effect. Even an apparently opaque sheet of hard rubber does not entirely do this. When the sheet of hard rubber was held near the disk interrupter the rotation of the disk interrupted what was then an invisible beam which passed over a space of about twelve feet before it reached the lens which finally concentrated it upon the selenium cell. A faint but perfectly perceptible musical tone was heard from the telephone connected with the selenium. This could be interrupted at will by placing the hand in the path of the invisible beam. It would be premature, without further experiments, to speculate too much concerning the nature of these invisible rays; but it is difficult to believe that they can be bent rays, as the effect is produced through two sheets of hard rubber containing between them a saturated solution of alum. Although effects are produced as above shown by forms of radiant energy which are invisible, we have named the apparatus for the production and reproduction of sound in this way "*The Photophone*," because an ordinary beam of light contains the rays which are operative.

It is a well-known fact that the molecular disturbance produced in a mass of iron by the magnetizing influence of an intermittent electrical current can be observed as sound by placing the ear in close contact with the iron. It occurred to us that the molecular disturbance produced in crystalline selenium by the action of an intermittent beam of light should be audible in a similar manner without the aid of a telephone or battery. Many experiments were made to verify this theory without definite results. The anomalous behaviour of the hard rubber screen suggested the thought of listening to it also. The experiment was tried with extraordinary success. I held the sheet in close contact with my ear, while a beam of intermittent light was focussed upon it by a lens. A distinct musical note was immediately heard. We found the effect intensified by arranging the sheet of hard rubber as a diaphragm, and listening through a hearing-tube. We then tried crystalline selenium in the form of a thin disk, and obtained a similar but less intense effect. The other substances which I enumerated at the beginning of my address were now successively tried in the form of thin disks, and sounds were obtained from all but carbon and thin glass. We found hard rubber to produce a louder sound than any other substance we tried, excepting antimony, and paper and mica to produce the weakest sound. *On the whole, we feel warranted in announcing as our conclusion that sounds can be produced by the action of a variable light from substances of all kinds, when in the form of thin diaphragms.* We have heard from interrupted sunlight very perceptible musical tunes through tubes of ordinary vulcanized rubber, of brass and of wood. These were all the materials at hand in tubular form, and we have had no opportunity since of extending the observations to other substances.—(*Address before the American Association at Boston, August*, 1880.)

THE CHEMICAL COMPOSITION AND NUTRITIVE VALUES OF FISH.

A paper with this title was read before the chemical sub-section at the recent meeting of the American Association by Professor W. O. Atwater, of Middleton, Ct., and gave the results of an investigation made under the auspices of the Smithsonian Institution and the United States fish commission. They included analyses of a large number of specimens of more common food fishes, whose details, though quite extended, were mainly of theoretical value. Some of the applications, however, were of much practical interest. In 100 pounds of the flesh of fresh cod we have 83 pounds of water and only 17 pounds of solids, while the flesh of the salmon contains only 66½ per cent. of water and 33½ per cent. of solids: that is to say, about one-sixth of the flesh of cod and one-third of that of salmon consists of solids, that is, of nutritive substances, the rest being water. Lean beef, free from bone, contains about seventy-five per cent. water and twenty-five per cent. solids. The figures for some of the more common sorts of fish were:—

In flesh of	Solids. per cent.	In flesh of	Sŏlids. per cent.
Flounder	17.2	Halibut, fat	30.7
Cod	16.9	Mackerel	[illegible]2.2
Striped bass	20.4	Shad	30.7
Bluefish	21.8	Whitefish	30.4
Halibut, lean	20.6	Salmon	33.6

If we take into account not the flesh only, but the whole fish as sold in the market, including bones, skin and other waste, the actual percentage of nutritive material is, of course, smaller. Thus the following percentages of edible solids were found in samples analysed:—

Flounder	7.1	Shad	14.8
Ccd	10.5	Shad	18.7
Mackerel	11.4	Lake trout	13.6
Halibut, lean	15.6	Salmon	25.6
Halibut, fatter	27.2		

This subject has of late attracted unusual attention. The chemico-physiological investigation of the past two decades has brought us where we can judge with a considerable degree of accuracy, from the chemical composition of a food-material, what is its value for nourishment as compared with other foods. The bulk of the best late investigation of this subject has been in Germany, where a large number of chemists and physiologists are busying themselves in the experimental study of the laws of animal nutrition. They have already got so far as to feel themselves warranted in computing the relative values of our common foods, and arrange them in tables, which are coming into popular use. The valuations are based upon the amounts of albuminoids, carbohydrates and fats, each being rated at a standard, just as a grocer makes out his bill for a lot of sugar, tea and coffee, by rating each at a certain price per pound, and adding the sums thus computed to make the whole bill. A table was given showing the composition of a list of animal foods. Thus it appeared that, while medium beef has about three-fourths water and one-fourth solid, milk is seven-eighths water and one-eighth solids. Assuming a pint of milk to weigh a pound, and speaking roughly, a quart of milk and a pound of beefsteak would both contain the same amount—about four ounces—of solids. But the quart of milk would not be worth as much for food as the pound of steak. The reason is that the nutrients of the steak are almost entirely albuminoid, while the milk contains a good deal of carbohydrates and fats, which have a lower nutritive value. According to the valuations given, taking medium beef at 100, we should have for like weights of flesh free from bone :—

Medium beef	100.0	Bluefish	85.0
Fresh Milk	23.8	Mackerel	86.0
Skimmed milk	18.5	Halibut	88.0
Butter	124.0	Lake trout	94.0
Cheese	155.0	Eels	95.0
Hens' eggs	72.0	Shad	99.0
Cod (fresh fish)	68.0	Whitefish	103.0
Flounders	65.0	Salmon	104.0
Halibut	88.0	Salt Mackerel	111.0
Striped bass	79.0	Dried codfish	346.0

These figures differ widely from the market values. But we pay for our foods according, not to their value for nourishing our bodies, but to their agreeableness. Taking the samples of fish at their retail prices in the Middletown, Conn., markets, the total edible solids in striped bass came to about $2.30 a pound, while the Connecticut shad's nutritive material was bought at 44 cents per pound. The cost of the nutritive material in one sample of halibut was 57 cents, and in the other $1.45 per pound, though both were purchased in the same place at the same price,—15 cents per pound, gross weight. In closing, Professor Atwater referred to the widespread but unfounded notion that fish is particularly valuable for brain food on account of its large content of phosphorus. Suffice it to say that there is no evidence as yet to prove that the flesh of fish is specially richer in phosphorus than other meats are, and that, even if it were so, there is no proof that it would be on that account more valuable for brain food. The question of the nourishment of the brain and the sources of intellectual energy are too abstruse for speedy solution in the present condition of our knowledge.

BAKING POWDERS AND THEIR ADULTERANTS.

By J. T. Donald, B.A.,

of Hubbard & Donald, Analytical Chemists, Montreal.

At first sight my subject may seem scarcely a fitting one to bring before such a Society as this, yet when we remember that there is an enormous amount of this substance used, with good or evil results to the consumers; when we recall to mind the fact that there is no Sanitary Association before which such subjects may be ventilated; and especially when we consider that one of the highest duties of science is to contribute to the welfare of mankind, it will be admitted, I hope, that the discussion of this subject is not beyond the scope of a Natural History Society. Glancing first at the history of baking powders, we find that until within a comparatively recent date, in Canada at least, every cook or housewife made her own baking powder as required, by adding to her dough or paste a certain number of spoonfulls of baking soda and twice as many of bitartrate of potash or cream of tartar. The frequent presence of particles of undissolved soda in pastry and the varying degree of lightness of the pastry made under the old system, suggested to some ingenious individual the idea of making a mixture which should supersede—because of its uniformity of action and thorough mixture of ingredients—the time-honored soda and cream of tartar.

About thirty years ago, so far as I can learn, a mixture composed chiefly of these ingredients, and manufactured abroad, was introduced into this country under the name of "German Baking Powder." Shortly afterwards a similar article was manufactured in this city, as well as in the Dominion, for the first time. Since then the manufacture and use of this substance have increased wonderfully; to such an extent, indeed, that large establishments both in our own country and the United States are exclusively engaged in the production of this article. In Britain, strange to say, but little of this substance is used.

A baking powder in so far as the manufacture of this substance is concerned, is essentially a mixture of soda bicarb. and some dry acid substance, which latter acting upon the soda drives off its carbonic acid, and this rising through the mass renders it light and porous. Before proceeding further it will be necessary to define an ideal baking powder wherewith we may compare powders that are offered for sale throughout the land. Our ideal powder then is a mixture of one part soda bicarb. with as nearly as may be, two parts cream of tartar. When moistened these substances acting upon each other give off about 16·5 per cent. of carbonic dioxide, tartrates of potassium and sodium being formed, none of which are injurious to the human system.

And just here I may be permitted to add that if our Government intend the law concerning adulteration of food to be any more than a dead letter, in so far as this substance is concerned it will be necessary for it to define a pure article, which should be done by stating the minimum amount of carbonic acid that the powders shall produce and the acid substances which may or may not be used, for as matters stand at present any one may call his powder pure, for so it may be according to his formula and his idea of pure and impure baking powders.

It has fallen to my lot to examine a large number of baking powders, nearly every powder manufactured to any extent in Canada, and also many from the United States. Nearly all that I have examined may be included in three classes:

The first class contained those powders which come sufficiently near to our theoretical one to be called commercially pure.

One of these contained besides soda and cream of tartar 10·61 per cent. of flour, and produced 15·4 per cent. of carbonic dioxide.

A second contained, in addition to the essential ingredients, flour 9·8 per cent. and lime nearly 2 per cent., and gave off 15·5 per cent. of carbonic dioxide.

Another contained, in addition to soda and cream of tartar, flour 3·2 per cent. and lime 2·78 per cent.

The only points wherein the members of this group depart from our type is that they all contain flour, from 3 to 10 per cent., and that two of them have a small quantity of lime.

Now, whilst flour is certainly not essential to a baking powder as such, it is a necessary ingredient of a powder which is to fully retain its properties for any length of time. When mixed with the soda bicarb. and cream of tartar it to a certain extent keeps the particles of the two substances apart; did they lie in immediate contact a certain amount of the carbonic acid would be dissipated and the powder lose strength. I cannot say with certainty what proportion of flour is necessary for this purpose, I should think, however, that 10 per cent. would amply suffice, although a leading manufacturer tells me that 25 or 30 per cent. is necessary. I should certainly consider this quantity much greater than is absolutely necessary, for baking powders are not generally kept for any great length of time, and further I have found upon careful examination that those powders containing 10 per cent. or less of flour had not lost any of the carbonic acid they originally obtained; of course I cannot say how long they had been made before examined.

The presence of a small quantity of lime, say 2 or 3 per cent., cannot be regarded as injuring the powder. It is a well-known fact that bakers frequently use lime-water to produce in their bread "whiteness, softness, and capacity of retaining moisture." The lime removes all acidity from the dough, and supplies an ingredient needed in the structure of the bones but which is deficient in the flour. It is therefore advantageous rather than otherwise that a baking powder should contain a small percentage of pure lime.

The second class contain those powders which depart from our type in having alum substituted in part or entirely for cream of tartar. One of this class contained alum 4·7, flour 47·59, and yielded carbonic dioxide only 8·42. Another had alum 1·89, flour 34·00, and yielded carbonic dioxide 10·4. In these two, alum only partially replaced the cream of tartar, but in many powders it is the sole acid substance. One of this group contained alum 17·032, flour 67·25, and yielded 11 per cent. of carbonic dioxide.

The second class of powders is remarkable for several reasons. First, the small percentage of gas produced; secondly, from the fact that alum in part or entirely replaces cream of tartar; and lastly, because of the large quantity of flour they contain.

Cream of tartar costs about 28 or 30 cents per lb., whilst alum can be purchased for less than 2 cents per lb. The former must be used in much larger quantity than alum to act upon the same quantity of soda in order to deprive it of all its carbonic dioxide. There is therefore an inducement, so strong that many cannot withstand it, to use alum as a substitute for cream of tartar in the manufacture of baking powder.

Now, is this alum to be regarded as an adulterant? Is it injurious to those who use it in these powders? To both of these questions we answer in the affirmative. The very composition of these alum baking powders shows that those who manufacture them are desirous of concealing the fact. With alum as the acid substance, a baking powder can be produced that will yield a much larger percentage of gas than can possibly be obtained from a powder made solely with cream of tartar. And since the value of these powders, other things being equal, depends upon their available amount of carbonic acid, one would imagine that a manufacturer believing that alum was a wholesome ingredient, and desiring to build up a business, would place upon the market a powder giving off a much greater quantity of gas than could possibly be obtained from a powder whose acid substance is cream of tartar. This, however. is never done; every alum powder that I have examined producing *less* carbonic acid than could be obtained with cream of tartar. Flour is added to make up the difference from 34 to 67·25 per cent., according to amount of alum used.

The great majority of scientific authority condemns alum as an article of food; the law of Britain strictly forbids its use. If alum be present in a baking powder in excess, a certain amount will enter the body unaltered, and tends to "produce dyspepsia, constipation, vomiting, griping, and even inflammation of the gastro-enteric mucous membrane, as it is a powerful astringent, acting chemically on the tissues." Although these effects will not be produced by the quantity in bread or pastry used at any one time, yet it is certain that persons continuing to eat bread containing alum will in time suffer from its evil effects, and the weaker the constitution the sooner will the effects be noticed. If however the alum in the powder be just sufficient to act upon the soda so as to drive off all its gas, when the gas is driven off sulphate of soda will be formed, and the alumina which is set free will form with the phosphates of the flour an insoluble phosphate of alumina, so that the action of phosphates will be lost to the system and the nutritive value of the bread lessened to that extent. In any case, therefore, the use of alum as an article of food is attended with greater or less evil results.

Two samples represent as well as constitute the third group.

One of them produced—

Carbonic acid -	9·101	and contained besides soda and cream of tartar,
Flour - - -	40·9	
Sulphate of lime -	6·269	

The other yielded—

Carbonic acid -	9·35	and contained in addition to soda and tartar,
Flour - - -	24·70	
Sulphate of lime -	20·78	

These two powders depart from our type in containing much flour, and also in having a large quantity of sulphate of lime. I do not think it possible that any one would use the latter substance imagining it would act as lime, and therefore the only inference possible is that sulphate of lime is used to increase the weight of the powder and thereby fraudulently augment the producer's gain, a procedure which cannot be too loudly condemned,

From the facts I have submitted we learn that whilst there are before the public, baking powders which contain neither injurious nor unnecessary ingredients, and which therefore may be used safely and advantageously, there are in the market many which besides producing only a very small quantity of carbonic acid gas, contain unnecessary substances, as well as substances acting injuriously upon the human system, and which should therefore be left severely alone.

NATURAL SELECTION AND THE INK-GLAND OF DIBRANCHIATE CEPHALOPODS.

By S. P. Robins, LL.D.

"Nothing at first can appear more difficult to believe than that the "most complex organs and instincts have been perfected, not by "means superior to, though analogous with, human reason, but by "the accumulation of innumerable slight variations each good for the "individual possessor. Nevertheless, this difficulty, though appear- "ing to our imagination insuperably great, cannot be considered real "if we admit the following propositions, namely, that all parts of the "organization and instincts offer, at least individual differences—that "there is a struggle for existence leading to the preservation of profit- "able deviations of structure or instinct—and, lastly, that gradations "in the state of perfection of each organ may have existed, each good "of its kind. The truth of these propositions cannot I think be dis- "puted."—*Darwin, Origin of Species, chapter* 14.

Extensive as is the literature that has gathered around the celebrated "Origin of Species" of Mr. Darwin, the subject is by no means exhausted. The doctrine of the evolution of species by descent, with modifications under natural selection, must still be considered as *sub judice*. Many related topics of the greatest significance have met but partial, incidental, and quite unsatisfactory treatment. Among these neglected topics is the question of the genesis of individual organs by gradual modification under natural selection. For example, how has the eye of the vertebrates reached its highest development? What successive stages of increasing efficiency connect that vague sensibility to sonorous vibrations which may be conceived as inhering to the whole sarcodous mass of a rhizopod, with the highly complex and efficient auditory apparatus of a man? From what common structures and along what lines of development have homologous organs, which subserve different functions, descended? If we trace back the genealogy of the van of a bat and of the paddle of a porpoise, in what sort of structure will they meet? And what, from that structure, have been the causes and the courses of a divarication so wide? Full discussion of a hundred such questions is the necessary but as yet unattempted preliminary to any conclusive deliverance respecting the origin of specific forms through heredity and adaptation. For every specific form results from the integration of a multitude of organs, each of which is of great complexity. The whole, therefore, comprises parts so numerous, and involves correlations so intricate, that no understanding, however comprehensive, can grasp it, before the parts have been separately submitted to exhaustive study.

When the formal attempt shall be made to account for the formation of complex organs "by the accumulation of innumerable slight variations, each good for the individual possessor," the following principles will emerge as the necessary conditions to the solution of the problems presented.

1st. The function which each organ subserves must exist in a rudimentary condition in the ancestral germ, or both the function and the organ will be absent from every individual descendant. No slight variation can account for the first appearance of a new function. The interval between the absence of a function and its presence, in however small amount, is infinitely greater than between its most rudimentary and its most complete manifestation. "Numerous, slight, successive modifications" may account for the development of that which is insignificant until it shall attain commanding proportions and interest, but they can never cause that which is non-existent to arise into being.

2nd. The function in its most rudimentary condition must have been serviceable to its possessor, and with each successive upward modification must have been increasingly serviceable in the struggle for existence, or the organ that subserves it could not have been improved by natural selection.

