Technical and Bibliographic Notes / Notes techniques et bibliographiques

The Institute has attempted to obtain the best original copy available for filming. Features of this copy which may be bibliographically unique, which may alter any of the images in the reproduction, or which may significantly change the usual method of filming, are checked below.

L'Institut a microfilmé le meilleur exemplaire qu'il lui a été possible de se procurer. Les détails de cet exemplaire qui sont peut-être uniques du point de vue bibliographique, qui peuvent modifier une image reproduite, ou qui peuvent exiger une modification dans la méthode normale de filmage sont indiqués ci-dessous.

- ☐ Coloured covers/ Couverture de couleur
- ☐ Covers damaged/ Couverture endommagée
- ☐ Covers restored and/or laminated/ Couverture restaurée et/ou pelliculée
- ☐ Cover title missing/ Le titre de couverture manque
- ☐ Coloured maps/ Cartes géographiques en couleur
- ☐ Coloured ink (i.e. other than blue or black)/ Encre de couleur (i.e. autre que bleue ou noire)
- ☐ Coloured plates and/or illustrations/ Planches et/ou illustrations en couleur
- ☑ Bound with other material/ Relié avec d'autres documents
- ☑ Tight binding may cause shadows or distortion along interior margin/ La reliure serrée peut causer de l'ombre ou de la distorsion le long de la marge intérieure
- ☐ Blank leaves added during restoration may appear within the text. Whenever possible, these have been omitted from filming/ Il se peut que certaines pages blanches ajoutées lors d'une restauration apparaissent dans le texte, mais, lorsque cela était possible, ces pages n'ont pas été filmées.

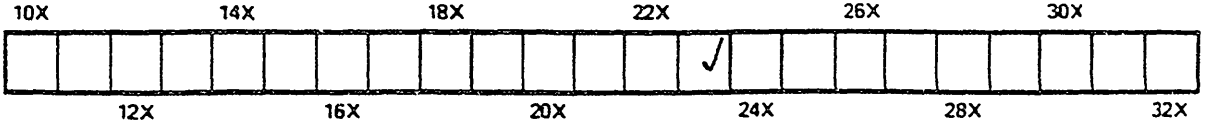
- ☐ Coloured pages/ Pages de couleur
- ☐ Pages damaged/ Pages endommagées
- ☐ Pages restored and/or laminated/ Pages restaurées et/ou pelliculées
- ☑ Pages discoloured, stained or foxed/ Pages décolorées, tachetées ou piquées
- ☐ Pages detached/ Pages détachées
- ☑ Showthrough/ Transparence
- ☐ Quality of print varies/ Qualité inégale de l'impression
- ☑ Continuous pagination/ Pagination continue
- ☐ Includes index(es)/ Comprend un (des) index

Title on header taken from:/ Le titre de l'en-tête provient:

- ☐ Title page of issue/ Page de titre de la livraison
- ☐ Caption of issue/ Titre de départ de la livraison
- ☐ Masthead/ Générique (périodiques) de la livraison

☐ Additional comments:/ Commentaires supplémentaires:

This item is filmed at the reduction ratio checked below/
Ce document est filmé au taux de réduction indiqué ci-dessous.



THE

CANADIAN NATURALIST

AND

Quarterly Journal of Science.

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

* 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 petrosilex 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 announced 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. 821; Hughes, Nov. 1879, p. 682; Maw, Aug. 1878, p. 764; also Hicks, rocks of Rossshire, 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 con-

cisely 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.

Professor in the Presbyterian College, Montreal.