3rd. A series of profitable modifications, if not known at least conceivable, must connect the diffused and imperfect manifestation of the function in the low ancestral germ with the highly specialized and complex organ that fulfils the function in its most developed form.

It is not necessary to the present purpose to point out that, even if in the case of any organ or totality of organs in individuals these three criteria be met, it by no means follows that we must admit genetic connection between the several forms, lowest, higher and highest; but, undoubtedly, if any one of them fail to be met, the possibility of such connection must be emphatically denied. Mr. Darwin says, in the second paragraph of chap. 14 of the "Origin of Species": "If it could be demonstrated that any complex organ existed that could not possibly have been formed by numerous, successive, slight modifications, my theory would absolutely break down." This is true; and it is no less true that we shall have demonstrated an organ that could not possibly have been so formed, if we show one that performs a function wholly unrepresented in its supposed ancestral germ, or a function that until highly developed is quite useless to its possessor, or a function that admits of no complete gradation from lowest to highest.

He who attempts to account for the origin of functions by heredity, variability, and the survival of the fittest, will not meet his chief difficulties when he considers the great common functions of animal life and the organs by which they are accomplished. The functions of prehension, ingestion, digestion and assimilation of food; of secretion, of excretion, of sensation, of voluntary motion, of the correlation of sensation to motion; all these without specialization by separate organs are diffusely and vaguely manifested in the lowest amoeboid form. Further, all these functions are not merely advantageous but they are essential to every thing that has animal life, and with each more distinct differentiation of function and specialization of organ they give to the possessor an increased advantage in the struggle for existence. And, again, so numerous are the forms of nature, ranging through so vast a scale of being, that it is possible to connect by gradations almost imperceptibly progressive the lowest with the highest form of each function and organ.

For example, the eye is a most complex, delicate and efficient organ, replete with admirable adjustments and adaptations, yet of its genesis by evolution a plausible account may be given. We can trace the beginning of the function in that sensibility to the presence or absence of light which is exhibited in the whole mass of the humblest protozoan forms. To them their rudimentary and vague appreciation of alternate sunshine and shadow, scarcely to be called vision, is doubtless useful for the avoidance of danger, and every stage of advance in quickness and precision must give increased advantage in escaping from peril and in the procurement of food. And, finally, the comparative anatomist may trace for us the several gradations, insensibly blended, by which we pass from a few pigment cells on the swimming disk of a medusa up to the most fully developed organ of sight in the vertebrate sub-kingdom. Wide as is the interval between tho eye-speck of a radiate and the human eye, that interval may be filled by the selection of a continuous, advancing series of slowly differing forms, such a series as must have united the extremes, if all the structures had originated by descent with accumulated minute modifications from a protozoan ancestry.

Not more difficult will be the task of accounting for the progressive development of any of the remaining common functions of life whether animal or vegetable. They are all represented in a rudimentary manner in the lowest forms of life. They all are profitable to the possessor, and increasingly profitable with increased specialization of the function and development of its organs. And, finally, from the boundless diversity of nature it is possible to choose forms which may be arranged in lineal series, exhibiting the links which may be supposed to connect the simplest with the most highly organized manifestation of the function·

But if there be in nature any organ which does not now exist in a rudimentary form anywhere, and of which nature furnishes no evidence that it ever did exist in a rudimentary form, then it is obvious that evidence of its development through evolution is wanting. And if, further, it is impossible to conceive that the function could ever usefully exist in the rudimentary condition, we are compelled to say that we cannot conceive how such organs as subserve the function could be produced by any process of evolution.

So far as appears there are many aberrant or peculiar organs in the animal economy that cannot be accounted for by evolution, because the terms of any conceivable theory of evolution cannot apply. Let us take but one example—the ink bag of the octopus. It is well known that all the dibranchiate cephalopods, when threatened by danger, eject into the surrounding water a dense, dark liquid that forms an opaque cloud to cover their escape. This dark brown or black liquid is secreted abundantly by a somewhat large sac-like gland—the ink bag. Exteriorly the ink bag is pear shaped, and has a pearly or silvery lustre. Within, its walls are cavernous, and pour the secretion into a central cavity, from which a tube conveys it to the funnel of the animal. When alarmed the animal forcibly expels water from its funnel. By the reaction of this water it is driven rapidly backward. At the same time the contents of the ink bag are shed into the escaping jet of water, so that the very act by which the animal escapes, aids in the formation of the cloud that covers its escape.

This function of darkening the water by a dense coloured secretion is one which is not found in protozoan life. It exists nowhere in the animal world in a rudimentary condition. The geological record shows that just when, in the jurassic seas, the armored cephalopods had reached their culmination, the belemnites and teuthidæ suddenly appeared in considerable numbers, both of individuals and species, all destitute of the protection of an external shell, but all fully provided with the unique means of defence described above. But geology gives no record of any preceding form of life that had a similar though less perfectly developed defence. Yet, if such form of life had existed, it would surely have left some record of its existence. If in no other way, its indestructible ink would, in some cases at least, have remained to witness for it. There is no evidence then of the evolution of the ink bag of the cuttle fish. It appears at once fully developed. Nor is it possible to conceive its evolution. A cloud of ink insufficient in quantity or pale and translucent in colour, so far from being of utility, would have been a serious disadvantage to the ink spiller. It could not have served for concealment; it would have been a means of betrayal only. The evolution of an ink bag by selection under the struggle for existence, and the survival of the fittest, is not only not known as a matter of history, it is inconceivable as a matter of hypothesis.

There is one way yet remaining in which, consistently with evolution, it is possible to account for an organ that could not have been evolved from a primitive organ of similar function but of less efficiency. It is by that which has been tacitly assumed but not explicitly named in the speculations of evolution —the *transmutation of function*. What in amphipods are locomotive organs become in lobsters the so-called foot-jaws. In like manner it has been assumed that fins for swimming have been transmuted gradually into legs for walking, into wings for flying, into hands for grasping.

Not to speak of the fact that all such plausibly asserted transmutations are not from one function to another of different order but from one modification of a function to another modification of the same function, it is sufficient to the present purpose to point out that in all such cases the transmuted organs are homologous, and necessarily homologous; morphologically they are alike, though functionally they differ. Now so long as it was supposed, as by the earlier anatomists, that the ink bag was a peculiar sort of gall-bladder, it was possible to suppose that by transmutation of function what in other molluscs was an organ of digestion in the naked cephalopods had been transmuted into an organ of defence. But it is now well known that the ink bag is a special organ, homologous to none other among molluscs. It cannot then be accounted for by transmutation of function.

It is worthy of remark that this organ is always found in those cephalopods which have no external shell. It is never found in those which have such a covering except in the case of the paper nautilus, whose fragile shell, belonging only to the female, serves not as a defence to the occupant but merely as a place for the deposition and incubation of its eggs.

Many—not all—evolutionists roundly declare that there is no proof of design in the universe. Many theologians, stunned by the constant and noisy iteration, are almost ready to abandon Paley's grand argument, as though somehow it had grown obsolete. Let them take into consideration the ink-bag of the cuttle fish. Here is one organ that cannot have been produced by natural selection, nor can it have resulted from transmutation of function. It appears early in mesozoic time fully developed in the first of the naked cephalopods. Its sole use is the defence of the possessor by blinding the path of its escape. The construction of the organ, the situation of the organ, the position of its emissive duct, all have a nicely calculated relation to the result. Whether other organs of the animal economy have been produced perfect at once or not, this must have been. Whether other organs have had an intelligent creator and a plan in their construction or not, this particular organ must have been created with prescience, calculation, design. If we may no longer with fond delusion worship the Great Unknown as the creator of man, let us still continue to bow down before Him as the creator of the ink-bag of the cuttle fish.

AMERICAN GEOGRAPHY.*

"My recent predecessors in this chair have dealt, with a knowledge and ability with which I cannot vie, not only with great problems in terrestrial physics, such as the genesis of our oceans, continents, and mountain-chains; the circulation of the waters of the ocean, with its consequences on climate; the reciprocal influence of conditions of nature upon man, and of man's ability to modify those conditions; but also on the progress of geographical discovery on the great theatres of political interest or commercial rivalry; and the archæology of our science, as regards Asia, has been touched by a master's hand. Turning, then, from themes on which I could offer nothing worthy of your attention, I find, with a sense of relief, that there is a region of the globe, and it is one with which I have the most personal acquaintance, which has received very little attention at their hands. I refer to the great continent of America, and more especially its northern portion; and I hope for your indulgence if I enlarge a little upon that theme.

"How vast have been, in very recent times, the additions to our knowledge in that quarter, how continuous is the progress of discovery, cannot, I think, but worthily occupy your attention for a few minutes. In other regions geography is the pioneer of

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* From the Address to the Geographical Section of the British Association, Swansea, 1880, by Lieut.-General Sir J. H. Lefroy, C. B., K. C. M. G., R. A., F. R. S., F. R. G. S. President of the Section.

civilisation and commerce. We look, and often look long, fo their footsteps to follow. Here for the first time she has been outstripped, for the telegraph and the railway have tracked the forest or prairie, and traversed the mountains by paths before unknown to her.

"I remember that patriarch of science, Sir Edward Sabine, once telling me how eagerly he, as a young man, had desired to retread the footsteps of Lewis and Clarke, whose journey from St. Louis to the Pacific in 1805, was at the time, and must long remain, one of the most remarkable achievements on record,

"Let me, then, remind you that within living memory (I grant a long one) no traveller known to fame had crossed the American continent from east to west, except Alexander Mackenzie, in 1793. No traveller had reached the American Polar Sea by land, except the same illustrious explorer and Samuel Hearne. The British Admiralty had not long before instructed Captain Vancouver to search on the coast of the Pacific for some near communication with a river flowing into or out of the Lake of the Woods. The fabulous Straits of Annian are to be found on maps of the last century. 'The sacred fires of Montezuma' were still burning in secluded valleys of Upper California when her Majesty ascended the throne.

"It is very interesting to observe that De la Hontan, whose name has been recently given by the American geologists to the great Miocene Sea, now represented by Carson Lake in Nevada, ascended the Mississippi, and even penetrated up the Yellowstone, very nearly to the 'National Park,' at all events, into the present territory of Montana, so early as 1687. He introduces into his rude map a head-water lake, on Indian information, which must, I think, be identical with a lake in that reserve. 'Je sçais,' says his biographer, 'que tous les voyageurs sont sujets à caution, et que s'ils ne sont point parvenus au privilége des poëtes et des peintres, il ne s'en faut guére : mais il faut excepter de la noblesse ; est-il croyable qu'un baron voulût en imposer ?' But I am not pursuing the attractive theme offered by historical geography, and must not dwell on the memorable expeditions of Franklin and Richardson, of Back and Simpson and Rae, but proceed to point out the many agencies at work of late years to open up the continent: the military operations, for example, of the United States' Government against Mexico; the discovery of the precious metals; the exploration for the Union Pacific and Canada Pacific Railways; International Boundary Surveys; the Geological Surveys of the American and Canadian Governments. These have all resulted in a surprising extension of geographical knowledge, without any of them having it particularly in view. It was a bold figure of speech of Lord Dufferin's which described the Rocky Mountains in 1877 as being nearly 'as full of theodolites as they could hold,' but the Dominion Government has spent about three-quarters of a million sterling on explorations or surveys for their railway, and we have only to glance at a recent map to discover nine sovereign states, and nine territories, west of the Mississippi, bounded by right lines, which neither war nor diplomacy has determined, laid out like garden-plots, to see that neither Asia nor Africa have unfolded more of their secrets in our times, than has the nobler continent where Britain has cast her swarms.

"The thoroughness characteristic of the scientific operations of the American Government has been greatly favoured by the physical features of the region of their trigonometrical survey, in the American Cordilleras. Sharp rocky peaks, bare of vegetation, rise to altitudes of 10,000 to 12,000 feet, at convenient distances of 60 to 80 miles apart, so situated as to form well-conditioned triangles, while the purity of the atmosphere makes observation easy. In this manner has an immense region comprising some 87,000 square miles in Nevada, Utah, and Colorado, been topographically surveyed since 1867: not indeed with the detail of a European national survey, but with all the accuracy required for first settlement. The two pre-historic seas, now designated Lake Bonneville, of which Salt Lake is the remains, and Lake La Hontan, already referred to, have been defined, and facts of remarkable physical interest have been ascertained. The evaporation of Great Salt Lake, for example, is no longer in excess of its annual tribute; it has risen 11 feet since 1866. The natural basis of Pyramid Lake is now full, its level has risen 9 feet, and the overflow is filling up Winnemucca Lake in like manner; the latter lake has risen 22 feet, and its area has doubled within the same short period. We cannot allow the geologists to monopolise the interest of these physical changes, which the magnificent volume of Mr. Clarence King has presented to them.

"Lying a little to the east and south of the region just referred to is another, which includes yet loftier mountains, and has been surveyed by Professor Hayden. Here, on the tributaries of the rivers Colorado and S. Juan, we find those mysterious monuments of ancient civilisation and a dying people, the cliff-houses on the Rio Mancos and Rio de Chelly, the Pueblos of the Chaso Canon; and here the wandering Apachès still practice on their prisoners those revolting and indescribable cruelties which make humanity shudder, and which seal their doom of extermination. No less than eighteen summits in the Sierra Blanca have been found to rise above 14,000 feet. Blanca Peak, in South Colorado, attains 14,464 feet, and is the monarch of mountains, if such there may be, in the great Republic. Lake Tahoe, the largest of western lakes, familiar to readers of the brilliant pages of Miss Bird, was surveyed by Lieutenant Macomb in 1877, and the height of Pyramid Peak ascertained to be 10,003 feet. A town of 20,000 inhabitants (Leadville, Colorado) has sprung into being at an elevation of 11,000 feet, which ranks it among the highest inhabited places on the globe.

"Very different in their character are the survey operations of the Canadian Government in the north-west, where the problem presented is to prepare a vast territory. wholly wanting in conspicuous points, for being laid out in townships of uniform area, and farms of uniform acreage. The law requires that the eastern and western boundaries of every township be true astronomical meridians; and that the sphericity of the earth's figure be duly allowed for, so that the northern boundary must be less in measurement than the southern. All lines are required to be gone over twice, with chains of unequal length, and the land surveyors are checked by astronomical determinations. In carrying out this operation, which will be seen to be of great nicety, five principal meridians have been rigorously determined, and in part traced—the 97th, 102nd, 106th, 110th, and 114th; and fourteen base-lines, connecting them, have been measured and marked. One of these, on the parallel of 52° 10′ is 183 miles long. Eleven astronomical stations have been fixed since 1876, and from these sixty-six determinate points have been fixed in latitude, forty-five in longitude, often under conditions of no little difficulty from the severity of the climate. The claims of Messrs. Alexander and Lindsay Russell, of Mr. Aldous, and Mr. King, the observers, to rank as scientific travellers, will, I am sure, be warmly recognized by this Section.

"The sources of the Frazer river were first reached in February 1875, and found in a semicircular basin, completely closed in by glaciers and high bare peaks, at an elevation of 5,300 feet. The hardy discoverer, Mr. E. W. Jarvis, travelled in the course of that exploration 900 miles on snow shoes, much of it with the thermometer below the temperature of freezing mercury, and lived for the last three days, as he expressed it, 'on the anticipation of a meal at the journey's end.

"We are still imperfectly acquainted with the region north of the parallel of 50° in British Columbia, where the Canadian engineers have long been searching for a practical railway line from one or other of three known passes of the Rocky Mountains proper through the tremendous gorges of the Cascade Mountains, to the Pacific. These passes are, the Yellowhead, at an elevation of 3,645 feet, the Pine river, at 2,800 feet, and the Peace river, said to be only 1,650 feet above the sea, all of them comparing very favorably in respect to height with the other transcontinental railways. The Union Pacific Railway, for example, runs, as you will remember, for 1,500 miles at elevations of over 4,500 feet, and its summit level is 8,242 feet. The Dominion Government has recently adopted a line from the Yellowhead Pass to Burrard Inlet, which may be made out in any good map by following the course of the Thompson and Frazer rivers. By this line the Pacific coast will be reached in 1,945 miles from Lake Superior, and it is already partly under contract. This is not a place to enter upon engineering details. I will only remark that greater difficulties have seldom been presented to human enterprise than must here be conquered. That peculiar feature in physical geography, the canon or deep gorge, of which the Via Mala is an example familiar to many persons, is presented all over the region upon a scale of grandeur unsurpassed. When not perpendicular cliffs, their sides are in these latitudes seamed by avalanches on the largest scale; while the mountain torrents which rush down them defy navigation. Mr. Jarvis describes how, on one occasion, having walked into a hole concealed by snow, the current caught his snow-shoes, turning them upside down, and held him like a vice, so that it required the united efforts of all his party to extricate him. * * * *

"The final decision of the Canadian Government to adopt Burrard Inlet for the Pacific terminus of their railway, relegates to the domain of pure geography a great deal of knowledge acquired in exploring other lines: explorations in which Messrs

Jarvis, Horetsky, Keefer, and others, have displayed remarkable daring and endurance. They have forced their way from the interior to the sea-coast or from the coast to the Peace River, Pine or Yellowhead Passes, through country previously unknown, to Port Simpson, to Burke Channel, to the mouth of the Skeena, and to Bute Inlet, so that a region but recently almost a blank on our maps, which John Arrowsmith, our last great authority, left very imperfectly sketched, is now known in great detail, and I regret to add, the better known, the less admired. The botany has been reported on by Mr. Macoun, and the geology by Dr. Dawson, *pari passu* with its topography. I have great hope that the Section will receive from the last-named traveller in person some account of his many arduous journeys in the prosecution of geological research. Of these, the latest is the exploration of Queen Charlotte Islands, a part of the British possessions, very little known to most of us, although we had a communication on the subject in 1868. He regards them as a partly submerged mountain chain, a continuation north-westward of that of Vancouver's Island and of the Olympian Mountains in Washington Territory. An island, 156 miles long and 56 wide, enjoying a temperate climate, and covered with forests of timber of some value (chiefly *Abies Menziesii*), is not likely to be left to nature much longer. But the customs of the natives in regard to the inheritance and transfer of land are unfavorable to settlement, and will demand just and wise consideration when the hour comes. It is as much private property as any estate in Wales.

"Mr. Dawson's report contains a vocabulary of the language, which presents this peculiarity, that the words expressing family relationship vary with the speaker. Thus, 'father,' said by a son is *Haung*; said by a daughter, is *Hah-ta*. 'Son,' said by a father, is *keet*; said by a mother, is *kin*. Evidently at some periods the mothers were captives of a different tribe. It would be difficult to produce on the globe a more conspicuous example of the beneficent effect of missionary influence, combining industrial with religious instruction, than has been presented by the Tsimpsheean Indians at Metla Katla, under Mr. Duncan, a layman commissioned by the Church Missionary Society.

"I must now call your attention to the remarkable explorations, little known in this country, of l,Abbé Petitot, also a lay missionary (Frère Oblat) of the Roman Catholic Church, in the

Mackenzie River district, between Great Slave Lake and the Arctic Sea, a region which that Church has almost made its own. Starting sometimes from St. Joseph's mission station, near Fort Resolution, on Great Slave Lake, sometimes from S. Theresa, on Great Bear Lake, sometimes from Notre Dame de Bonne Espérance on the Mackenzie, points many hundreds of miles asunder, he has, on foot or in canoe, often accompanied only by Indians or Esquimaux, again and again traversed that desolate country in every direction. He has passed four winters and a summer on Great Bear Lake, and explored every part of it. He has navigated the Mackenzie ten times between Great Slave Lake and Fort Good Hope, and eight times between the latter post and its mouth. We owe to his visits in 1870 the disentanglement of a confusion which existed between the mouth of the Peel River (R. Plumée) and those of the Mackenzie, owing to their uniting in one delta, the explanation of the so-called Esquimaux Lake, which, as Richardson conjectured, has no existence, and the delineation of the course of three large rivers which fall into the Polar Sea in that neighborhood, the 'Anderson,' discovered by Mr. MacFarlane, in 1859, a river named by himself the Macfarlane, and another he has called the Roncière. Sir John Richardson was aware of the existence of the second of these, and erroneously supposed it to be the 'Toothless Fish,' River of the Hare Indians (Beg-hui-la on his map). M. Petitot has also traced and sketched in several lakes and chains of lakes, which support his opinion that this region is partaking of that operation of elevation which extends to Hudson's Bay. He found the wild granite basin of one of these dried up, and discovered in it, yawning and terrible, the huge funnel opening by which the waters had been drawn into one of the many subterranean channels which the Indians believe to exist here.

"These geographical discoveries are but a small part of l'Abbé Petitot's services. His intimate knowledge of the languages of the Northern Indians has enabled him to rectify the names given by previous travellers, and to interpret those descriptive appellations of the natives, which are often so full of significance. He has profoundly studied their ethnology and tribal relations, and he has added greatly to our knowledge of the geology of this region.

"It is, however, much to be regretted that this excellent traveller was provided with no instruments except a pocket watch and a compass, which latter is a somewhat fallacious guide in a region where the declination varies betwen 35° and 58°. His method has been to work in the details brought within his personal knowledge, or well attested by native information, on the basis of Franklin's charts.

"M. Petitot expresses his persuasion that the district of Mackenzie river can never be colonized—a conclusion no one who has visited it will be disposed to dispute; but he omits to point out that the mouth of that river is about 700 miles nearer the port of Victoria, in British Columbia, than the mouth of the Lena is to Yokohama, and far more accessible. It needs no Nordenskiold to show the way. Its upper waters, the Liard, Peace, Elk, and Athabasca rivers, drain an enormous extent of fertile country, not without coal or lignite, and with petroleum in abundance. As the geological survey has not yet been extended so far, we are not fully acquainted with its mineral resources; but I can add my testimony to that of more recent travellers, as to the remarkable apparent fertility, and the exceptional climate of the Peace River valley. It is no extravagant dream that sees in a distant future the beneficent influence of commerce, reaching by this great natural channel, races of mankind, in a high degree susceptible to them; and alleviating what appears to us to be the misery of their lot.

"There are few subjects of greater physical interest, or which have received less investigation, than the extent to which the soil of our planet is now permanently frozen round the North Pole. Erman, on theoretical grounds, affirms that the ground at Yakutsk is frozen to a depth of 630 feet. At 50 feet below the surface it had a temperature of 28°.5 F. (—6° R.), and was barely up to the freezing point at 382 feet. It is very different on the American continent. The rare opportunity was afforded me, by a landslip on a large scale, in May 1844, of observing its entire thickness, near Fort Norman, on Mackenzie river, about 200 miles further north than Yakutsk, and it was only 45 feet. At York Factory and Hudson's Bay it is said to be about 23 feet. The recent extension of settlement in Manitoba has led to wells being sunk in many directions, establishing the fact that the permanently frozen stratum does not extend so far as that region, notwithstanding an opinion to the contrary of the late Sir George Simpson. Probably it does not cross Churchill river, for I was assured that there is none at Lake à la Crosse. It depends, in some measure, on exposure. In the neighborhood of high river banks, radiating their heat in two directions, and in situations not reached by the sun, the frost runs much deeper than in the open. The question, however, to which Sir John Richardson called attention so long ago as 1839, is well deserving of systematic enquiry, and may even throw some light on the profoundly interesting subject of a geographical change in the position of the earth's axis of rotation. Indeed, Dr. Haughton has actually, on other grounds, assigned a position in the neighbourhood of Yakutsk to the pole of the earth in Miocene times.

"The Saskatchewan was first navigated by steam in 1875, when a vessel of about 200 tons ascended from the Grand Rapid to Edmonton, 700 miles. There is, however, an obstacle at Cole's Falls, below Carlton House, which has led to a break of navigation, and a small steel steamer, originally intended for the Upper Athabasca, has recently been transferred to the Upper Saskatchewan; between the two, it is now navigated from the Grand Rapids, near Lake Winnipeg, to the base of the Rocky Mountains. A steamer also plies regularly on Lake Winnipeg, and has ascertained many interesting particulars, of which we have hitherto been ignorant. Its greatest depth apparently does not exceed 100 feet. Its discharge has at last been followed by Dr. Robert Bell, down the Nelson river, to the sea. That gentleman reports the impediments to navigation to be insuperable, and a company has been very recently formed to make a railway from the lowest navigable point to the mouth of the Churchill river.

"Our hopes of further light upon the history of the ill-fated Franklin expedition, based on information given by a Netchelli Esquimaux, to the American Captain Potter in 1872, have been again disappointed. An American search expedition landed at Depôt Island, (lat. 64°,) in the neighbourhood of which traces were reported, in August 1878, wintered there, and examined the country, as yet with no result, except a correction of the charts.

"Hudson's Bay itself cannot fail at no distant day to challenge more attention. Dr. Bell reports that the land is rising at the rate of 5 to 10 feet in a century, that is, possibly, an inch a year. Not however, on this account will the hydrographer notice it; but because the natural seaports of that vast interior now thrown open to settlement, Keewatin, Manitoba, and other provinces unborn, must be sought there. York Factory, which is nearer Liverpool than New York, has been happily called by Prof. H. Y. Hind, the Archangel of the West. The mouth of the Churchill, however, although somewhat further north, offers far superior natural advantages, and may more fitly challenge the title. It will undoubtedly be the future shipping port for the agricultural products of the vast north-west territory, and the route by which emigrants will enter the country.

"Before leaving this quarter I must allude to the praiseworthy efforts of some of the Western States, especially Nebraska and Minnesota, to encourage the planting on the great plains by premiums, in which they have been followed by our own Province of Manitoba. Many years must elapse before the full climatic effects can be realized, but in time they cannot be doubtful, and with the impending disappearance of the buffalo, will disappear much of that arid treeless region, embracing nearly 600,000 square miles, which he now wanders over, and assists to keep bare by so doing. On the other hand, the short-sighted and destructive habit of burning off the prairie grasses to promote a young growth, increases with settlement, and is chargeable with incredible mischief. These fires have the curious effect, when they extend into wooded regions, of helping to exterminate the more slow-growing and valuable descriptions of timber, and favouring the prevalence of the more worthless quick-growing kinds. But the Indians are even more chargeable with them than the whites, and the traveller encounters few more melancholy sights than a forest of charred and lifeless trunks extending over an area as large as a county, the fruit perhaps of a signal from one band to another."

GEOLOGICAL NOTES OR ABSTRACTS OF RECENT PAPERS

By T. Sterry Hunt, LL.D., F.R.S.

I. THE TACONIC SYSTEM IN GEOLOGY.

(Abstract of a paper read before the National Academy of Sciences at Washington, April 18, 1880.)

The existence of a series of stratified rocks in the Appalachian Valley, intermediate in age between the older crystalline or Primitive schists and the Palæozoic rocks of the New York system, was taught by Eaton and maintained by Emmons, whose

Taconic system, as first proposed, was later declared by him to consist of an upper division, which he referred to the horizon of the Calciferous sandrock of the New York system, and a lower division, the proper Taconic. In this latter were included a great group of quartzites, limestones, and soft crystalline schists, which have since, by different geologists, been assigned to not less than three distinct horizons in the New York system. The grounds of those contradictory opinions have been supposed stratigraphical relations, and also the apparent association with the Taconic limestones of organic remains belonging to these various horizons.

In localities away from the disturbed regions of the Appalachian Valley there exists a series of rocks, occupying the position assigned by Emmons to his Lower Taconic, and agreeing with this in its essential characters. Such a series is found to the north-west of the Appalachian region, a little to the north of Lake Ontario, where it rests upon schists like those of the Green Mountains, and is unconformably overlaid by the Trenton limestone and totally distinct from the lower members of the New York system in the adjoining region. Another locality is to the south-east of the Atlantic belt, in southern New Brunswick, where a similar series of several thousand feet of limestone, quartzites, and schists occupies a position inferior to the fossiliferous Cambrian (Menevian). In both of these localities the rocks in question correspond closely in volume and in mineralogical characters to the Lower Taconic rocks of the Appalachian Valley, with which the speaker believed them to be identical.

Again Mr. W. O. Crosby has lately described a similar series in the island of Trinidad, resting on the ancient crystalline rocks, and overlaid unconformably by limestones of Trenton age. We have thus abundant evidence of a great and wide-spread series of rocks, pre-Cambrian in age, and occupying the position assigned by Emmons to the Lower Taconic or Taconian system,—which, according to him, extends continuously along the Appalachian valley from Vermont to Alabama, and moreover occupies large areas to the south-east of the Blue Ridge, from Virginia to Georgia, constituting, in South Carolina, the Itacolumite series of Lieber.

Within the vast region occupied by these rocks in the great valley have been found a few small areas of fossiliferous strata, belonging chiefly to the Ordovian (Siluro-Cambrian) or to the

Cambrian series; but the characters of the great mass of these rocks are such as to lead to the conclusion that they constitute, as maintained by Emmons, a more ancient series.

To the Taconian rocks belong the peculiar magnetic iron ores found at Reading, Cornwall, and Dillsburg, Penn., which have been by some geologists regarded as Mesozoic, but were by Rogers assigned to the base of the Palæozoic. To this same series belong the limonites of the great Valley, which occur in clays derived from the sub-aërial decay of the rocks. These, in their unchanged condition, contain beds and masses of siderite and pyrites, and the alteration of these *in situ* has given rise to the limonites. In the formation of this from the siderite, or iron-carbonate, it was pointed out by the speaker that there is a contraction of volume equal to about 20 per cent.; to which is due the cellular character of the limonites and their frequent occurrence in the form of geodes.

These older rocks are not without traces of organic life, having yielded in the Appalachian Valley the original *Scolithus* and related markings, besides obscure *Brachiopods*; and in Ontario, besides similar Scolithus-like markings, a form apparently identical with the *Eozoon* of the more ancient gneisses. We may hope to find in the Taconian series a fauna which shall help to fill the wide interval that now divides that of the Eozoic rocks from the Cambrian. We should seek in the study of stratigraphical geology not the breaks dividing groups from each other, so much as the beds of passage which serve to unite all these groups in one great system, remembering that there is no local hiatus which is not somewhere filled up by the continuous process of nature.

II. THE GENESIS OF CERTAIN IRON ORES.

(Abstract of a paper read before the American Association for the Advancement of Science at Boston, August 28, 1880.)

Dr. Hunt began by considering the presence of iron, generally in a ferrous condition, in mineral silicates in the crystalline rocks, and its liberation therefrom by the sub-aërial decay of these, as hydrous ferric oxide. This, as is well known, is, by the agency of organic matter, again reduced to ferrous oxide, which is dissolved in natural waters by carbonic acid, from which solutions it may be deposited either as hydrous peroxide (limonite, etc.,) as carbonate (siderite), as silicate, or as sulphide (pyrite, etc.), in all of which forms iron is found in sedimentary deposits. As regards the formation of siderite, he described experiments which show that solutions holding five grammes of ferrous carbonate dissolved as di-carbonate in a litre of water, are spontaneously decomposed in close vessels at the ordinary temperature, and deposit two-thirds of their iron as a white crystalline (hydrated) mono-carbonate, with liberation of carbonic-dioxide. This serves to render more intelligible the reduction and segregation of iron as siderite in earthy sediments, as long since pointed out by W. B. Rogers, for the ores of the coal-measures.

The intervention of the soluble sulphates, and their reduction through organic agency to sulphides, determines the formation of sulphide of iron in sediments. The generation of a bi-sulphide (pyrite or marcasite) was then discussed, and it was shown that the ferrous mono-sulphide, which naturally is first generated, may fix a further portion of sulphur, and thus form a more stable compound. One example of this is seen when recently precipitated hydrous ferrous sulphide is brought in contact with a solution of a ferric salt, which takes up a portion of the iron, leaving sulphur free to unite with the undecomposed sulphide, and form therewith a very stable higher sulphide of iron. Experiments now in progress lead the writer to believe that sulphur liberated from soluble sulphides may, in a similar manner, unite with ferrous sulphide, and thus help us to explain the generation of pyrites in nature, in the presence of water, at ordinary temperatures.

The changes of siderite and pyrite under atmospheric influences were next considered. The latter by oxidation yields, as is well known, ferrous sulphate. Its frequent conversion by sub-ærial decay into limonite was conceived to be due to the intervention of water holding carbonates, which conjointly with oxygen, changes it into hydrous peroxide (limonite), which latter often retains the form of the pyrites. The transformation of carbonate of iron into hydrous peroxide is a familiar fact.

Limonite ores may thus be produced in three ways. They are sometimes formed by the peroxidation and precipitation of dissolved salts, as in the so-called bog-ores; but more frequently from the alteration *in situ* of deposits of pyrite or siderite. Such as these are the limonites which mark the outcrops of beds or veins of pyrites in the decayed crystalline rocks of the Blue Ridge. The similar ores found in the decayed Taconic schists of the great Appalachian valley can be shown to be due in some cases to the alteration of included masses of pyrites, and in others to the alteration of similar masses of siderite, both of which species are found in the unaltered Taconic rocks, as, indeed, at various other horizons in the geological series.

If we take the specific gravity of pyrites at 5.0, we shall find that its complete conversion into a limonite of sp. gr. 4.0 would be attended with a contraction of only 2.7 hundredths, while if the limonite have a sp. gr. of 3.6, there would be an augmentation of 10.7 p. c. With siderite of sp. gr. 3.6, on the contrary, its conversion into a limonite of the same density would result in a contraction of 19.5 p. c., and into a limonite of sp. gr. 4.0, in a contraction of 27.5 p. c. The evidences of this contraction may be seen in the structure of the limonite derived from siderite, which is often found a porous or spongy mass. In the case, however, of nodules or blocks of very compact ore, the conversion beginning at the outside of the mass, an external layer of compact limonite is formed, and then another within this, and still another, till the change is complete. The void space resulting from contraction is then found between the layers, which are arranged like the coats of an onion, or sometimes wholly at the centre, where a cavity will be formed, holding in many cases, more or less clay or sand, the impurites of carbonate which have been separated in the process of conversion into limonite. In this way are formed the hollow masses sometimes known as bomb-shell ore. Their structure will generally serve to distinguish the sideritic from the pyritic limonites.

These differences were illustrated in the history of various iron-ores in the Applachian valley, and it was further pointed out that the pyritic limonites, other circumstances being equal, should be freer from phosphorus than those derived from siderite, since the native carbonates almost always contain phosphates, from which pyritous deposits are comparatively free. The source of limonites thus becomes a question of importance to the metallurgist. In conclusion, it was pointed out that deposits of manganese-ores are, in some cases at least, generated by the alteration *in situ* of manganous carbonates, by a process analogous to that by which limonite is produced from siderite.

III. ON THE ORIGIN OF ANTHRACITE.

(Read before the National Academy of Sciences, N. Y., 1880.)