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 Hit-

tite 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.	....	....	clydn.
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.	caomh	....	....
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, os.	....	esga.	....
lid.	....	....	lleuad.
mountain.....tal.	tula.	....	....
mouth.....ca, gu.	....	....	ceg
multitude.....caradin.	....	....	gwradd o ddynion.
dugu.	dese	....	....
khig.	....	....	haig.
nail.....obin.	....	....	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.....uknu, 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.....adudo, 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.....clu, *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.....cizid, *B.*	chediad, *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.*	con. *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.*	cin. *G.*
meddan, *B.*	modh, *G.*
coran, *G.*	cearn, *G.*, gur, *W.*
milk.....aho, *G.*, acho, *B.*, achi, *Si.*	as, *G.*, eco, *E.*
mother.....mamma, *B.*	mam, *W.*
mountain.....aya, "	ais, *G.*
iddra, *S.*, athraar, *B.*	torr, "
neck.....arguh, *B.*	arusg, *E.*
nets.....tararach, "	dorga, "

	Berber.	Celtic.
night	id, *B.*	oidche, *G.*
	ciar. *Sho.*	ciar, *E.* (dark.)
nose	chunfur, *S.*	comar, *E.*, ffri, *W.*
pitcher	ganigo, *G.*	cunnog, *W.*
priest	fayeayg, "	faigh. *E.*
property	ajda, *B.*	eiddo, *W.*
	agla, "	cail, *G.*
report	issawal, *B.*	adchwedl, *W.*
road	abreede, "	ffordd, *W.*
servant, slave.	issemg, *S.*	ciomach, *G.*
sheep	ikerri, *B.*	caora, "
	thikhsi, *B.*, tihaxan, *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.*, llwyddur, *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, Per-

uvian 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

---

* 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.	tesserés, *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.	quchebi, *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.	ciric, *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	hicani.	....	....	caine.
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.	ccap.	....	....
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.	base.	....	....
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.	....	....	haul.
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.	olgeth, *Welsh.*
day .....tokaf.	thafath, *Berber* (light).
dog .....enoo.	anu, *Aymora.*
drink .....horopsee.	srub, *Gaelic.*
earth .....toui.	tudd, *Welsh.*
sirikata.	urakko, *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.	pisco, "
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.	cquenayu, *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.	cchuja, *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.	eubihuro, *Sapibocono.*
serpent ..... tsir.	katari, *Aymara.*
servant ..... sun.	yana. "
sheep ..... dara.	taruco, *Quichua.*
sick ..... tura.	usuri, "

Accad.	Peruvian.
silver.....babbar.	lovir, *Atacamena.*
skin.....sir.	ceara, *Quichua.*
spirit.....alat.	llantu, "
star.....ul.	sillo, *Aymara.*
stone.....tak.	kak, " *Quichua.*
strike.....takh.	taka, *Quichua.*
sun.....utuci.	itoco, *Cayubaba.*
lakh.	villca, *Aymara.*
tail.....cun, izkun.	hinchinca, "
take.....tab.	hapi, *Quichua.*
tongue.....emi.	ine, *Cayubaba.*
tree.....iz. gu, gis.	khoka, *Aymara*, icheni, *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, thlou.
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.*; usussiy, *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.*	.....	shatzoh.
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.*	.....	hcene.
		umorria.	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.*	ezuea.	sheyzen.
moon	coyllor, *Q.*; halar, *At.* (star)	illarguia.	
mother	mamay, *Q.*	ama.	
mountain	monono, *Yuracares.*	munoa.	
	mocco, *A.*	.....	meyzeo.
mouth	khaipe, *At.*	auba.	
name	simi, *Q.*	icena.	
neck	.....	iduna.	eddee.
night	tuta, *G.*	.....	tshoytshee.
		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.	karo, *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	atasci, *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.	toygha.
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.	
	cubi, *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, $\frac{1}{2}$ to $\frac{3}{4}$ 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 ¾ to 1¼ 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 1½ 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 1½ 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 2¼ to 2¾ 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 $R_3 \dot{R}_2 Si_3 O_{12}$ 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 $\dot{R}$ 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		
Mg	013×2	26	1316	

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 Tête 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.

---

* *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	10½
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 (*Perussaccia*) *labricoides*, 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	.2966	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				.25088	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 semi-fluid 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.*

Published May 7th, 1880.