From comparative studies of carbonaceous minerals as long ago as 1861, the author reached the conclusion that petroleum and anthracite form the extremes of a series, all of which may have been derived from organic matters by natural processes at ordinary temperatures.*

To this is opposed the ordinary view that anthracite, on the one hand, and petroleum, on the other, result from the action of heat on matters of intermediate composition;—the one being a distillate, and the other a residuum. Late geological studies, however, show that such an hypothesis is untenable for petroleum, and the author, while not denying that a local coking of bituminous coals must naturally result from the proximity of igneous rocks, has long taught that it is equally so for our anthracite fields. The prevalent notion has hitherto been that the differences between these and the bituminous coals farther west are in some way connected with the mechanical disturbance of the strata in the former region; but to this is opposed the fact that, while the undisturbed coals of Arkansas are anthracitic, the highly disturbed coals of north-eastern America, Belgium and other regions are bituminous.

These considerations I have for many years presented to my classes in geology, and have maintained that the change which results in the conversion of organic matters into anthracite was effected before the disturbance of the strata; that the hydrogen was removed, as in ordinary vegetable decay, in the forms of water and marsh-gas; and that differences in aëration, during the processes of change and consolidation of the carboniferous vegetation, are adequate to explain the chemical differences between anthracitic and bituminous coals. Bischof had already enunciated a similar view.

Prof. J. P. Lesley, to whom I have explained my views, has pointed out that there is an apparent connection in the great Appalachian coal-basin, between the more or less arenaceous and permeable nature of the enclosing sediments and the more or less complete anthracitic character of the coal; while Principal Dawson informs me that he has observed similar facts in the coal-measures

* Canadian Naturalist, July, 1861, and Report Smithsonian Institution for 1862; also Chem. and Geol. Essays, p. 177.

of north-eastern America. Inquiries which promise to throw farther light on this question are in progress, and the present note to the Academy is to be considered as only preliminary to a further discussion of the subject.

IV. ON THE RECENT FORMATION OF QUARTZ AND ON SILICIFICATION IN CALIFORNIA.*

(From the American Journal of Science, Vol. xix, May, 1880.)

At the meeting of the American Institute of Mining Engineers in New York, Feb. 18, 1880, Prof. George W. Maynard exhibited a remarkable specimen lately obtained by him from the mines of the Gold Run Hydraulic Co. at Dutch Flat in California. It consisted of a mass of milky vitreous quartz, in which a recent fracture had disclosed an imbedded fragment, about half an inch in diameter, of the characteristic so-called *blue gravel* of the region, holding in its paste a worn and rounded piece of gold of several grains' weight. Portions of a similar blue gravel adhered closely to certain parts of the mass of quartz. Remarks were made on this specimen by Professors Silliman and Egleston, and by Dr. T. Sterry Hunt, all of whom, after examination of it, were satisfied of the correctness of the opinion expressed by Professor Maynard, that the quartz had made part of a vein formed in the auriferous gravel subsequent to the solidification of the latter.

Dr. Hunt, in commenting on this occurrence, remarked that it is in accordance with what we already know of the recency of some of the quartz of this region, and cited the microscopic

* This communication had been printed and revised before the writer had seen Professor Joseph LeConte's paper on the Old River Beds of California, in the March number of the American Journal of Science, where (on pages 179-181) he has so well described the auriferous gravels here referred to, and pointed out the true relations between the blue gravel and the upper and altered portions of the deposit. As regards the process of silicification, it is not, I think, necessary to suppose the infiltration of alkaline waters from the overlying volcanic rock in order to explain the solution of the silica. As elsewhere pointed out by the writer, the removal of the silica in a soluble form from the silicates which make up a large part of the gravel itself, does not require the intervention of alkalies.

I hope soon to continue the discussion of this problem, which is one of the most important in the whole domain of what I venture to call *mineral physiology*.

studies of John Arthur Phillips, who has shown that a great part of the silicious deposit from certain thermal waters of Lake County, California, and from the Steamboat Springs of Washoe County, Nevada, is of the nature of crystalline quartz.

[Mr. Phillips has, since the first printing of this note, informed the writer in a private note, of the existence of beautiful crystals of quartz which had grown in a cavity found at the meeting of small fissures in the auriferous *blue gravel*, near Washington, Nevada County, California.]

Dr. Hunt then gave an account of some observations made by him at the Blue Tent placer mine, in Nevada County, California, in 1877, showing that the process of depositing quartz is there going on in the auriferous gravel of the region, independent of thermal waters, and is connected with the sub-aërial decay of the silicates in the gravel, which is here made up in great part of the *débris* of the crystalline Huronian schists of the region, including much greenstone or diorite-rock. The gravel below the drainage-level is greenish or bluish in color, and contains disseminated pyrites, together with trunks of trees in the condition of lignite, while the feldspar, and hornblende of the greenstone are undecayed.

Above the drainage-level, however, these silicates are more or less decomposed, the greenstone-pebbles becoming earthy in texture, rusty in color, and exfoliating, and the accompanying pyrites oxidized. The lignite is at the same time more or less completely silicified, being sometimes converted into agatized masses, often with drusy cavities lined with quartz-crystals, and at other times only penetrated or injected with silicious matter, which has filled the pores of the exogenous wood, the vegetable tissue of which still remains, often incrusted with crystals of quartz. In still other cases, a slow subsequent decay of the tissue, in coniferous woods, has left these silicious casts in the form of bundles of fibres, which have been mistaken for asbestus. The various specimens from this locality illustrate perfectly the theory of silicification of vegetable structures set forth by the speaker in 1864,* based on his own microscopic studies conjoined with those of Göppert and of Dawson. The silica by which the tissues are thus successively filled and replaced is, according to the speaker, that which is set free in a soluble form by the decay of the sili-

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* See Can. Naturalist, New Series, vol. i, p. 56; also Hunt's Chem. and Geol. Essays, p. 286.

cates in the gravel. The lignite, in the undecomposed and unoxidized portions of this which lie below drainage-level is, as yet unsilicified. Dr. Hunt acknowledged his obligations to Mr. D. T. Hughes, a memberof the Institute of Mining Engineers, in charge of the mine in question, and a skilled and careful observer, who had called his attention to the facts just set forth.

Professor W. C. Kerr stated that his recent and as yet unpublished observations on the fossil woods found in ancient gravels in North Carolina were in accordance with those described by Dr. Hunt.

A PECULIAR MINERAL OF THE SCAPOLITE FAMILY.*

By Chas. Upham Shepard.

The substance here described was sent to me by that zealous mineralogist, Mr. John G. Miller, of East Templeton, Ottawa County, Canada. It occurs in the bluish gray saccharine limestone of Galway, Province of Ontario, Canada. It had been referred with a query to chiastolite, which it certainly resembles in several respects. It presents itself in distinct and rather large crystals, thickly disseminated through the gangue, crossing each other in various directions. Their form is that of a right square prism, with truncated lateral edges. Their terminations are imperfect, and when well defined even, are still rough and drusy. They exhibit no combinations with the prismatic planes. The usual habit of the crystals is distinctly quadrangular, though in the larger individuals they are octangular, having their sides about equally produced. Their length is many times their thickness; and they are uniformly straight and sharply defined. The largest have a diameter of an inch, the smallest are rarely below one-eighth of this size. They preserve the same diameter throughout their length, with the exception of a single example, where one of the larger size, shows a tendency to a regular acumination. The length of this crystal is 3½ inches, its diameter at the largest extremity being half an inch, and at the smaller, but one-third. All the crystals have much evenness of surface and considerable smoothness, notwithstanding a slight degree of

* From the *American Journal of Science*, Vol. XX, July, 1880.

pitting or indentation, which almost requires a microscope for observation. They are without striation. The color is black, with a slight intermixture of gray and blue. In a few instances an area of cyanite-blue occupies a face of the larger crystals, but only to a slight depth from the surface. This part of the crystal is semi-transparent; while for the rest, the entire mineral is dark ash gray to bluish black, and only translucent on the edges. The vertical cleavages, parallel with the primary prism, parallel with the narrower planes in the quadrangular prisms. Only traces of a transverse cleavage exist. A marked peculiarity of the larger crystals is the regular interlamination of thin films of white calcite, parallel with the eight sides of the prism. These layers, to the number of two or three, are equi-distant, thus imparting to the fractured ends of the crystals a checkered aspect, strongly suggesting the structure of chiastolite.* Luster, resinous to vitreous. Hardness = 7· . . . 7·5. Specific gravity, 2.608.

A very striking peculiarity of the mineral is the extremely fetid odor occasioned by its fracture; nor does this cease to be emitted until the fragments are reduced to an impalpable powder. The color of the powder is a bluish ash gray. It cannot be regarded as a hydrated mineral, as its content of water does not exceed 1·6 p. c. By exposure, however, to full ignition in a shallow platinum dish for several hours, it loses 4·6 p. c., this loss proceeding from the presence of organic matter, graphite, and carbonic acid from the decomposition of carbonate of lime. The powder still partially retains its grayish tint after long ignition; and it is only before the blowpipe that the portion most strongly heated loses its color. The thinnest part then undergoes fusion, attended by a feeble ebulition, into a colorless transparent glass.

Owing to the variable presence of graphite, calcite and quartz, the chemical examination is attended with uncertainty. The SiO_2 varied from 48·65 to 51·30; the Al_2O_3 from 13·45 to 19·62; the CaO from 17·43 to 21·6, and the TiO_2 from 4·35

* Prof. E. S. Dana has kindly made a section of one of the crystals, and examined it in polarized light. He finds "the black color to be due to foreign matter, present in the form of minute grains that seem to be metallic, making up no small part of the whole," and is of opinion that "its analysis is not a guide to the real composition of the mineral."

to 5·21. In a single trial, NaO 4·35, and KO 1·109, MgO 0·468 were obtained. The powder is very feebly acted upon by the strong acids.

From the foregoing it would appear that the mineral differs chemically from normal scapolite, and especially from the vitreous couseranite of Saleix (Pyrenees) analyzed by Pisani; though it must be kept in mind that the example analyzed by him, had been so much altered as to have its hardness reduced to 3. I am therefore led to regard the Galway crystals as the original, unaltered mineral, from which couseranite and dipyre have originated through hydration,† in the same manner as scapolite has given rise to wilsonite, huntite, algerite and terénite. Should it prove a new species, I propose to call it *Ontariolite.*

PROCEEDINGS NATURAL HISTORY SOCIETY OF MONTREAL.

The first regular meeting for the session 1880-81 was held in the Society's Rooms on the evening of Monday October 25th. Principal Dawson occupied the chair. Thomas Branierd, Esq. of the Hamilton Powder Co. was nominated for election as an ordinary member. Henry Montgomery Esq. Toronto and Rev. Charles Rogers, LL.D., London, Eng., were nominated for corresponding members.

The deputation to the American Association for the Advancement of Science, reported that they had attended the meeting of this body in Boston, in August last, and presented the invitation of this Society together with the resolutions of the Corporation of McGill University, the Council of Arts and Manufactures and the Medico Chirurgical Society; that the invitation was favorably received by the nominating committee and the general meeting, and that the two resolutions were introduced by the committee and unanimously and most cordially passed by the Association—the first resolution expressing thanks for the invitation, and the second recommending it to the favorable consideration of the next meeting's committee. This was as far as the Association could proceed in accordance with its constitution, which does not per-

† Possibly chiastolite may have been similarly produced, though the origin must have been attended with a more radical metamorphism.

mit the arrangement of meetings more than a year in advance. It was considered, however, as virtually pledging the American Association to accept the invitation, provided it be renewed at the meeting to be held in Cincinnati next year. The Committee ask that it be continued, with power to add to its numbers, and be authorized to correspond with men of science, abroad or otherwise, to prepare for a meeting of the Association in Montreal in 1882. Further, that this report be communicated to the other bodies which joined in the invitation.

The report was unanimously adopted.

Mr. WHITEAVES, then read a paper on "Some new and remarkable fossil fishes from the Devonian rocks of the northern side of the Baie des Chaleurs." He commenced by remarking that until last year a long strip of the northern side of the bay had been mapped as belonging to the conglomerates of the Bonaventure formation, which form the base of the Carboniferous system. Last year, however, Mr. R. W. Ells, of the Geological Survey, discovered a fine specimen of a fossil fish belonging to the genus *Pterichthys*, of Agassiz, in Escuminac Bay, a discovery which led to a careful re-examination of the locality by Messrs. R. W. Ells, T. C. Weston and A. H. Foord. From the researches of these gentlemen, we now know that at this point Devonian rocks crop out from under the Bonaventure conglomerates, and further, that these Devonian rocks hold a rich and extremely interesting series of fossil plants and fishes. The vegetable organisms will be described by Principal Dawson at some future time. but the fossil fishes, of which many specimens were exhibited at the meeting, were shown to belong to the following genera and species:—1. *Pterichthys*. A fine species, supposed to be new, which has been described in the August number of the *American Journal of Science* as *Pterichthys Canadensis*. It is very closely allied to a fossil fish found in the Old Red sandstone of Scotland and Russia, and is the first species of this remarkable genus yet found in America. 2. *Diplacanthus*. A cluster of fin rays only, of a small form, possibly referable to this genus. 3. *Cheirolepis*. A beautifully preserved fossil fish, about a foot in length, which cannot at present be distinguished from the *Cheirolepis cumingiæ* of Agassiz, which was so named in honour of Lady Gordon Cuming, of Altyre. 4. *Phaneropleuron*, nov. sp. 5. *Tristichoporus*, nov. sp. 6. Portion of the vertebral column of the above species of *Tristichoporus* shewing the neural and hæmal spines and the processes which support the rays of the tail, also the two ischiatic bones with the metatarsals attached, which must have formed the bases of two enormously developed ventral fins.

The structural characters of the different specimens exhibited were described and explained at some length.

Mr. McFarlane asked whether these fishes were air breathing animals, whether atmospheric oxygen was essential to their existence.

Mr. Whiteaves replied that the inference was they breathed through their gills like ordinary fishes. Of course only the hard parts had been preserved and there was nothing to show they had gills.

The Chairman said whatever opinion might be entertained of the theory, there must no doubt have been sufficient oxygen in the air for animal life, since butterflies were found in periods before the Carboniferous. There was nothing to prove that these fishes had not a rudimentary lung through which they inhaled oxygen like reptiles, as well as through the gills. He expressed the great obligations the Society were under to Mr. Whiteaves for his excellent paper, and stated that the specimens were a feather in the cap of the Geological Survey, being on a par with the fishes discovered in the Old Red sandstone of Scotland.

The Secretary moved a vote of thanks to Mr. Whiteaves, which was unanimously adopted.

Fifteen specimens were exhibited, all of which, with one exception, were discovered by Messrs. Foord and Ells. Several lithographs illustrative of the subject were also shown.

The following donations to the Museum were upon the table:

1. Apatite Crystal from Bob's Lake, Bedford, Ont., presented by W. J. Morris, Esq.

2. Moss coated with mineral matter from Colorado, presented by Dr. Kennedy.

3. Collection of English Plants, by Col. G. E. Bulger, F.L.S., F.Z.S.

4. A fine *Limulus polyphemus*, from Miss E. Mathewson.

The second meeting was held on Monday 29th November. The President in the chair. The Secretary read minutes of last meeting, and announced that arrangements had been made for the Sommerville lectures.

Messrs. Thomas Brainerd, Henry Montgomery, M.A., and Rev. Charles Rogers, LL.D., were elected members of the Society (the last two corresponding members).

Mr. Wm. Muir then read the Cabinet Keeper's report, which will be found under the head of Miscellaneous Articles.

Mr. J. T. Donald next read a paper on "Baking Powders and their Adulterants."

Drs. T. Sterry Hunt and Harrington made some remarks on the subject, the former expressing his great satisfaction with a Baking Powder in which the acid substance was "Biphosphate of Lime."

Mr. A. R. C. Selwyn, F.G.S., exhibited a very fine series of fossil leaves from the Lignite Tertiary of the Souris River, Manitoba.

Principal Dawson presented some "Notes" on this collection, an abstract of which will be found among our Miscellaneous Articles.

REPORT OF CABINET-KEEPER OF THE NATURAL HISTORY SOCIETY OF MONTREAL.

By Wm. Muir, Esq.

The following is the report of work done on the building and in the Museum from May 1st to December 1st 1880:

I. Work on the Building.—On the left hand side of the Entrance Hall, a convenient store-room has been added, the ceiling of which gives a floor suitable for the accommodation of several specimens formerly in the Museum.

The side entrance has been enclosed by a ceiling and partition, forming an inside porch and adding greatly to the comfort of the place in winter; and the head of the rear stairway leading up to the gallery has been floored over, increasing the accommodation afforded by the gallery.

Eleven windows have been put in on three sides of the gallery, increasing its cheerfulness and light; curtains have also been placed on the skylights.

The whole of the large wall cases in the main room, 27 in number, have been cleaned and painted, and the shelves made narrower and better adapted to show the specimens thereon.

The Gallery (north and south side fronts) has been raised, levelled and supported.

II. WORK IN THE MUSEUM.—The whole of the birds (1194 in all!), the mammals, reptiles and fishes have been thoroughly dusted and cleaned. The birds have been remounted on handsome black walnut stands and painted blocks, and the old soiled labels replaced by new ones; the fishes have been removed to the aquarium room, and the mammals rearranged and put in the space thus left vacant.

The whale, two of the alligators and the large seal have been removed to the floor covering the store-room to the left of the main entrance hall; and the floor-cases, formerly in the aquarium room, have been brought into the main room.

The following is a list of birds which were found to be so much injured that they were destroyed :

Grass Finch, *Pooecetes gramineus.*
Purple Martin, *Progne purpurea.*
Red-shouldered Hawk, *Buteo lineatus.*
Lesser Red Poll, *Ægiothus linaria.*
Common Crow, *Corvus americanus.*
Yellow-throated Fly Catcher, *Vireo flavifrons.*
Cat Bird, *Galeoscoptes carolinensis.*
Brown Thrush, *Harporhynchus rufus.*
Red-eyed Fly Catcher, *Vireo olivaceus.*
Sparrow Hawk, *Tinnunculus sparverius.*
Shore Lark, *Eremophila cornuta.*
Satin Grakle (female)—*Kitta holosericea.*
Great Northern Shrike (old male), *Collyrio borealis.*
" " " (female), " "
Diphyllodes magnifica—New Guinea. J. F. W.

Additions to the Museum since June 1st 1880.

Donations, with names of donors.

Grey Squirrel, *Sciurus carolinensis.* N. P. Leach, Esqr.
Albino Robin, *Turdus migratorius.* "
Barred Owl, *Syrnium nebulosum.* J. A. Ogilvy, Esqr.
Great Blue Heron, *Ardea herodias.* Geo. Edwards, Esqr.,of Thurso.
Barred Owl, *Syrnium nebulosum.* Jno. Nichols, Esqr.
Horned Grebe, *Podiceps cornutus.* "
Two Blue Jays, *Cyanura cristata.* G. L. Marler, Esqr.
A Remora or Sucking Fish. Geo. F. Phelps, Esqr.
Head of a Male Salmon. Robt. J. Fowler, Esqr.
A box made out of a plank from the Royal George. Captain Dutton, of SS. Sardinian.
A lock of Grace Darling's Hair. Capt. Dutton.
Moss Coated with mineral matter, from Colorado. Dr. Kennedy.
Apatite Crystal from Bob's Lake, Bedford, Ont. W. J. Morris., Esqr.
Collection of English Plants. Col. Bulger. F.R.Z.S., F.L.S.
Limulus polyphemus. Miss E. Mathewson.

The Remora or sucking fish mentioned above has the top of the head flattened and occupied by a laminated disk. composed of numerous transverse cartilaginous plates, the edges of which are spiny and directed obliquely backwards. By means of this apparatus these fishes are able to attach themselves to ships, larger fishes, etc.

The natives of the Mozambique coast make use of a larger species in catching turtles. By means of a ring a rope is attached to the tail of the Remora, and it is thrown into the sea. In endeavoring to escape, it attaches itself to the nearest turtle, when both are drawn ashore together.

Purchases:

Belted Kingfisher, *Ceryle alcyon.*
Coot, *Fulica americana.*
Baltimore Oriole, *Icterus baltimore.*
Sparrow Hawk, *Tinnunculus sparverius.*
Shore Lark, *Eremophila cornuta.*
Loggerhead Shrike (male and female), *Collyrio ludovicianus.*
Bonaparte Gull (young), *Larus philadelphia.*
Two Black-bellied Plovers. *Squatarola helvetica.*
Racoon (old female), *Procyon lotor.*
" (young) " "
Mink, *Putorius vison.*

Subjoined is a list of skins that have been mounted. The first three lots are from the number presented, on a former occasion, by the Smithsonian Institute; the others, from the Society's ordinary collection:

California Grey Squirrel, *Sciurus fossor.*
Thirteen-striped Squirrel (2 specimens), *Spermophilus tridecem-lineatus.*
Seven Mice.
Black-throated Blue Warbler, *Dendroica canadensis.*
" " Green " *Dendroica virens.*
Yellow Bird (female), *Chrysomitris Tristis.*
Blue Bird (young), *Sialia sialis.*
Wild Pigeon, *Ectopistes migratoria.*

The Taxidermist is at present engaged mounting the following skins:

Loon, *Colymbus torquatus.*
Spruce Partridge, *Tetrao canadensis.*
Goshawk, *Astur atricapillus.*
Black Woodpecker, *Picoides arcticus.*
Hooded Merganser, *Lophodytes cucullatus.*
Wild Geese (2), *Bernicla leucopareia.*

Brant Goose, *Bernicla brenta.*
American White-footed Goose, *Anser albatus.*
Goshawk (old), *Astur atricapillus.*
Horned Grebe, *Podiceps cornutus.*
Weasel, *Putorius vulgaris.*

Submitted to the Natural History Society, Nov. 29, 1880.

MISCELLANEOUS.

Sketch of the Geology of British Columbia.* By George M. Dawson, D.S., A.R.S.M., F.G.S.—British Columbia includes a certain portion of the length of the Cordillera region of the west coast of America which may be described as consisting here of four parallel mountain ranges running in a north-west and south-east bearing. Of these the south-western is represented by Vancouver and the Queen Charlotte Islands, and may be referred to as the Vancouver Range; while the next, to the north-east, is the Coast or Cascade Range, a belt of mountainous country about 100 miles in width. This is succeeded by the interior plateau of British Columbia, relatively a depressed area, but with a height of 3000 to 3500 feet. To the north-east of this is the Gold Range, and beyond this the Rocky Mountains proper, forming the western margin of the great plains of the interior of the continent.

Tertiary rocks, which are probably of Miocene age, are found both on the coast and on the interior plateau. They consist on the coast of marine beds, generally littoral in character, which are capped, in the Queen Charlotte Islands, by volcanic rocks. The interior plateau has been a fresh-water lake, in or on the margin of which, clays and sandstones, with occasional lignites, have been laid down. These are covered by very extensive volcanic accumulations, basaltic or tufaceous.

Cretaceous rocks from the age of the Upper and Lower Chalk to the Upper Neocomian, and representing the Chico and Shasta groups of California, occur on Vancouver and the Queen Charlotte Islands. Beds equivalent to the Chico group yield the bituminous coals of Nanaimo, while anthracite occurs in the somewhat

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* Abstract of paper read before the British Association for the Advancement of Science at Swansea, August 1880.

older beds of the Queen Charlotte Islands. Within the Coast Range the Cretaceous rocks are probably for the most part equivalent in age to the Upper Neecomian. The Cretaceous rocks are of great thickness, both on the coast and inland, and include extensive contemporaneous volcanic beds.

The Pre-Cretaceous beds have been much disturbed and altered before the deposition of the Cretaceous, and their investigation is difficult. On Vancouver Island, beds probably Carboniferous in age include great masses of contemporaneous volcanic material, with limestones, and become altered to highly crystalline rocks resembling those of parts of the Huronian of Eastern Canada. In the Queen Charlotte Islands these beds also probably occur, but an extensive calcareous argillite formation is there found, which is characterised by its fossils as Triassic.

The Coast Range is supposed to be built up chiefly of rocks like those of Vancouver Island, but still more highly altered, and appearing as gneisses, mica-schists, &c., while a persistent argillaceous and slaty zone is supposed to represent the Triassic argillites of the Queen Charlotte Islands.

The older rocks of the interior plateau are largely composed of quartzites and limestones; but still hold much contemporaneous volcanic matter, together with serpentine. Carboniferous fossils have been found in the limestones in a number of places. The Triassic is also represented in some places by great contemporaneous volcanic deposits with limestones.

In the Gold Range, the conditions found in the Coast Range are supposed to be repeated; but it is probable that there are here also extensive areas of Archæan rocks. Some small areas of ancient crystalline rocks supposed to be of this age have already been discovered.

The Rocky Mountain Range consists of limestones with quartzites and shaly beds, dolomites and red sandstones. The latter have been observed near the 49th parallel, and are supposed to be Triassic in age. The limestones are, for the most part, Carboniferous and Devonian, and no fossils have yet been discovered indicating a greater age than the last-named period. On the 49th parallel, however, the series is supposed to extend down to the Cambrian, and compares closely with the sections of the region east of the Wahsatch, on the 40th parallel, given by Clarence King. Volcanic material is still present in the Carboniferous rocks on the 49th parallel.

The oldest land has been that of the Gold Range, and the Carboniferous deposits laid down east and west of this barrier differ widely in character. The Carboniferous closed with a disturbance which shut the sea out from a great area east ofthe Gold Range, in which the red gypsiferous and saline beds of the Jura-trias were formed. In the Peace River region, however, marine Triassic beds are found on both sides of the Rocky Mountains.

A great disturbance, producing the Sierra Nevada and Vancouver ranges, closed the Triassic and Jurassic period. The shore line of the Pacific of the Cretaceous in British Columbia lay east of the Coast Range, and the sea communicated by the Peace River region with the Cretaceous Mediterranean of the great plains. The Coast Range and the Rocky Mountains are probably in great part due to a post-Cretaceous disturbance, though the last-named range existed before the Cretaceous period in the Peace River region.

No Eocene deposits have been found in the province. The Miocene of the interior plateau is probably homologous with King's Pah-Ute lake of the 40th parallel Miocene. In the Pliocene the country appears to have stood higher above the sea-level than at present, and during this time the fiords of the coast were probably worn out.

Abstract of Notes by Principal Dawson on Fossil Plants Collected by Mr. Selwyn, F.R.S., in the Lignite Tertiary Formation, at Roches Percées, Souris River, Manitoba.—The Lignite Tertiary Group of Manitoba and elsewhere in the Western Plains, rests immediately on the Upper Cretaceous, and holds extensive deposits of valuable Lignite, associated with shale and sandstone containing numerous remains of plants. This flora resembles very closely in its aspect that of the Miocene Tertiary of Europe, but its stratigraphical position and animal fossils seem to indicate that its actual age is greater than this. Various attempts have been made to subdivide it, and to separate portions of different ages; but, so far, there is reason to suspect that the subdivisions are merely local, and that the whole belongs to a period of transition between the Cretaceous and Tertiary ages.

Mr. Selwyn's specimens are remarkable for their good state of preservation, being enclosed in a hard arenaceous and ferruginous material, much better adapted to their preservation than the soft shales in which the fossils of this formation usually occur.

One of the most remarkable leaves in the collection is that of a magnificent *Platanus* or Sycamore, a foot or more in length and of proportionate width. It is identical with *P. Nobilis* of Newberry, from the Tertiary beds of Fort Clarke on the upper Missouri. Mr. Selwyn's specimens, which show the venation and margin very perfectly, justify Newberry's reference of the leaf to the genus *Platanus*. They also show, in one specimen, a feature not preserved in those previously found, namely the presence of two short basilar lobes extending backward on the petiole. Each of these is about an inch in length, pointed at the extremity, and with one large lateral tooth, and two nerves, one extending to the point, the other terminating in the tooth.

Another interesting leaf represents a species of *Sassafras*, a genus not hitherto found in our Lignite Tertiary, though represented in the Cretaceous and in modern times. The species has been dedicated to Mr. Selwyn, being apparently new. The collection also includes several Poplars, as *Populus arctica*, Heer, *P. cuneata*, Newberry, and *P. acerifolia*, Newberry, a Hazel and a chestnut-leaved Oak, apparently a new species. There are also some interesting coniferous trees, as *Sequoia Langsdorfii*, an ally of the giant trees of California, *Taxodium Occidentale*, of Newberry, and *Taxites Olriki* of Heer.

The flora indicated is, on the whole, similar to that of the Porcupine Creek group of Dr. G. M. Dawson's Report on the forty-ninth parallel, that of the Lignitic area of the Mackenzie River, described by Heer as Miocene, that of the Fort Union group of Newberry, and of the Carbon group of Lesquereux,—formations variously regarded as Eocene or Lower Miocene, and very widely distributed over the western plains.

These plants will be fully described in a forthcoming report of the Geological Survey, where their affinities and geological relations will be discussed.

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THE

CANADIAN NATURALIST

AND

Quarterly Journal of Science.

REVISION OF THE LAND SNAILS OF THE PALEOZOIC ERA, WITH DESCRIPTIONS OF NEW SPECIES.

By J. W. Dawson, LL.D., F.R.S.

(*From the American Journal of Science.*)

The Gasteropods as a class occur as early as the Upper Cambrian, but all the earlier known types are marine. That portion of the group distinguished by the possession of air sacs instead of gills (Pulmonifera) has not hitherto been found in any formation older than the Carboniferous, and only four Carboniferous species have been described. In the present paper I propose to state some additional facts respecting the species already known, to discuss their affinities, and to describe two additional species, making six in all from the Paleozoic rocks, including one from the Erian or Devonian. For reasons to be mentioned in the sequel, I do not admit the genus *Palæorbis* founded, by some German naturalists, on fossils which I believe to be tubes of Annelids.

It may be useful to premise that of the two leading subdivisions of the group of Pulmonifera, the Operculate and Inoperculate, the first has been traced no farther back than the Eocene. The second, or Inoperculate division, includes some genera that are aquatic and some that are terrestrial. Of the aquatic genera no representatives are known in formations older than the Wealden and Purbeck, and these only in Europe. The terrestrial group or the family of the *Helicidæ*, which, singularly enough, is that which diverges farthest from the ordinary gill-bearing Gasteropods, is the one which has been traced farthest back, and includes the Paleozoic species. It is further remarkable that a very great gap exists in the geological history of this family. No species are known between the Carboniferous and the early Tertiary, though in the intervening formations there are many fresh-water and estuarine deposits in which such remains might be expected to occur. There is perhaps no reason to doubt the continuance of the Helicidæ through this long portion of geological time, though it is probable that during the interval the family did not increase much in the number of its species, more especially as it seems certain that it has its culmination in the modern period, when it is represented by very many and large species, which are dispersed over nearly all parts of our continents.

The mode of occurrence of the Paleozoic Pulmonifera in the few localities where they have been found is characteristic. The earliest known species, *Pupa vestuta*, was found by Sir Charles Lyell and the writer, in the material filling the once hollow stem of a Sigillaria at the South Joggins in Nova Scotia, and many additional specimens have subsequently been obtained from similar repositories in the same locality, where they are associated with bones of Batrachians and remains of Millipedes. Other specimens, and also the species *Zonites priscus*, have been found in a thin, shaly layer, containing debris of plants and crusts of Cyprids, and which was probably deposited at the outlet of a small stream flowing through the coal-formation forest. The two species found in Illinois occur, according to Bradley, in an underclay or fossil soil which may have been the bed of a pond or estuary, and subsequently became a forest sub-soil. The Erian species occurs in shales charged with remains of land plants and which must consequently have received abundant drainage from neighboring land. It is only in such deposits that remains of true land-snails can be expected to occur; though, had fresh-water or brackish water Pulmonates abounded in Carboniferous age, their remains should have occurred in those bituminous and calcareo-bituminous shales which contain such vast quantities of debris of cyprids, lamellibranchs and fishes of the period, mixed with fossil plants.

With reference to their affinities, the Paleozoic land snails present no very remarkable peculiarity except their close resemblance to some modern forms. Of the known species, four belong to the genus *Pupa* in its wider sense, and are very near to sub-generic types still represented on the American continent and its islands. One is a small helicoid shell not separable from the modern genus *Zonites*, and the remaining one, though it has been placed in a new genus, is very near some small American snails of the present day (*Stenotrema*, etc.) All the species are of small size, though not smaller than some modern shells of the same types.

I shall now proceed to give the characters and descriptions of the several species, adding to the account of those previously known, such new facts as have occurred in my more recent explorations and examinations. I should state here that many of the new facts detailed have been obtained in the course of excavations for extraction of erect trees holding land animals, undertaken with the aid of a grant from the Government fund for aiding original researches, at the disposal of the Royal Society of London, and carried on within the past three years.

1. *Pupa vetusta* Dawson. (Figs 1 to 4, and 14, *a*, *b*.)

[Sir C. Lyell and Dr. Dawson on Remains of Reptiles and a Land Shell from the South Joggins in Nova Scotia, Journal of Geological Society of London, vol. ix, 1852 (figured but not named). Dawson's Acadian Geology. 1855, p. 160. Dawson's Air-breathers of the Coal Period, 1863. Acadian Geology, 2nd and 3rd editions, p. 384, 1868 and 1879.]

Description.—Shell cylindrical, somewhat abruptly conical at the apex, in some specimens tending to diminish in diameter in the latter turns or whorls of the shell. Whorls nine in adult shells, slightly convex, in width equal to half the diameter of the shell. Suture impressed. Aperture evenly rounded, not continuous above, rather longer than broad, destitute of teeth; peristome slightly reflected and smooth. Surface shining, marked with longitudinal smooth ridges, separated by spaces a little wider than the ridges; spaces about $\frac{1}{500}$th inch in width. Shell calcareous, thin, prismatic in structure. Young specimens abruptly conical and helicoid in form. Nucleus round, smooth, the first turn below the nucleus marked with rows of little pits which gradually pass into the continuous striæ. The last whorl of the adult presents irregular lines of growth instead of the regular microscopic ribs of the middle turns. Mature ovum membranous, or so slightly calcareous that it can be compressed without breaking: the embryo shell sometimes visible within. Length of adult shell rather less than 1 centimeter, breadth in middle 4 millimeters.

Variety tenuistriata.—Along with the ordinary form there are others of similar size and general structure, but with the apex less obtuse and a somewhat greater tendency to diminish in diameter in the later whorls. They have also the microscopic ridges in the shell about half as far apart as those of the ordinary form. This form I was at first disposed to regard as specifically distinct, but there seems to be a gradual transition from one to the other, and the two forms seem to accompany each other throughout the entire range of the species.

State of preservation.—The shells are usually entire, but often somewhat flattened, and cracked or distorted in the process. Many fragments of shells, however, occur with the entire specimens, and some of these have a whitened or bleached appearance like that of modern land shells after having been exposed to the weather. In one layer I found impressions of several flattened shells, the substance of the shell having been altogether removed. Ordinarily the shell remains in such a state as to show its structure, and the more perfect specimens found in the erect trees have a grayish brown color, like that of some modern Pupæ.

The habitat of this species was in forests of the Coal-formation period, composed of *Sigillaria*, *Calamites*, *Lepidophloios* and *Ferns*. The only known locality is the South Joggins, Nova Scotia. At this place the shells have been obtained in considerable numbers, though perfect specimens which can be disengaged from the matrix, are comparatively few. They have been found in erect *Sigillariæ* and also in a bed of shale. The lowest and highest beds in which they occur are separated by 2,000 feet of vertical thickness of strata, including no less than thirty-five beds of coal and many underclays supporting erect trees, so that the species must have inhabited the locality for a very long time and must have survived many physical vicissitudes.

The first specimen, which was also the first known Paleozoic land shell, was found by Sir Charles Lyell and the writer in 1851, in breaking up the contents of an erect tree holding reptilian bones. The specimens obtained from this tree having been taken by Sir Charles to Cambridge and submitted to the late Prof. Jeffries Wyman, the shell in question was recognized by him and the late Dr. Gould, of Boston, as a land shell. It was subsequently examined by M. Deshayes and Mr. Gwyn

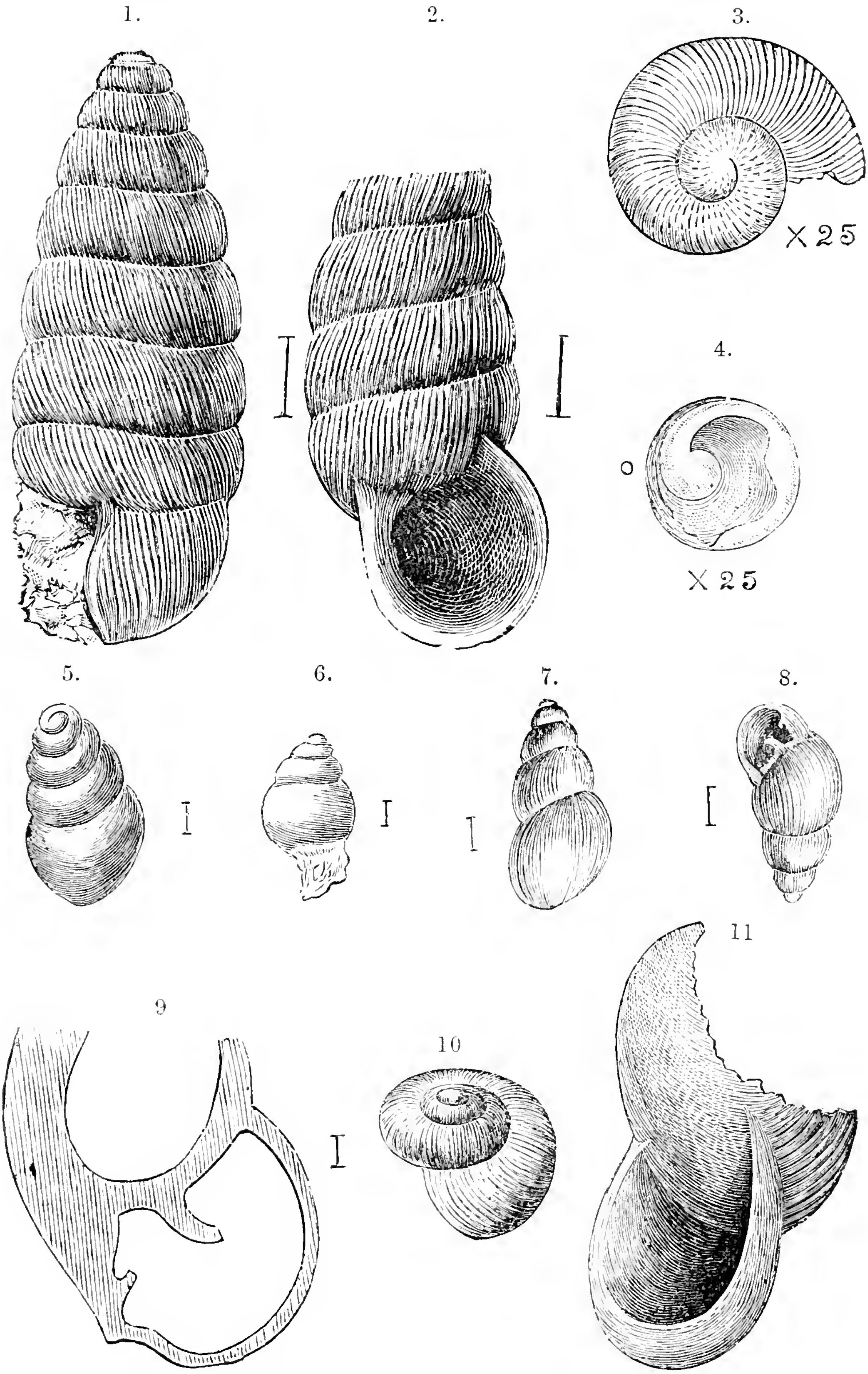

Fig. 1, *Pupa vetusta*, magnified 8 times lineally; 2, same, showing the aperture, × 8; 3, same, nuclear whorl, × 25; 4, same, mature egg and embryo shell, × 25; 5, 6, *Pupa Bigsbii*, × 8; 7, *Pupa Vermilionensis* × 8; 8, same, showing aperture, × 8, the small tooth on the columella somewhat exaggerated; 9, same, section of aperture, showing tooth × 16; 10, *Zonites priscus*, × 8; 11, same, crushed specimen, showing aperture × 20.

Jeffries, who concurred in this determination; and its microscopic structure was described by the late Prof. Quekett, of London, as similar to that of modern land shells. The single specimen obtained on this occasion was somewhat crushed and did not show the aperture. Hence the hesitation as to its nature, and the delay in naming it, though it was figured and described in the paper above cited in 1852. Better specimens showing the aperture were afterward obtained by the writer, and it was named and described by him in his "Air-breathers of the Coal Period," in 1863. Prof. Owen, in his "Palæontology," subsequently proposed the generic name *Dendropupa*. This I have hesitated to accept, as expressing a generic distinction not warranted by the facts; but, should the shell be considered to require a generic or sub-generic distinction, Owen's name should be adopted for it. There seems, however, nothing to prevent it from being placed in one of the modern sub-genera of simple-lipped Pupæ. With regard to the form of its aperture, I may explain that some currency has been given to an incorrect representation of it, through an unfortunate accident. In the case of delicate shells like this, imbedded in a hard matrix, it is of course difficult to work out the aperture perfectly; and in my published figure in the "Air-breathers," I had to restore somewhat the broken specimens in my possession. This restoration, specimens subsequently found have shown to be very exact. Nevertheless it was criticised by some English conchologists, and when Sir Charles Lyell was about to publish his Student's Manual, he asked me to give him one of my best specimens to be figured. This I sent with micro-photographs of others. It seems, however, that the artist or engraver mistook the form of the aperture and gave it an entirely unnatural appearance in the Student's Manual. That now given is taken from a photograph of the most perfect and least compressed specimens in my possession.

As already stated, this shell seems closely allied to some modern Pupæ. Perhaps the modern species which approaches most nearly to it in form, markings and size, is *Macrocheilus Gossei* from the West Indies, specimens of which were sent to me some years ago by Mr. Bland, of New York, with the remark that they must be very near to my Carboniferous species. Such edentulous species, as *Pupa (Leucochila) fallax* of Eastern America very closely resemble it; and it was regarded by the late Dr. Carpenter as probably a near ally of those species which are placed by some European conchologists in the genus *Pupilla.*

The lowest bed in which *Pupa vetusta* occurs belongs to group VIII of Division 4 of my section of South Joggins, and is between Coal 37 and Coal 38 of Logan's Section, being about 42 feet below Coal 37. The next horizon, and that in which the shell was first discovered, is 1217 feet of vertical thickness higher, in group XV of Division 4 of my section. The shells occur here in erect *Sigillariæ*, standing on Coal 15 of Logan's section. The third horizon is in group XXVI of Division 4, about 800 feet higher than the last. Here also the shells occurred in an erect *Sigillaria.*

In the lowest of these three horizons, the shells are found, as already stated, in a thin bed of concretionary clay of dark gray color, though associated with reddish beds. It contains *Zonites priscus* as well, though this is very rare, and there are a few valves of *Cythere* and shells of *Naiadites*, as well as carbonaceous fragments, fronds of ferns, *Trigonocarpa*, etc. The *Pupæ* are mostly adult, but many very young shells also occur, as well as fragments of broken shells. The bed is evidently a layer of mud deposited in a pond or creek, or at the mouth of a small stream. In modern swamps, multitudes of fresh water shells occur in such places, and it is remarkable that in this case the only gastero-pods are land shells, and these very plentiful, though only in one bed about an inch in thickness. This would seem to imply an absence of fresh-water Pulmonifera. In the erect *Sigillariæ* of Group XV, the shells occur either in a sandy matrix, more or less darkened with vegetable matter, or in a carbonaceous mass composed mainly of vegetable débris. Except when crushed or flattened, the shells in these repositories are usually filled with brownish calcite. From this I infer that most of them were alive when imbedded, or at least that they contained the bodies of the animals; and it is not improbable that they sheltered themselves in the hollow trees, as is the habit of many similar animals in modern forests. Their residence in these trees as well as the characters of their embryology are illustrated by the occurrence of their mature ova. They may also have formed part of the food of the reptilian animals whose remains occur with them. In illustration of this, I have elsewhere stated that I have found as many as eleven unbroken shells of *Physa heterostropha* in the stomach of a modern *Menobranchus*. I think it certain, however, that both the shells and the reptiles occurring in these trees must have been strictly terrestrial in their habits, as they could not have found admission to the erect trees unless the ground had been sufficiently dry to allow several feet of the imbedded hollow trunks to be free from water. In the highest of the three horizons the shells occurred in an erect tree, but without any other fossils, and they had apparently been washed in along with a grayish mud.*

2. *Pupa Bigsbii* s. n. (Figs. 5 6.)

Description.—Shell half the size of *Pupa vetusta*, or between three and four millimeters in length, and one and five-tenths millimeters in breadth. Form long, conical. Body whorl about one-third of the entire length, giving the shell a somewhat bulimoid form. Whorls five in the largest specimens found, tumid, suture much impressed. Surface smooth. Aperture apparently oval in form, but not perfectly known, as the body whorl is crushed in all the specimens.

A few specimens, none of them quite perfect, were found in the erect trees of group XV at the Joggins, along with *Pupa vetusta*. They differ from that species in smaller size, different form and absence of sculpture. The specimens do not show whether the aperture was toothed or simple, but it was probably the latter, as the lip is evidently very thin and delicate. From its form it is probable that it belongs to a different sub-genus from *P. vetusta*. It is very much more rare than that species in the erect trees, and has not been found elsewhere.

I dedicate it to my venerable and dear friend Dr. Bigsby, F.R.S., of London, a pioneer of American geology, and still an indefatigable worker in the science.

3. *Pupa Vermilionensis* Bradley. (Figs. 8 and 9, and 14c.)

[Bradley in Report of Geological Survey of Illinois, vol. iv, p. 254 Id. in Am. Jour. Sci., vol. iv, p. 87.]

Description.†—Shell spindle-shaped, tapering to an obtuse apex, covered with microscopic ridges (25 to 30 in a millimeter) parallel to the lines of growth. Aperture oblique, oval. Outer lip thin, slightly reflexed. Columella lip reflexed, thickened;

* The discovery of the shells in this tree was made by Albert I. Hill, C. E.

† Slightly modified from Bradley.

furnished with a single central curved tooth, projecting nearly half way across the aperture. Junction of columella and outer lip somewhat angular and dentiform. In old individuals the columella tooth is often continuous through an entire turn or farther. It is not seen on shells having less than three turns. The last turn forms nearly half the length of the shell. Whorls rounded. Suture impressed. Surface glossy. Color black or gray. Length three and six-tenths millimeters. Width two millimeters. Some individuals are smooth or destitute of the fine microscopic ridges, but whether this is a natural peculiarity or a result of injury to the outer surface, is not certain.

As compared with *Pupa vetusta* this shell is less than half the size, of a less cylindrical form, its whorls more rounded, and its body whorl much larger in proportion. Its sculpture is much finer. The conspicuous tooth in the aperture is of course a strong mark of distinction. The shell is thin, and from its black color and failure to show structure under the microscope, I infer that it must have been of a horny or corneous texture, with little calcareous matter. The matrix is light-colored and concretionary, and somewhat hard and calcareous.

As compared with modern American species, *P. Vermilionensis* is very near to several of the smaller forms with teeth in the aperture. In its form and aperture it approaches closely to *P. (Leucochila) corticaria* of Say, or to the immature shell of *P. rupicola*. It has also some resemblance to the western species *P. hordeacea* Gabb, from Arizona.

This shell was discovered by the late Mr. F. H. Bradley in 1869, in concretionary limestone accompanying the underclay of Coal No. 6, Wabash Valley Section, at Pelly's Fort, Vermilion River, Illinois. In the first notice, which appeared in the Report of the Geological Survey of Illinois, it was referred to *Pupa vetusta*, but was subsequently described by Mr. Bradley in the American Journal of Science, under the name above cited.

I am indebted for specimens of this shell to Mr. John Collett, of the Geological Survey of Indiana, and also to Mr. W. Gurley, of Danville, Illinois.

4. *Zonites* (*Conulus*) *priscus* Carpenter. (Figs. 10 and 11, and 14*d*.)

[Quarterly Journal of Geological Society of London, Nov. 1867. Acadian Geology, 2nd edition, 1868, p. 385.]

*Description.**—Shell small, helicoid. Length two and five-tenths millimeters, width two and eight-tenths millimeters. Spire little elevated. Nucleus small. Whorls four, somewhat flattened, with the suture little impressed. Base somewhat excavated, with large umbilicus. Aperture oblique, suboval, somewhat regularly rounded. Lip simple. Surface marked with uneven striæ and somewhat more conspicuous ridges of growth. Angle of divergence about 130°. Shell thin and probably horny.

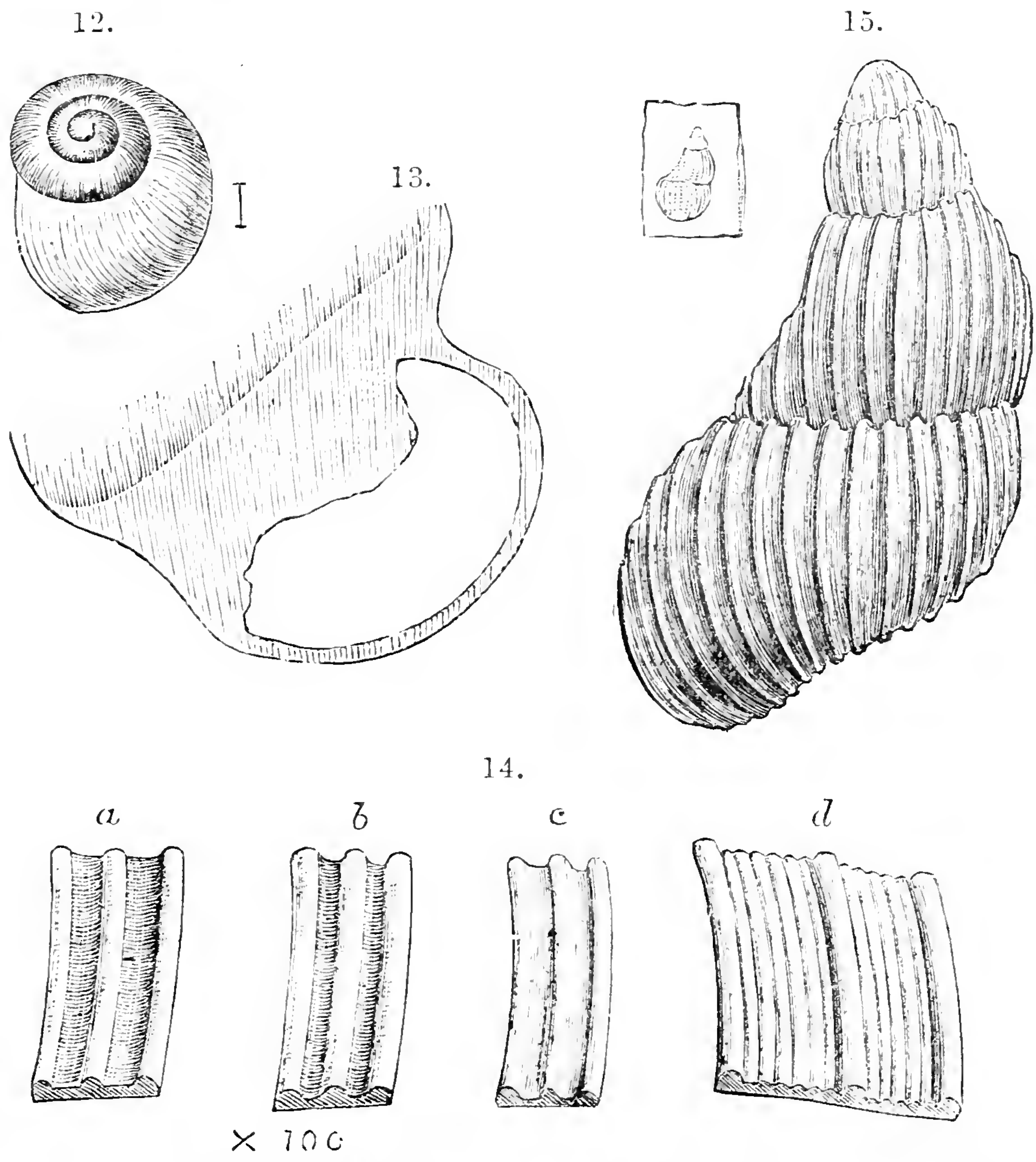

Fig. 12. *Dawsonella Meeki*, × 8; 13, same, section of aperture, × 16; the outer edge of the lamella is imperfect. 14, Markings of surface × 100: (*a*) *Pupa vetusta*; (*b*) *Pupa vetusta* var. *tenuistriata*; (*c*) *Pupa Vermilionensis*; (*d*) *Zonites priscus*. 15, *Strophites grandæva*, natural size, and magnified 8 diameters.

This little shell was discovered in 1866, in the bed already referred to as the lowest of those at the South Joggins in which *Pupa vetusta* has been found. Shortly after I had discovered this bed, being impressed with the probability that it might

* Slightly modified from Carpenter.

hold other remains of land animals beside the *Pupa*, I had some excavations made in it, and a considerable quantity of material taken out. I found, however, that the thin layer containing the land shells was not continuous, but in limited patches, and was rewarded only by the discovery of a few specimens of *Zonites priscus* and a small and not determinable fragment of bone, in addition to specimens of *Pupa vetusta*.

The specimens found at this time were submitted to the late Dr. P. P. Carpenter, by whom the species was named and described. One or two crushed specimens have been subsequently found in the erect trees holding *Pupa vetusta* in group XV, but the species is extremely rare in comparison. This may however, have depended on some difference in habitat or mode of life, rendering it less likely to be imbedded in the deposits in process of formation. It is also to be observed that the shell is much more delicate than that of *Pupa vetusta*, and therefore less likely to be preserved.

With regard to its affinities, it was compared by Dr. Carpenter with the African species *Paryphanta Caffra* Fer., "on an extremely small scale." Dr. Carpenter also compared it with *Hygromia*, and stated that it might well be ranked under *Pseudohyalina* of Morse, with the living species *minuscula* and *exigua*. He thought it best, however, to place it in the subgenus *Conulus* of the genus *Zonites*, as defined by Messrs. Adams. With regard to the subgeneric name, Dr. Carpenter explained that the subgenus *Conulus* of Fits, 1833, appears to be synonymous with *Trochiscus* Held, 1837, (non Sby.); also with *Petasia* Beck, 1837; and with *Perforatella* Schlütt.; and according to Adams is a subgenus of *Zonites* Montf. (non Leach, Gray). Those who do not care to enter into these subgeneric distinctions, may designate the species as a *Zonites*, or even, speaking loosely, as a *Helix*. There seems nothing in its characters to separate it, more than specifically, from many of our smaller helicoid snails with thin shells and simple aperture.

5. *Dawsonella Meeki* Bradley. (Figs. 12 and 13.)

[Report of Geological Survey of Illinois, vol. iv, p. 254. Am. Jour. of Sci., III, vol. iv, p. 88. Ibid. vol. vii, p. 157.]

*Description.**—Shell broad, depressed, helicoid. Spire obtuse, consisting of three to three and one-half turns. Length three

* Modified from Bradley.

and two-tenths millimeters, width four millimeters. Surface smooth, but with microscopic lines of growth, about fifteen in a millimeter. Aperture oblique, oval, greatly contracted by a broad lamellar expansion of the columella, extending more than half way across, even in small individuals. Outer lip thickened, slightly reflexed. Suture little impressed, imperforate, but last turn slightly excavated in the umbilical region. The shell is usually black in color, and under the microscope shows no distinct structure, from which it may be inferred that it was corneous in texture. It is thicker than the shell of *Zonites priscus.*

This species is found along with *Pupa Vermilionensis*, and was discovered by Bradley, who was, however, at first disposed to refer it to the genus *Anomphalus* of Meek; but subsequently, and with good reason, regarded it as distinct and as a land shell. In size and general form it resembles *Zonites priscus*, though expanding less rapidly and with rounder whorls; but it is at once distinguished by its want of the somewhat coarse sculpture of that species, and by the plate which partially covers its aperture. Its nearest modern allies in eastern America would seem to be such shells as *Helix* (*Triodopsis*) *palliata*, and *H.* (*Stenotrema*) *monodon.*

For specimens of this shell I am indebted to the persons above named as having furnished specimens of *Pupa Vermilionensis.*

6. *Strophites grandæva*, *s.* n. (Fig. 15.)

Description.—Shell cylindrical, with obtuse apex. Whorls four or more. Surface covered with sharp vertical ridges, separated by spaces three times as wide. The body whorl about four millimeters in diameter, with about thirteen vertical ridges visible on one side. Length of specimen probably not quite perfect, about eight millimeters. The shell, which has disappeared, must have been very thin, and the surface remaining is smooth and shining. In general form, so far as can be ascertained from a very imperfect specimen, this shell must have closely resembled the modern Pupæ of the genus *Strophia* of Albers.

The only specimen known is from the Erian (Devonian) plant-beds of St. John, New Brunswick, which, besides affording great numbers of remains of land plants, have produced the only Erian insects as yet known. It was sent to me by Mr. G. F. Matthew, of St. John, along with specimens of fossil plants;

several years ago, but I hesitated to describe it, waiting in hope of additional specimens. As these have not occurred, and I have now carefully examined the whole of the material from these beds, to which I have been able to obtain access, I venture to name it as probably the oldest known land shell, the beds in which it is found being either middle or upper Erian.

If a land snail, it is larger in size, and probably of a higher type than any of those known from the Coal-formation. This would not be wonderful, when we consider the greater variety of surface and the high character of the vegetation, which, as I have elsewhere endeavored to show, distinguished the later Erian age in north-eastern America.

Concluding Remarks.

It may be proper to mention here the alleged Pulmonifera of the genus *Palæorbis* described by some German naturalists. These I believe to be worm-tubes of the genus *Spirorbis*, and in fact, to be nothing else than the common *S. carbonarius* or *S. pusillus* of the Coal-formation. The history of this error may be stated thus. The eminent paleobotanists Germar, Gœppert and Geinitz have referred the *Spirorbis*, so common in the Coal-measures, to the fungi, under the name *Gyromyces*, and in this they have been followed by other naturalists; though as long ago as 1868 I had shown that this little organism is not only a calcareous shell, attached by one side to vegetable matters and shells of mollusks, but that it has the microscopic structure characteristic of modern shells of this type.* More recently, Van Beneden, Cænius and Goldenberg, perceiving that the fossil is really a calcareous shell, but apparently unaware of the observations made in this country by myself and Mr. Lesquereux, have held the *Spirorbis* to be a pulmonate mollusk allied to *Planorbis*, and have supposed that its presence on fossil plants is confirmatory of this view, though the shells are attached by a flattened side to these plants, and are also found attached to shells of bivalves of the genus *Naiadites*. Mr. R. Etheridge, Jr., of the Geological Survey of Great Britain, has recently summed up the evidence as to the true nature of these shells, and has revised and added to the species, in a series of articles in the Geological Magazine of London, vol. viii.

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* Acadian Geology, 2nd edition, p. 205.

If we exclude the alleged *Palæorbis* above referred to, all the Paleozoic Pulmonifera hitherto found are American. Since, however, in the Carboniferous age, Batrachians, Arachnidans, Insects and Millipedes occur on both continents, it is not unlikely that ere long European species of land snails will be announced. The species hitherto found in eastern America, are in every way strangely isolated. In the plant-beds of St. John, about 9,000 feet in thickness, and in the Coal-formation of the South Joggins, more than 7,000 feet in thickness, no other Gasteropods occur, nor, I believe, do any occur in the beds holding land snails in Illinois. Nor, as already stated, are any of the aquatic Pulmonifera known in the Paleozoic. Thus, in so far as at present known, these Paleozoic snails are separated not only from any predecessors, if there were any, or successors, but from any contemporary animals allied to them.

It is probable that the land snails of the Erian or Carboniferous were neither numerous nor important members of the faunæ of those periods. Had other species existed in any considerable number, there is no reason why they should not have been found in the erect trees, or in those shales which contain land plants. More especially would the discovery of any larger species, had they existed, been likely to have occurred. Further, what we know of the vegetation of the Paleozoic Period would lead us to infer that it did not abound in those succulent and nutritious leaves and fruits which are most congenial to land snails. It is to be observed, however, that we know little as yet of the upland life of the Erian or Carboniferous. The animal life of the drier parts of the low country is indeed as yet very little known; and but for the revelations, in this respect, of the erect trees in one bed in the Coal-formation of Nova Scotia, our knowledge of the land snails and millipedes, and also of an eminently terrestrial group of reptiles, the *Microsauria*, would have been much more imperfect than it is. We may hope for still further revelations of this kind, and, in the mean time, it would be premature to speculate as to the affinities of our little group of land snails with animals either their contemporaries or belonging to earlier or later formations, except to note the fact of the little change of form or structure in this type of life in that vast interval of time which separates the Erian Period from the present day.

NOTE.—(Feb. 21, 1881.)—Since the above paper was written, Prof. Whitfield of New York has announced * the discovery of another species of land snail in the coal formation of Ohio. It is a small species, three and one-third millimeters in length, of that type of pupidae having the aperture nearly vertical and armed with several projecting teeth. It has besides the peculiar feature of a small nearly circular notch near the upper end of the lower lip. On account of this peculiarity it is placed in a new genus *Anthracopupa*, and the species is named *A. ohioensis*.

Prof. Whitfield also mentions that he has examined the aperture of *Dawsonella Meeki*, and finds reason to believe, from the form of the callus in the aperture, and the peculiar thickening of the outer lip, that it may have been an operculated shell, though he admits that no trace of the operculum has yet been found.

NOTE ON FOSSILS FROM THE RED SANDSTONE SYSTEM OF PRINCE EDWARD ISLAND. BY MR. F. BAIN.

(Read at the Meeting of the Natural History Society, January 31, 1881.)

In the course of some short geological excursions during the past summer, I obtained from the system of strata classified as Triassic in Dr. J. W. Dawson's Report on the Geology of Prince Edward Island, the following fossil plants :

Walchia gracilis, Dawson.
Calamites gigas, Brongt.
Calamites Suckovii, Brongt.
Pecopteris rigida, Dawson.
Pecopteris arborescens (?), Schlotheim.

These were taken from various localities on the north side of the Hillsborough Bay and the south side of Lot 65, and occur through a depth of strata amounting to more than one thousand feet.

On the Island, two distinct systems of rocks are recognized : the Permo-carboniferous and the Triassic. In the first of these are a number of beds rich in remains of plants. But the Triassic is characterised by an exceeding barrenness of well-preserved organic remains.

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* American Journal of Science, Vol. XXI, No. 122.

Hitherto the most characteristic species obtained from it have been the reptile *Bathygnathus borealis* and fossil wood of a type elsewhere found in the Mesozoic. These are, however, sufficient to distinguish it from the underlying Permian. The fossils now referred to are species belonging to the latter, but found in beds heretofore referred to the Trias. The inference would be that the Permo-carboniferous formation is more extensively distributed on the south side of Prince Edward Island than has been supposed.

The following section observed at Rice Point and vicinity, shows the nature and arrangement of the beds affording the fossils referred to:

SECTION IN DESCENDING ORDER.

Rocks.	*Feet.*	*Fossils..*
1. Dark Red or Brown Sandstones,	15	
2. Dark red Sandstone, irreg. bed.,	50	{ *Calamites Suckovii, Knorria,*
3. Shale, red......................	50	{ *Pecopteris arborescens.*
4. Dark red Sandstones, irregularly bedded, often calcareous; many obscure remains of plants and bituminous markings; some thin beds of shale............	325	*Knorrta.*
5. Red Sandstones, not often calcareous; few markings of plants; a few feet of Cal. Conglomerate and ochre-colored beds	175	*Calamites gigas.*
6. Alternate Beds of Red Sandstone and Shale with grey indurated bands at their junction; more regularly bedded than 4 and 5..	586	
7. Red Sandstone with indurated Calcareous bands.............	40	*Walchia gracilis, Pecopteris rigida.*
	1241	

THE SEQUOIAS OR GIANT TREES OF CALIFORNIA.

By Prof. O. Heer.

(Read before the Botanical Section of the Swiss Natural History Society.)

[Translated by W. B. Dawson.]

The Sequoia belongs to that most beautiful and widespread tribe, the Conifers; and I therefore take the liberty of bringing before your notice a description of these giant trees.

The name itself deserves consideration. It is that of an Indian of the Cherokee tribe, Sequo Yah, who invented an alphabet without any aid from the outside world of culture, and taught it to his tribe by writing it upon leaves. This came into general use among the Cherokees, before the white man had any knowledge of it; and afterwards, in 1828, a periodical was published in this character by the missionaries. Sequo Yah was banished from his home in Alabama, with the rest of his tribe, and settled in New Mexico, where he died in 1843.

When Endlicher was preparing his synopsis of the Conifers, in 1846, and had established a number of new genera, Dr. Jacbon Tschudi, the present Swiss ambassador at Vienna, who was then living with Endlicher, brought before his notice this remarkable man, and asked him to dedicate this red-wooded tree to the memory of a literary genius so conspicuous among the red men of America. Endlicher consented to do so, and only endeavored to make the name pronounceable by changing two of its letters. The tribe of the Cherokees is dying out, and with it, its language; but Sequo Yah's name will live as the designation of the giant trees of his country.

Endlicher has founded the Genus on the Redwood of the Americans, *Taxodium sempervirens* of Lamb; and has called the species *Sequoia sempervirens*. These trees form large forests in California, which extend along the coast as far as Oregon. Trees are there met with of 300 feet in height and 20 feet in diameter. The seeds have been brought to Europe a number of years ago, and we already see in upper Italy and around the Lake of Geneva high trees; but, on the other hand, they have not proved successful around Zurich.

In 1852, a second species of Sequoia was discovered in California, which, under the name of Big Tree, soon attained a considerable celebrity. Lindley described it, in 1853, as *Wellingtonia gigantea;* and, in the following year, Decaisne and Dr. Torrey proved that it belonged to Sequoia, and that it accordingly should be called *Sequoia gigantea.* But Endlicher had already employed that name for another species, in 1847, and the prodigious size which he ascribes to that tree makes it probable that he had in some way received information respecting this Californian giant before it was made known by Lindley. It therefore remains doubtful whether his *Sequoia gigantea* is identical with *Wellingtonia gigantea* or not.

While the *Sequoia sempervirens,* in spite of the destructiveness of the American lumbermen, still forms large forests along the coast, the Sequoia gigantea is confined to the isolated clumps which are met with inland at a height of 5,000 to 7,000 feet above sea level, and are much sought after by tourists as one of the wonders of the country. Reports came to Europe concerning the largest of them which were quite fabulous, but we have received accurate accounts of them from Prof. Whitney. The tallest tree measured by him has a height of 325 feet, and in the case of one of the trees the number of the rings of growth indicated an age of about 1300 years. It had a girth of 50 to 60 feet.

We know only two living species of Sequoia, both of which are confined to California. The one (*S. sempervirens*) is clothed with erect leaves, arranged in two rows, very much like our yew-tree, and bears small round cones; the other (*S. gigantea*) has smaller leaves, set closely against the branches, giving the tree more the appearance of the cypress. The cones are egg-shaped, and much larger. These two types are therefore sharply defined.

Both of these trees have an interesting history. If we go back into the Tertiary, this same genus meets us with a long array of species. Two of these species correspond to those living at present: the *S. Langsdorfii* to the *S. sempervirens,* and the *S. Sternbergii,* to the *S. gigantea.* But whilst the living species are confined to California, in the Tertiary they are spread over several quarters of the globe.

Let us first consider the *Sequoia Langsdorfii.* This was first discovered in the Lignite of Wetterau, and was described as *Taxites Langsdorfii.* I found it in the upper Rhone and in Monod, and there lay beside the twigs the remains of a cone, which showed me that the *Taxites Langsdorfii* of Brogn... belonged to the Californian genus Sequoia established by Endlicher. I afterwards found much better preserved cones, together with seeds, under the plants of Samland and Greenland which fully confirmed the determination. At Atanekerdzuk in Greenland (about 70° N. Lat.) this tree is very common. I have received from this place hundreds of twigs with the leaves, and also the flowers and numerous cones, which leave no doubt that this tree stands very near to the Redwood. It differs from it, however, in having a much larger number of scales in the cone. The tree is also found in Spitzbergen at nearly 78° north latitude, where Nordenskiöld has collected, at Cape Lyell, wonderfully preserved branches. From this high latitude the species can be followed down through the whole of Europe as far as the middle of Italy (at Senegaglia, Gulf of Spezia). In Asia also we can follow it to the steppes of Kirghisen, to Possiet, and to the coast of the Sea of Japan, and across to Alaska and Sitka. It is thus known in Europe, Asia and America, from 43° to 78° north latitude, whilst its most nearly related living species, perhaps even descended from it, is now confined to California.

With this *S. Langsdorfii*, three other Miocene species are nearly related: (*S. brevifolia*, Hr., *S. disticha*, Hr., and *Nordenskiöldi*, Hr.) These have been met with in Greenland and Spitzbergen, and one of them has lately been found in the United States. Three other species, in addition to these, have been described by Lesquereux, which appear to belong to the group of the *S. Langsdorfii*, viz., *S. longifolia*, Lesq., *S. angustifolia* and *S. acuminata*, Lesq.

These species thus answer to the living *Sequoia sempervirens*; but we can also point to a Tertiary representative (in the Miocene) of the *S. gigantea*. It is the *Sequoia Sternbergii*, (*Araucarites Sternbergii*, Goepp.). The leaves are stiff and sharp-pointed, are thinly set round the branches, and lie forward in the same way: the egg-shaped cones have the same size. The species was first found in Austria, and was classed with the Araucaria; but the cones found by Massalongo show it to belong to Sequoia. I have specimens of the species from Oeningen, and also from Iceland and Greenland. The twigs are abundant in Surturbrand;* and the opinion may be expressed that the stumps and roots which Prof. Steenstrup has met with in the basaltic beds of Iceland belong to this tree.

* Brown Coal.

Although this species is not as widely distributed as the *Sequoia Langsdorfii*,, we can yet trace it from the middle of Italy to north Greenland, in latitude 70° north, and it is met with from the beginning of the Miocene to its close.

The *S. Langsdorfii* and *Sernbergii* represent the two extreme forms of the genus Sequoia. It is therefore very noticeable that we have in the Miocene six species, which fill up the gap. They are the *S. Couttsiæ*, *S. affinis*, Lesq., *S. imbricata*, Hr., *S. sibirica* Hr., *S. Heerii* Lesq., and *S. biformis* Lesq. Of these, *S. Couttsiæ*, Hr., is the most common and most important species. It has short leaves, lying along the branch, like *S. Sternbergii* and *gigantea*, and small round cones, like *S. Langsdorfii* and *sempervirens* I have received from Bovey Tracey in Devonshire splendid specimens of cones, seeds and twigs, which I have described in the Philosophical Transactions. More lately, Count Saporta has described specimens of cones and twigs from Armissan. Specimens of this species have also come to me from Samland and Greenland, and must therefore have had a wide range. It is very like to the American *S. affinis*, Lesq.

In the Tertiary there have been already found fourteen well marked species, which include representatives of the two living types, *S. sempervirens* and *S. gigantea*.

CRETACEOUS.

We can follow this genus still further back. If we go back to the Cretaceous age, we find ten species, of which five occur in the Urgon of the Lower Cretaceous, two in the Middle, and three in the Upper Cretaceous. Among these, the Lower Cretaceous exhibits the two types of the Sequoia sempervirens and *S. gigantea*. To the former the *S. Smithiana* answers, and to the latter, the *Reichenbachii*, Gein. The *S. Smithiana* stands indeed uncommonly near the *S. Langsdorfii* both in the appearance of the leaves on the twigs and in the shape of the cones. These are, however, smaller, and the leaves do not become narrower toward the base. The *S. pectina*, Hr., of the Upper Cretaceous has its leaves arranged in two rows and presents a similar appearance. The *S. Reichenbachii* is a type more distinct from those now living and those in the Tertiary. It has indeed also stiff, pointed leaves, lying forward, but they are arcuate, and the cones are smaller. This tree is already known for a long time, and it serves, in the Cretaceous, as a guiding star, which we can follow from the Urgon of the Lower Cretaceous up to the Cenomanian. It is known in France, Belgium, Bohemia, Saxony, Greenland and Spitzbergen. It has been placed in another genus—Geinitzia—but I can recognize, by the help of the cones, that it belongs to Sequoia.

Below this, there is found in Greenland a nearly related species, the *S. ambigua*, Hr., of which the leaves are shorter and broader, and the cones round and somewhat smaller.

The connecting link between *S. Smithiana* and *Reichenbachii* is formed by *S. subulata* Hr., and *S. rigida*, Hr., and three species (*S. gracilis*, Hr., *S. fastigiata* and *S. Gardneriana*,, Carr.) with leaves lying closely along the branch, and which come very near to the Tertiary species *S. Couttsiæ*. We have therefore in the Cretaceous quite an array of species, which fill up the gap between the *S. sempervirens* and *gigantea* and show us that the genus Sequoia had already attained a great development in the Cretaceous. This was still greater in the Tertiary, in which it also reached its maximum of geographical distribution. Into the present world the two extremes of the genus have alone continued; the numerous species forming its main body have fallen out in the Tertiary.

JURASSIC.

If we look still further back, we find in the Jura a great number of conifers, and, among them, we meet in the genus Pinus with a type which is highly developed and which still survives; but for Sequoia we have till now looked in vain, so that for the present we cannot place the rise of the genus lower than the Urgon of the Cretaceous, however remarkable we may think it that in that period it should have developed into so many species; and it is still more surprising that two species already make their appearance which approach so near to the living *Sequoia sempervirens* and *S. gigantea*..

Altogether, we have become acquainted, up to the present time, with 26 species of Sequoia. The 14 species of the Arctic zone I have described and figured in my "Fossil Flora of the Arctic Regions."

THE HORNED CORYDALIS.

By the Rev. T. W. Fyles.

Corydalis cornutus is the monarch of the water-flies. I can well recall the admiration with which I first looked upon the weird beauty of this remarkable insect. The undulating body, dark and glabrous; the plated thorax; the square head, and powerful mandibulæ; the projecting eyes, black and bead-like; the long setaceous antennæ; the wonderful wings, clouded, yet transparent, flecked with white, nerved and barred, and measuring five inches from tip to tip,—presented, *tout ensemble*, an appearance both grim and fascinating. Beholding it, one could not but desire to know more of the creature's history.

In June and July of last year, this desire, as regards myself, was in a measure gratified. I had the pleasure of watching the insect through its changes, from its larval to its perfect condition. The circumstances were these:

On the 12th of June, a friend brought me a strange creature, which he had captured as it was crawling up the bank of the Yamaska River. It was four inches long, and about half an inch broad. Its color was dark-sepia. It had twelve segments besides the head. The first three of these were evidently thoracic, for the legs were attached to them, a pair to a segment. Each of the nine abdominal segments carried two remarkable appendages—one on each side—inclosing, I suppose, the branchiæ or gills. They were about a quarter of an inch in length, and gave the insect a fringed appearance. On the last segment they approached and overlapped the anal setæ. The square head of the insect was suggestive; and I said to myself: "This is the larva of the Horned Corydalis," and accordingly took measures for its safety.

I procured a large flower-pot, and half filled it with earth. In this earth I sank, to the rim, a glass saucer, full of water. I then put in the lava, and covered the pot with a pane of glass. The creature buried itself on the second day. I left it undisturbed for a week, and then thought I would remove the earth carefully until I came to it; but, on lifting the glass saucer, I found that I had no need to do more, for the larva lay exposed before me—

it had formed a cist immediately under the saucer. In this cist it remained, inactive, until the 28th of the month, when it underwent a change. The skin of the three segments next the head divided down the back, and the pupa made its *début* through the opening. The metamorphosis was very striking. Instead of the dark muddy larva, with all its grotesque appendages, there lay the bright, clean, yellow pupa, with rudimentary wings and antennæ, and eyes showing blue through the waxen skin. Spiracles, of the usual form, appeared along the sides, where the branchiæ had been cast off; and the six legs were drawn up under the body. The creature was very sensitive, either to the light, or to the slight jar occasioned by the removal of the glass, for it became uneasy; and, although it could use neither wings nor legs, it worked itself out of its cist, and made a complete tour of its prison yard, drawing itself along by its formidable jaws, which, at this stage, closely resembled those of the female imago. In a few days a change of color began to show itself. The abdomen became mottled with olive-green; and gradually the whole body of the insect darkened with the same hue.

The change to the imago took place in the afternoon of the 12th of July. The skin was rent in the same way as that of the larva had been; and the perfect insect crept from its ruptured envelope. It crawled up a slight frame-work which I had placed for its convenience, shook out its wings, and, in a few minutes, assumed its full proportions. One thing surprised me greatly. I had expected to see a *female* insect appear from the case; for the mandibles of the pupa had been, as I have said, of the exact size and shape of those of the female imago; but the creature, on making its appearance, presented the preposterously long and scythe-shaped mandibulæ of the *male*. These frightful appendages are doubtless weapons of offense; for the creature showed its *vim* by striking with them, viciously, at my finger. So eager was it for a fray, that, in following my hand with repeated snaps, it drove the weapons through its own extended wings. I noticed that the sharp tips of the "horns" were red, as if they contained a colored fluid. And I dare say it would be interesting to allow the creature to inflict a wound, for the sake of noting the effects. I was very unwilling, however, to deprive some one else of the satisfaction of being the first to try the experiment.

Although the mandibles of the male *C. cornutus* are of use to the insect for attacking a foe, I doubt whether this is the only, or the chief purpose for which they are intended. I imagine that, in the nuptial flight, they are used for grasping the well-defended neck of the female.

C. cornutus lays its eggs on the stones and piles projecting from the river, where they are soon submerged. The aquarium would afford opportunities for studying the habits of the larva in its native element.

PROCEEDINGS OF THE NATURAL HISTORY SOCIETY OF MONTREAL.

The third meeting of the Society for the Session 1880–1881 was held on Monday evening Jan. 21st. The President occupied the chair. The Secretary read the minutes of last meeting, and announced the subjects of the Somerville lectures, together with the names of the lecturers.

Dr. Dawson then delivered an address on "New Devonian plants and other Canadian fossils."

He first described a new species of *Piloceras*, a remarkable chambered shell found by Mr. Macpherson in one of Dr. Dawson's excursions with his class in Geology, in the neighborhood of Lachute, and which, as he explained, throws much light on the structure of this ancient and curious group of shells.

He next noticed a globular organism found in great numbers in the Corniferous limestone of Kelly's Island, near Sandusky, and which he had described, some years ago, as a foraminiferal shell, under the name of *Saccammina Eriana*. He mentioned some new facts respecting it, and gave reasons for adhering to his former determination. The specimens described had been sent to him by Prof. Perry, of New York, and by Mr. Walker, of Hamilton.

He then proceeded to describe several ferns and other plants collected by Mr. Foord and Mr. Weston, of the Geological Survey, in the Devonian rocks of the Bay de Chaleur. Two of them, *Cyclopteris obtusa* and *Cyclopteris* (*Platyphyllum*) *Brownii*, are known elsewhere as upper Devonian forms. Another, *Archæopteris Gaspiensis* is new. These are from the locality of the remarkable fossil fishes recently described by Mr. Whiteaves.

From another locality, and probably somewhat lower horizon, are abundant specimens of *Psilophyton* and *Cordaites angustifolia*, as well as a lycopodiaceous cone, probably new.

Lastly, he noticed the discovery, by Mr. F. Bain, of North River, Prince Edward Island, of several species of certain fossil plants in portions of the Red Sandstone formation of that Island considerably higher in stratigraphical position than that in which they were previously known to occur. The effect of this would be to require us to recognise portions of the sandstone hitherto regarded as Triassic, as being really Permian. We thus have apparently both in Prince Edward Island; and in Virginia true Permian beds holding the fossil plants characteristic of that formation.

Dr. Osler presented some notes supplementing his paper on the Canadian Fresh-water Polyzoa read before the Society in January 1877. He directed attention to the following points:

1st. The occurrence of a species of *Cristatella* which was found in great abundance in the small lakes drained by the Rivière du Loup (*en haut*), Quebec. This is the most highly organized of all the Polyzoa and is capable of a slow, snail-like movement.

2nd. The occurrence of an additional species of *Plumatellidæ*, *P. diffusa* of Leidy.

3rd. A winter ovum or statoblast presenting certain peculiarities in structure and in the form and arrangement of the annular spines, which serve to separate it from the ova of the *Pectinatella* or *Cristatella*. It probably belongs to a new species.

4th. The Rev. Thomas Hincks, F. R. S., described, in the "Annals and Magazine of Natural History," a supposed Pterobranchiate Polyzoon from Canada, sent to him by the late Prof. Hincks, of Univ. College, Toronto. The general description of this corresponds to the *Pectinatella magnifica*, except in the arrangement of the tentacles, which were borne on two distinct erect lobes, and not disposed in a horse-shoe figure. Dr. Osler was of opinion that there had been a slight error in observation, and that the species was the *Pectinatella*. He was confirmed in this by the fact that he had himself taken the specimen to Prof. Hinks, when a member of his Botany class, and so far as he remembers, it presented the characteristics which he afterwards learned were peculiar to the *Pectinatella*.

The fourth meeting was held on Monday Evening February 28th. Principal Dawson occupied the Chair.

Mr. Kenneth R. Macpherson was proposed for election as an ordinary member. The cabinet-keeper, Mr. Wm. Muir exhibited a number of birds that had been recently added to the Museum.

Dr. G. M. Dawson then addressed the meeting on "The Geology of the Peace River region."

He remarked that absolutely nothing was known of the geology of the great region through which the Peace River flows till 1875. In that year Mr. Selwyn, the director of the Geological Survey, visited the district, exploring the Peace River as far down as the confluence of the Smoky River. The results of this survey were published in the Geological Survey report, and constitute the basis of subsequent work. In 1879 it was considered desirable to obtain definite information of the Peace River district in connection with the projected line of the Canadian Pacific Railway. The geological and geographical results of this expedition in conjunction with those before obtained now enable a clear general view to be taken of the region. The Rocky Mountains formed a shore line during the deposition of the cretaceous rocks, which, stretching eastward over a distance of at least 350 miles, imply the existence of a sea of that width. Near the mountains these rocks are almost altogether represented by sandstones and conglomerates, while to the eastward, shales are more abundant, till on the Smoky River the formation resolves itself into the following subdivisions, named from the highest downward: Upper Sandstone, Upper Shales, Lower Sandstone, Lower Shales. These represent in a general way the Fox Hill, Pierre, Niobrara and Benton subdivisions of the United States geologists. A large number of fossils have been obtained from the "Upper Shales," which are definitely correlated with the Pierre group, while an interesting estuarine and fresh-water fauna, with plant remains, characterises the Lower Sandstones. The economic importance of these rocks is found in the fact that coal seams occur on two separate horizons, viz., the Upper and Lower Sandstones. The coals of the former, near the mountains, are of very good quality and resemble true bituminous coals. Those of the latter must be clased as lignites, but still have a high calorific value. It cannot be doubted that these fuels will before long be extensively mined, for the portion of the Peace River Valley embraced in the exploration of 1879 is estimated to contain about 23,000 square miles of good soil, which should the climate be as favor. able for the growth of wheat as we have reason to believe, would produce over 300,000,000 bushels annually.

Mr. Whiteaves made some remarks concerning the fossils which Dr. G. M. Dawson had exhibited to illustrate his address.

It was moved by Mr. G. L. Marler, seconded by Mr. T. C. Brainerd, and unanimously resolved. "That this Society, in view of the contemplated removal of the Geological Survey from the city, would earnestly deprecate any departure from the pledge given on behalf of the Government by the Hon. Mr. Masson in his letter to the Board of Trade, of December 20th, 1879, that the museum accumulated under the late Sir W. E. Logan should be maintained in Montreal, and would express the hope that regard to the promise made, as well as the respect due to the expressed wish of Sir W. E. Logan, to the important educational and individual interests represented in this city, and to what we believe would be the unanimous wish of scientific men throughout the world were they consulted in the matter, may lead to the adoption of such measures as will leave undisturbed the collection made by our late lamented colleagues Logan and Billings"

Principal Dawson said a definite pledge had been given in an autograph letter from Hon. Mr. Masson to the Board of Trade that the Museum would be maintained. So the matter remained till a few weeks ago, when the rumor spread that the Museum building had been rented and that the Survey had been requested to pack up and leave by the first of May. To his mind the destruction of the Museum was an act of the grossest vandalism. The Museum, the work of men like Sir William Logan and the late Mr. Billings, was a kind of sacred inheritance to Canada, and he fully believed that if it were known to scientific men throughout the world that it was being so removed, there would be an unanimous cry of indignation against it from every scientific man worthy the name.

MISCELLANEOUS.

On new Erian (Devonian) Plants. By J. W. Dawson, LL.D., F.R.S., F.G.S. [Abstract of a paper read before the Geological Society of London, June 23d. 1880.]

The paper first referred to recent publications bearing on the Erian (Devonian) flora of N.E. America, and then proceeded to describe new species from New York and New Brunswick, and to notice others from Queensland, Australia, and Scotland.

The first and most interesting is a small Tree-fern, *Asteropteris noveboracensis*, characterised by an axial cylinder composed of radiating vertical plates of scalariform tissue, imbedded in parenchyma, and surrounded by an outer cylinder penetrated with leaf-bundles with dumb-bell-shaped vascular bundles. The specimen was collected by Mr. B. Wright, in the Upper Devonian of New York.

Another new fern from New York is a species of *Equisetites* (*E. Wrightianus*), showing a hairy or bristly surface, and sheaths of about twelve, short, acuminate leaves.

A new and particular form of wood, obtained by Prof. Clarke, of Amherst College, Massachusetts, from the Devonian of New York, was described under the name *Celluloxylon primævum*. It presents some analogies with *Prototaxites* and with *Aphyllum paradoxum* of Unger.

Several new ferns were described from the well-known Middle Devonian plant-beds of St. John, New Brunswick; and new facts were mentioned as confirmatory of the age assigned to these beds, as showing the harmony of their flora with that of the Erian of New York, and as illustrating the fact that the flora of the Middle and Upper Devonian was eminently distinguished by the number and variety of its species of ferns, both herbaceous and arborescent. It will probably be found eventually that in ferns, equisetaceous plants and conifers, the Devonian was relatively richer than the Carboniferous.

Reference was also made to a seed of the genus *Ætheotesta* of Charles Brongniart, found by the Rev. T. Brown in the Old Red Sandstone of Perthshire, Scotland, and to a species of the genus *Dicranophyllum* of Grand'-Eury, discovered by Mr. J. L. Jack, F.G.S., in the Devonian of Queensland.

In all, this paper added six or seven new types to the flora of the Erian period. Several of them belong to generic forms not previously traced further back than the Carboniferous.

The author uses the term "Erian" for that great system of formations intervening in America between the Upper Silurian and the Lower Carboniferous, and which, in the present uncertainty as to formations of this age in Great Britain, should be regarded as the type of the formations of the period. It is the "Erie Division" of the original Survey of New York, and is spread around the shores of Lake Erie, and to a great distance to the southward.

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